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Department for Levelling Up, Housing and Communities Final Report

Fire Safety: Construction Technologies, Design and Usage

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The project was commissioned by the Ministry of Housing, Communities and Local Government (MHCLG), which later became the Department for Levelling Up, Housing and Communities (DLUHC). Following the formation of the Building Safety Regulator (BSR) within the Health and Safety Executive (HSE), oversight of the research was transferred to the HSE. This report is published by the HSE; it contents, including any opinions and conclusions expressed, are those of the authors alone and do not necessarily reflect MHCLG or HSE policy.

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Executive Summary

The work reported in this report was carried out by a BRE Global Project team under a Contract placed by the Department for Levelling Up, Housing and Communities. Any views expressed are not necessarily those of the Department for Levelling Up, Housing and Communities.

This Final report is delivered as part of a Department for Levelling Up, Housing and Communities (DLUHC) (formerly the Ministry of Housing, Communities and Local Government (MHCLG)) project titled "Fire Safety: Construction Technologies, Design and Usage", DLUHC Contract reference CPD/004/121/082.

The aim of the project was to assess whether Approved Document B (AD B) provides up to date guidance for common buildings, sufficiently considering modern design, construction and usage practices to meet the minimum requirements under Part B of Schedule 1 of the Building Regulations 2010 (as amended).

This project was to provide DLUHC with sufficient information to consider whether AD B adequately addresses the risks presented by a modern design and construction for common buildings, and an understanding of where further research is needed to generate future policy options.

This project had the following specific objectives:

- To identify and review modern construction technologies and trends in design and building use (Objective A), and
- To review the current provisions in Approved Document B (AD B) considering the application of modern construction technologies and trends in design and building use (Objective B).

This work involved the active participation of a Project Technical Steering Group of industry experts.

The project had three overlapping phases:

1. Gathering data and information; analysing existing literature/information; consulting with various stakeholders; considering other Part B workstreams; devising and launching a survey and considering responses; presenting all of these strands of information to an interactive Technical Steering Group session, which resulted in 20 broad themes.
2. An initial sifting of the survey responses for the interactive Technical Steering Group session and detailed reviewing of the responses; creating two heat maps for AD B (Volumes 1 and 2) paragraphs causing most concern i.e. that AD B was not keeping pace with modern construction technologies, design and building use.
3. Holding workshops with Technical Steering Group participants to consider 14 of the themes, arising from the workshops, identifying potential considerations for future AD B revisions.

This report contains a compilation of the findings of the project and provides draft options / recommendations for potential future work to address the identified issues and the challenges to AD B.

In Objective A (section 3 of this report), BRE Global identified and reviewed modern construction technologies and trends in design and building use. This revealed an abundance of drivers and challenges. The diverse nature of challenges impacting AD B was further shown by 11 Examples. Each Example was described in terms of its driver, its evidence, the issues impacting AD B, the implications for AD B and finally the challenges to AD B arising. Three of the 11 Examples were deep dives into specific topic areas.

In section 6 of this report, BRE Global identified implications for AD B (Volumes 1 and 2) and future work / direction to inform future AD B editions for each of issues arising from a) the survey hot spots and b) the 14 themes identified during the workshop sessions. This mirrors the structure used in the 11 Examples.

The Survey hot spots gave rise to 17 issues affecting AD B Volume 1 and 15 issues affecting AD B Volume 2. Each issue was described in terms of its background information, its driver, its evidence (whether just respondent-driven i.e. derived from ‘practitioner viewpoint(s)’ or otherwise), the implications for AD B and challenges arising for AD B, with suggestions as to what AD B might address in the future.

BRE Global identified 22 considerations arising from the 14 themes, which were analysed using the same structure as that used for the Survey Issues and the 11 Examples.

It has not been possible to single out top matters for consideration. All sections in the report need to be considered in toto.

This work has proved to be a fruitful undertaking as it has shone a light on so many matters affecting / potentially affecting AD B. It is, however, only a snapshot at a point in time. A review such as this needs to be iterative. The intelligence derived from constant horizon scanning would provide the Department responsible for AD B with continuous evidence, to inform its decision making.

A danger of not making this an ongoing and iterative review can be very clearly demonstrated by looking at one of the Examples (Example 9) in this report.

AD B Edition(s) considered in this report

At the time of the survey, AD B (2019 edition – incorporating 2020 amendments) was the relevant edition of AD B. During the course of the project, AD B was revised to include 2022, 2025, 2026 and 2029 amendments. BRE Global has considered the content of these amendments in this report and associated circulars, Part B Frequently Asked Questions and other technical guidance.

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Report structure

This Final report has been prepared in two volumes, Volume 1 and Volume 2. These volumes are intended to be read in conjunction with each another and not independently.

Volume 1 (this volume) contains the main part of the report. Volume 2 contains the Appendices (A to H).

1 Introduction

This Final report is delivered as part of the Department for Levelling Up, Communities and Housing (DLUHC) (formerly the Ministry of Housing, Communities and Local Government (MHCLG)) project titled "Fire Safety: Construction Technologies, Design and Usage", DLUHC Contract reference CPD/004/121/082.

The aim of the project was to assess whether Approved Document B (AD B) provides up to date guidance for common buildings, sufficiently considering modern design, construction and usage practices to meet the minimum requirements under Part B of Schedule 1 of the Building Regulations 2010 (as amended).

This project was to provide DLUHC with sufficient information to consider whether AD B adequately addresses the risks presented by a modern design and construction for common buildings, and an understanding of where further research is needed to generate future policy options.

This project had the following specific objectives:

- To identify and review modern construction technologies and trends in design and building use (Objective A), and
- To review the current provisions in Approved Document B (AD B) considering the application of modern construction technologies and trends in design and building use (Objective B).

The scope of buildings covered by this project were those covered by the Building Regulations and more specifically AD B.

Uncommon buildings (e.g. fire safety engineered to BS 7974 *Application of fire safety engineering principles to the design of buildings – Code of practice* [1]) and building types such as airports and shopping centres were also outside the scope of AD B and this project (noting that all buildings are covered by the Building Regulations).

To meet the project objectives, the project was divided into tasks, as follows:

- Develop a project methodology,
- Establish a Technical Steering Group,
- Identify and review modern construction technologies and trends in design and building use (Objective A),

review the current provisions in AD B considering the application of modern construction technologies and trends in design and building use (Objective B), and

- Produce Final report.

This report contains a compilation of the findings of the Objective A review of modern construction technologies and trends in design and building use and the Objective B review of the current provisions in AD B considering the application of modern construction technologies and trends in design and building use. This report provides options/recommendations for potential future work to address the identified issues and the challenges to AD B.

AD B Edition(s) considered in this report

The project included a survey. At the time of the survey, AD B (2019 edition – incorporating 2020 amendments) was the relevant edition of AD B.

During the course of the project, AD B was revised to include 2022, 2025, 2026 and 2029 amendments. BRE Global has considered the content of these amendments in this report.

BRE Global has also considered the content of Departmental circulars in relation to amendments and Regulation changes, Part B Frequently Asked Questions and other technical guidance e.g. reports relating to fire safety by the Collaborative Reporting for Safer Structures UK (CROSS-UK) in this report, up to and including Autumn 2024.

2 Methodology for project

2.1 Overall approach

The project was carried out in three phases, see Figure 1:

A. Identifying the challenges to AD B.

B. Understanding the current provisions (or absence of) in relation to the challenges identified in A.

C. Outline the potential options to address the challenges and update AD B.

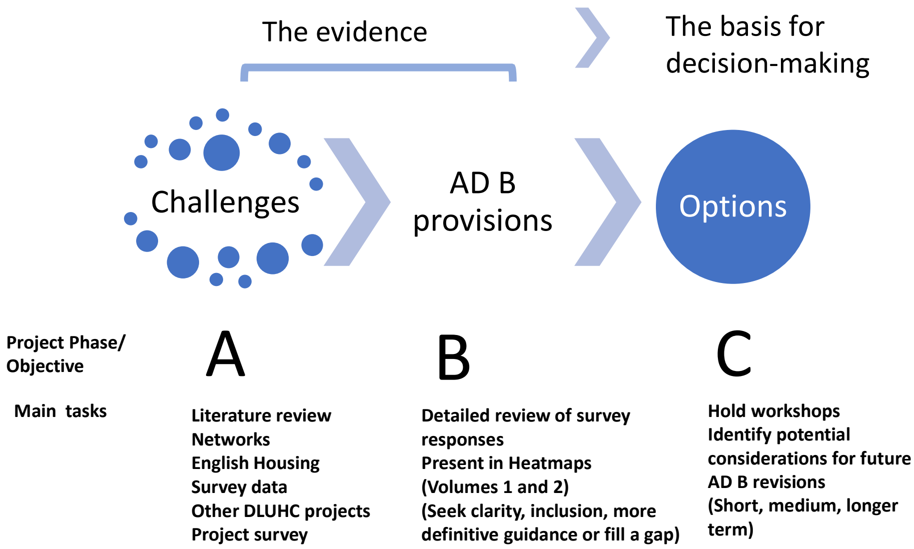

Figure 1 – Project infographic

The three overlapping phases involved:

A. Gathering data and information; analysing existing literature/information; consulting with various stakeholders; considering other Part B workstreams; devising and launching a survey and considering responses; presenting all of these strands of information to an interactive Technical Steering Group session which resulted in 20 broad themes.

B. An initial sifting of the survey responses for the interactive Technical Steering Group session and detailed reviewing of the responses; creating two heat maps for AD B (Volumes 1 and 2) paragraphs causing most concern i.e. that AD B was not keeping pace with modern construction technologies, design and building use.

C. Holding workshops with Technical Steering Group participants to consider 14 of the themes, arising from the workshops, identifying potential considerations for future AD B revisions.

This report uses examples to provide a broad evidence base covering the wide and diverse range of challenges identified in the project. The examples are used to support the commentary and discussions presented in the text. Examples rather than detailed case studies have been used to support this work as it became apparent during the project, that the detail emerging from the survey, the Technical Steering Group sessions, and wider sector conversations that BRE Global was party to, were sufficiently comprehensive, such that publicly available examples could be worked up to support the commentary and form an effective evidence base. Also, it was felt that using a limited number of bespoke case studies ran the risk of narrowing the focus on particular technologies, building design or building use, when the study needed look as broadly as possible to establish themes amongst all the challenges. The narrowing of the focus, by using case studies, would not have provided DLUHC with the breadth of evidence they requested for this project.

This report is therefore interspersed with 11 worked examples. These examples support and broaden the themes considered in section 3: *Identification and review of modern construction technologies and trends in design and building use*, the substance of the survey responses and the detail emerging from the Technical Steering Group workshop sessions.

Some examples are selected to show unintended consequences arising from new and unrelated Building Regulations, planning regulations or other initiative(s). One example highlights a referenced guidance document being no longer available and several examples are deep dives into specific topics introducing a breadth of background information feeding into a topic area, to show how complex and interwoven these subjects have become. Several examples culminate in challenges to AD B asking whether, in the mid-2020s, the guidance should be tweaked or consideration given to more structural change or deeper reconsideration of AD B's position. The detailed examples try to 'sow the seed' that makes the reader of this report ask why the guidance is as it is, and what is known about the risks associated with some of these issues.

As part of this data collecting process, it has become apparent to BRE Global that this type of ongoing horizon scanning based on field evidence could be considered as an effective iterative review mechanism for current guidance in AD B giving early warnings of upcoming challenges and emerging technologies designs and building use.

2.2 Methodology for Objective A – Identification and review of modern construction technologies and trends in design and building use

Modern construction technologies and trends in design and building use were identified and reviewed.

Information and input for Objective A was assembled by:

- Reviewing potential drivers for change in the way the UK (England) designs, constructs and uses buildings (within the scope of AD B), namely analysing existing literature, opinion pieces and reviewing future funding priorities of UK investment policies, considering changes in other legislation, condition/status reports, and press releases,
- Consulting and exchanging with networks, stakeholders, multi-disciplinary experts and the Technical Steering Group, as well as obtaining perspective from historical learning,
- Considering findings of initial reviews of other current DLUHC research strands and the previous MHCLG Call for evidence [2],
- Analysing survey feedback, and

- Bringing all of the challenges together, reviewing and adding insights from Technical Steering Group members and exploring high priority issues.

Note that the overlapping nature of this project can be seen in the way that it was necessary to consider the ‘essence’ of all the survey responses (which was, in effect, the major share of what was to become Objective B work) at the conclusion of the Objective A. The ‘essence’ of the survey responses was collated and fed into a Technical Steering Group interactive whiteboard session as sticky notes[1] (see section 3.6.3). The interactive session closed out Objective A with 20 emerging themes.

2.3 Methodology for Objective B – Review of AD B provisions

The provisions in Approved Document B Volumes 1 and 2, 2019 edition incorporating 2020 amendments (AD B), considering the application of modern construction technologies and trends in design and building use, were reviewed.[2]

The methodology for Objective B, the review of AD B on how current provisions cater for these modern approaches to constructing, designing and using buildings was, as follows:

- A survey was designed and launched to gather input from industry stakeholders. Respondents were asked to identify the paragraph(s) in AD B they found particularly problematic and given free-text opportunity to tell BRE Global what they wanted about a particular paragraph(s). Respondents were requested to respond in terms of their innovative/modern construction technology and/or modern building design and/or modern building use.
- 151 completed survey responses were received. BRE Global read each respondent’s comment(s), checking which paragraph(s) the respondent was claiming to be responding to. Where respondents did not reference a specific paragraph(s), BRE Global identified (as best it could) the relevant paragraph(s).
- To ensure uniformity of approach, BRE Global wrote up the comments in the same style. The style tried to capture whether the respondent: a) sought *clarity* on a point or b) sought *inclusion* in AD B regarding a point of guidance or c) generally *sought more definitive guidance* or d) sought to *fill a perceived gap in technical guidance*.
- From the survey comments, two heat maps (one each for Volumes 1 and 2) were generated.

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[1] The raw data word count of the survey responses was extremely high; accordingly, BRE Global needed to distil the thoughts of the survey respondents into either one or two words or a short statement on virtual sticky notes ready for Technical Steering Group members to review. BRE Global placed the notes on one of the three rectangular ‘pillars’ on the interactive board, representing either a construction technology, building design or building use. Notes of a similar theme were grouped, e.g. under the ‘Building design’ pillar there were groupings such as ‘Tall buildings/city living’ and ‘Changing use patterns’.

[2] Note that to make the report as current as possible, and at the time of writing, BRE Global had regard to the June 2022 amendments which came into effect on 1st December 2022.

- Due to resource constraints, BRE Global agreed with DLUHC that it would focus only on the hot spots and this point was conveyed to the Technical Steering Group.
- The threshold for inclusion as a hot spot was approximately 10 comments. BRE Global tried to capture the essence of what the respondents were saying in each hot spot. Where comments varied and where there was no single 'thrust', BRE Global identified either powerfully argued points or the new considerations perhaps not being captured by AD B in order to bring them to the Technical Steering Group participants' attention. BRE Global's sifting of comments was necessarily subjective.
- Detailed workshop sessions were held for Technical Steering Group member participants to consider the survey hot spots and the distillation of comments. There were 16 hot spots from Volume 1 and 15 from Volume 2. For each hot spot, there may have been three or four matters emerging. There was agreement on most points between the participants and the distilled comments from the survey hot spots. The Technical Steering Group participants added even more context to some points. These original or further contextualised points became tables of comments.

Note that another example of the overlapping nature of the objectives and Phase C work[3] concerns the close out of Objective B. BRE Global depended on the views of Technical Steering Group participants during two detailed workshops carried out under Phase C to help close out the Objective B review of the Part B survey hot spots.

The sources of information for Objective B were:

- Mainly the tailored survey responses, Technical Steering Group members input via Technical Steering Group meetings including an interactive virtual whiteboard session, detailed workshop sessions, BRE Global experience (such as Fire safety and Fire investigation), articles and technical journal papers and reports, detailed responses from survey respondents who provided their own opinions, research work, documents, information, drawings and detailing, and
- Technical conversations with the project leads on other 'parallel' Part B workstreams/projects (Specialised housing and care homes, Balconies, spandrel panels and glazing, Structural fire resistance and separating elements, Means of escape for disabled people, etc.)

2.4 Methodology for Phase C – Detailed workshops

The methodology for Phase C was as follows:

- Seven further detailed review workshop sessions were held with participants from the Technical Steering Group, covering the 14 themes emerging from the interactive white board session.
- Arising from the workshops, draft options/recommendations for potential future work for each of the 14 themes were identified and presented.

[3] The primary purpose of the Phase C detailed workshop sessions was to enable review of 14 of the original 20 broad themes (established during the interactive Technical Steering Group session).

- Section 6 of this report suggests future direction and work/research to inform future editions of AD B (themes and issues arising from both the survey and from the workshops).

3 Objective A − Identification and review of modern construction technologies and trends in design and building use

3.1 Introduction

This section focuses on Objective A, the potential (wide ranging) challenges to AD B. Some challenges are obvious (e.g. a guidance document being out of date), others may be pervasive and not so easily seen (e.g. a change in Town and Country Planning legislation). Some challenges need stripping back and looking at through a different prism to bring the issues they forewarn of into focus.

It will be seen that Objective A shows that there are an abundance of drivers and challenges. The 11 examples interspersed in the text, identified in the Objective A work, suggest that one of the key takeaways from this project is the need for a changing approach to maintaining the effectiveness of the AD to meet the challenges of the constantly changing construction market by use of a continuous horizon scanning approach which picks up of emerging challenges and warnings at an earlier stage. This approach would enable changes to the guidance to be addressed more effectively.

A second key takeaway is that if a technology, modern design or building use throws up a problem that cannot be solved by referencing AD B, there is a 'guidance vacuum' and the findings from this work suggest that industry will fill the vacuum with workaround solutions. The workaround(s) may be:

i) fine in every respect (backed by research and test evidence),

ii) like many solutions seen before or

iii) like many solutions seen before, but with the particular nuances of a particular technology, design or building use not fully implemented and/or not founded on specific relevant research and test evidence.

The danger with iii) in particular, is that once accepted it becomes the norm for the next 'guidance vacuum'.

The scope of the project, both in relation to the reach of AD B and the fact that it relates to the construction industry, one of the biggest sectors in the UK, was substantial. The built environment and the construction sector specifically affects the life of every person in Britain [3], employing more than 3 million people. It is central to the UK's drive to reach net zero greenhouse gas emissions by 2050, with buildings accounting for around 40% of the UK's energy consumption and 19% of the UK's greenhouse gas emissions. The sector produces about 120 million tonnes of waste per year, 60% of all UK waste. The drive for innovation and step change is a necessity societally and a focus of industry investment and action. Other societal drivers overlap and interact with the construction sector/built environment and its regulations; the most aligned and relevant in relation to this project, in BRE Global's assessment, have been reviewed (below). The built environment sectors, its stakeholders and industry (which are fundamental to the UK economy and its reach) can be argued to have a direct interface with practically every person in Britain.

Government intervention and decision-making in the built environment will always require AD B to be agile, keeping pace with developments and considering the needs of the future. Some challenges are not signposted, indeed gradual change in the way some parts of society functions can undermine cornerstones upon which AD B assumptions are predicated. An example of this can be showcased by the tangible and immediate impacts of the COVID-19 pandemic in recent years, which resulted in swift and demonstrable changes to people’s living and movement patterns (from March 2020 to the lifting of the last restrictions in spring 2022). The pandemic has altered the dynamics of cities and patterns of living and purchasing habits.

Example 1

Driver: The underlying driver in this example was (and remains) Government's intention to help support the hospitality sector get back on its feet following the COVID-19 pandemic.

Evidence: Arises from the Business and Planning Act 2020 Chapter 16 [4] (The Act). The Act made provisions for a fast-track authorisation process for obtaining a pavement licence, to facilitate alfresco drinking and dining.

Implication for AD B: This example highlights an unintended consequence of allied Legislation that has the potential to impact on AD B provisions.

The first material challenge to AD B relates to the principle (enshrined in the B1 functional requirement) that a final exit should lead to a place of safety outside the building, capable of being safely and effectively used at all material times, and whether there are some circumstances in some inner-city locations where the place outside may no longer be considered a 'place of safety'. The second potential challenge is on the assumption that where a building fronts a road (and the road is made-up to sustain vehicular loads) it is reasonable to assume Fire [and Rescue] Service vehicle appliances will be able to be used near the building [on fire].

Prior to The Act coming into effect, it was possible to apply for a street licence under part VIIA of the Highways Act 1980 Chapter 66 [5], but the process had a minimum consultation period of 28 days. The Act was intended to be a fast-track route with a seven-day public consultation period followed by a further seven-day determination period. The grant of a licence (or the failure to determine the application within the 14-day period) confers 'deemed approved' status under the Town and Country Planning Act 1990 Chapter 8 [6].

Deemed approved status, under the Town and Country Planning Act 1990, allows the applicant to place furniture on the highway (i.e. tables, chairs, stalls, barrier screens, heaters, counters and umbrellas). The first consideration for AD B is the effect that such street furniture may have on the viability of the Schedule 1 relevant requirement that requires appropriate means of escape to lead to:

> "*[…] a place of safety outside the building capable of being safely and effectively used at all material times*."

The definition of 'Final exit' in AD B (Appendix A: Key terms) is that it:

> "*[…] gives direct access to a street […] or open space, and is sited to ensure that people rapidly disperse away from the building so that they are no longer in danger from fire and/or smoke.*"

The second consideration relates to the effect that such street furniture may have on Fire and Rescue Service vehicular access. When the Fire and Rescue Service arrives at a fire scene, their 'set-up' may be delayed due to the presence of street furniture. The Intent behind Schedule 1 relevant requirement B5: *Access and facilities for the fire service* includes:

> "*External access enabling Fire [and Rescue Service] appliances to be used near the building [on fire]*".

It is reasonably foreseeable that the presence of alfresco drinkers and diners will slow response times at an incident ground. Firefighters need to unload equipment, access fire hydrant(s) and deploy hoses. These actions need to be undertaken immediately and they will be impacted by the public (some of whom may not be fully aware of the significance of the unfolding events due to distractions of environment, crowds and alcohol) and the presence of the street furniture[4].

Whilst researching this challenge to AD B, BRE Global noted several photographs, online [8], showing crowded streets in parts of inner-city areas which, when busy, may represent an impediment for the safe effective and rapid dispersal of people away from buildings. Restaurants (taking advantage of the now favourable view of pavement licences) in some parts of inner-city areas may be living 'cheek by jowl' with clubs, music venues and theatres. Some of these other venues may now be operating at pre COVID-19 levels of occupancy. When a club, music venue or theatre either undergoes a refurbishment or is newly formed, nothing in the current B1: *Means of escape* guidance nor the B5: *Access and facilities for the fire service* guidance, suggests caution where final exits open to streets which have pavement licences.

It could be assumed that, the more slowly people disperse away from a building, because of an obstructed street, the greater the likelihood of panic from those trying to exit the building. The part alcohol may play in such a circumstance should not be underestimated. It may be better that these applications are decided by a local authority service with experience of considering means of escape in event of fire e.g. a local authority entertainment licencing service or a building control service. Either would need to work closely with the local authority highways service (a named consultee under the regulations) and the Fire and Rescue Service (not a formal i.e. 'named' statutory consultee).

The consideration of means escape from other premises needs to be conducted rigorously and the current timescales and fee for such a licence does not appear to be reflective of the work involved.

Technical guidance would be required.

Terrorist threats and considerations like invacuation also warrant consideration as part of this activity.

During the time of writing this report, the scheme, favouring granting of pavement licences had been extended twice (from September 2022 to September 2023 by Statutory Instrument 2022 No. 862 [9] and from September 2023 to September 2024 by Statutory Instrument 2023 No. 900) [10]. The scheme, facilitated by The Act, having been extended to 2024, may become 'normalised'.

If the alfresco dining experience in the cities of Boston and New York (USA) are indicators of the potential for 'scale,' then consideration of rapid dispersal away from buildings and Fire and Rescue Service vehicular access (and efficient use of such vehicles) could become problematic in tight inner-city settings in England [11] [12].

[4]Reference [7] shows on average (over the last 12 years) 2,150 London Fire Brigade journeys were delayed due to traffic calming measures and 7,030 journeys due to weight of traffic (including roadworks). In 2021, (as lockdown eased, and it appeared to BRE Global that roads were not as busy as pre-pandemic levels) delays due to traffic calming and weight of traffic (including roadworks) rose above 12-year average by 40% and 5%, respectively. These figures are added to 'suggest' if roads and traffic return consistently to pre pandemic levels, it is reasonable to conclude delays will result.

Other COVID-19 legacies may need separate and detailed consideration. This would be an example where constant horizon scanning is required to gain an understanding of the issues (or potential issues) faced by the Fire and Rescue Services, particularly should the ‘relaxation’ become permanent (beyond September 2024). The Fire and Rescue Services are not currently a statutory consultee to the fast-track process under The Act.

Challenge to AD B arising from Example 1	
B1	Pavement licencing for alfresco drinking and dining may impact on the suitability of final exits (size and location) from other premises. The suitability of final exits is predicated on the space beyond the final exit being clear of obstruction so as to receive the flow of people evacuating a building. Screens, tables and chairs (etc) may prevent rapid and safe dispersal of large numbers of people away from a building.
B1 B3 and B5	Applications may be better placed being decided by either a local authority entertainment licencing service or a building control service, working in concert with the local authority highways service with the Fire and Rescue Service (and planning authority) both statutory consultees. Technical guidance would be required. Terrorist threats and considerations like invacuation warrant consideration.

Example 2

Driver: The underlying driver in this example arises from the Government's desire to increase housing supply.

Evidence: The evidence arises as a consequence of regulations (the Regulations) introduced in June 2020 [13][5] and an order (the Order) introduced in July 2020 [14][6] to amend Schedule 2 of the Town and Country Planning (General Permitted Development) (England) Order 2015. The Regulations introduced (in June 2020) new Class A developments, which permitted the construction of up to two additional storeys on existing detached blocks of flats (eligible buildings being between four and eight storeys tall).

Implication for AD B: It is not clear to the lay reader of AD B how to approach material changes of use e.g. ones triggering when an airspace extension is proposed (under Regulation 5(g)). Practitioners with a depth of knowledge of building control matters should know that when a Regulation 5(g) material change of use applies (this will trigger various considerations under Regulation 6). Moreover, they should know what applies when a 5(k) change of use occurs but findings from this study suggest a high degree of confusion exists.

The Order introduced (in July 2020) new Class AA developments, which permitted the construction of up to two additional storeys on existing detached commercial (shop, restaurant, café, financial and or professional use) buildings and mixed-use buildings (eligible buildings being between four and eight storeys tall). Note that these Regulations also paved the way for other permitted development classes AB, AC and AD. These extensions are sometimes referred to as 'airspace' extensions.

The material challenge to AD B is whether the guidance in the document is clear and well signposted when it comes to material alterations and material changes of use. The Government, on recognising that the Regulations (2020) or the Order (2020) may result in 'airspace' extensions becoming more frequent, issued building regulation clarification. The first piece of clarification came in the form of a circular letter (*The application of building regulations where additional storeys are provided to existing buildings* (10th August 2020)) [15] which was sent to Authorities Having Jurisdiction (AHJs) and Approved Inspectors. Two years later (23rd August 2022), the Part B webpage FAQs (question 20) *Upwards extensions*, addressed similar themes. The second material challenge is the AD B signposting of appropriate guidance for material alterations (including when conducting maintenance and repairs that trigger as a 'material' alterations) and how easy this is to find and follow. This second challenge, if resolved, would close out the Coroner's Rule 43 letter recommendations/observations following the Lakanal House fire of 3rd July 2009.

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[5] These Regulations amended Schedule 2 of the Town and Country Planning (General Permitted Development) (England) Order 2015, by introducing 'Part 20', creating Class A: New dwellinghouses on detached blocks of flats.

[6] These Regulations amend Schedule 2 of the Town and Country Planning (General Permitted development) (England) Order 2015, by introducing at Part 20 new Class AA: New dwelling houses on detached buildings in commercial and mixed use.

These relaxations to the Planning 'rules' brought about by the Regulations (2020) and the Order (2020), are additional to the changes introduced between 2013 and 2016. In May 2013, the General Permitted Development Order (GDPO) granted permitted development rights for changes of use from (vacant/disused) office buildings to residential use [16][7]. In April 2014, these permitted development rights (PDRs) were extended to changes of use from (vacant/disused) shops and financial/professional uses to residential use. In April 2016, Government announced that both changes (initially intended to be time limited to May 2016) were to become permanent PDRs.

These changes in permitted development are likely to result in some large and complex change of use projects and some large and complex 'airspace' extensions with the Building Regulations applying as follows:

a) Regulation 3 which considers the meaning of building work,

b) Regulation 3(1)(a) which describes an extension as being building work,

c) Regulation 4 which considers the requirements applicable to building work,

d) Regulation 4(1)(a) which makes clear that the extension should comply with applicable requirements contained in Schedule 1 and 4(1)(b) states:

   "*In complying with any such requirement there is no failure to comply with any other such requirement* […]",

e) Regulation 5 which describes the meaning of material change of use, and

f) Regulation 6 which describes the requirements relating to material change of use.

The extent to which an original building needs upgrade when carrying out an 'airspace' extension could be made clear and unambiguous in AD B guidance. Does the work to the original building derive from Regulation 4(1)(b) or the Regulation 5 triggers? Where a change of use occurs, there should be no debate, a building needs to be brought up to the standards defined in Regulation 6: *Requirements relating to material change of use.* The 'no worsening argument' should not apply.

Clarification, by way of an FAQ update (question 20), was placed on the DLUHC website [17] on 23rd August 2022. This clarification provided additional guidance to that contained in a circular letter, sent to all Authorities Having Jurisdiction (AHJs) and Approved Inspectors two years prior [15]. It is assumed that both pieces of additional guidance were issued in response to concerns the Department had that practitioners might be liable to misapply the guidance in AD B (e.g. that the guidance was not clear enough) or perhaps that the modern design and use arising from these PDRs could potentially result in

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[7] Note that the permitted development process requires an application (addressing 'limited scope' matters (i.e. flood risk and highways impacts) to be submitted to the local planning authority. Local Planning Authorities can 'block' this permitted development 'right', using Article 4 Directives. Additional 'rights' introduced via the Town and Country Planning (General Permitted Development etc) (England) (Amendment) Order 2021 (April) permit a Class MA Change of use from commercial, business and service use to a residential use with a 'limited scope' planning appraisal.

such schemes, and, that current provisions in AD B were not clear enough. Both the FAQ and the circular letter focus attention on the need to look at 'upgrade' works to existing buildings.

The Coroner's Rule 43 letter to the Secretary of State for Communities and Local Government of 28th March 2013, following the Lakanal House fire of 3rd July 2009 [18], made the following observations about AD B guidance:

> "…*AD B* [should] *provide*[s] *guidance which is of assistance to those involved in maintenance or refurbishment of older housing stock, and not only those engaged in design and construction of new buildings*'. [for refurbishment, one could add "including material change of use"]
>
> "…*AD B is a most difficult document to use…"*
>
> *"…it is necessary to refer to additional documents in order to find an answer to relatively straightforward questions…*"
>
> "…*that* [revisions of AD B should be] *expressed in words* […] *which are intelligible to the wide range of people and bodies engaged in construction* [including refurbishment of buildings] *and not just to professionals who may already have a depth of knowledge of building control matters*".

It could be seen that the FAQs and circular clarification letters are self-policing in that they hold a mirror to provisions that should be being applied and focus on the need to address and clarify matters in future editions of AD B. This suggests that the AD B, in its current format, does not provide clear enough guidance for those undertaking designs involving extensions, material alterations, and material changes of use. This tends to suggest that a wider review of AD B would be beneficial. AD B should give users of the document answers to simple (common) extension, material alterations and material change of use questions to make it clear that AD B is not just for new building work.

This example showcases the complexity of reviews such as these. It also highlights the importance of a wide-reaching and diverse approach (sometimes requiring a driver to be viewed through a different prism) in order to gather insights and understand where AD B appears to be slipping below the horizon of influence for 'current' design problems. It also serves as a reminder of what the Coroner, in the Rule 43 letter, following the Lakanal House fire of 3rd July 2009[Ibid] was observing about AD B guidance. If AD B is to be the logical place to "*…find answers to relatively straightforward questions…*" and if the guidance could be expanded to cover building work such as extensions, material alterations, changes of use, maintenance and refurbishment, this would increase AD B's relevance and use for all actors involved in the industry and bring closure to this aspect of the Rule 43 letter, see also Survey Issue 1j (below) on the subject of sprinklers and rooftop extensions.

Challenge to AD B arising from Example 2	
B1, B3, B4 and B5	The circular letter and 'Question 20' on the Government's Building Regulations guidance webpage: AD B: Fire safety-FAQs, is likely to achieve better 'reach' if the content (of both) could be included in a future revision of AD B. Actors want to know what is and is not acceptable and seek consistency of interpretation. Could AD B provide better certainty and therefore improve consistency of interpretation for extensions, material alterations, changes of use, maintenance and refurbishment? Actors undertaking building work would sooner have the *certainty of misery over the misery of uncertainty*[8]. Could such better guidance, include forms of construction which are *becoming* common? Would this be in an additional Volume of AD B or, as separate section(s) in the current Volumes. Broadly functional requirements and mandatory rules for some matters of fire safety could reasonably co-exist (as they did between 1985 and 1992). This might lead to certainty rather than uncertainty and consistency, nationally.

[8] This project identified that large construction projects invariably ran the risk of last-minute surprises since 'close out' of the fire strategy was likely to occur late in the build. Adapted from a quote attributed to author and psychotherapist Virginia Satir (1916 -1988) '*People prefer the certainty of misery to the misery of uncertainty'*.

3.1.1 Definition of 'challenge'

In this project, the 'challenge' to AD B focused on new construction technologies (including ways of building, materials and systems), modern designs and modern building uses. The two examples above showcase some of the breadth of the wider lateral challenges to AD B.

AD B covers 'common building situations' and also states that "*approved documents cannot cater for all circumstances, variations and innovations*" [19]. In the survey undertaken as part of the project, many respondents felt that an underlying problem with AD B when considering modern designs, in particular, related to whether AD B could be applied to their particular project or not. Examples such as the applicability of AD B for large timber or very tall buildings were queried. Many quoted the *Manual to the Building Regulations – a Code of Practice* [20] as giving conflicting advice and steer on the matter.

Therefore, the definition of 'challenge' as part of the project was purposefully kept flexible from the outset to encourage and canvas as wide an input as possible.

Type of challenges

The feedback on potential challenges to AD B was seen to originate from a number of sources, including:

- Those with experience of using AD B, with perceived typical, commonly used construction technologies, building designs and building uses,
- Those with an appreciation of the grey areas surrounding the scope and reach of AD B guidance, and
- A forward look to anticipated changes: five plus years into the future, considering implementation of key legislation (safety and others), changes in living patterns, demographic developments, and innovations.

The work took a multi-stranded approach to collating, as widely as possible, the potential both for challenges to AD B from specific issues (such as the popularity of single escape stairs in high-rise construction) to wider, societally driven drivers (such as the likely increased use of electric vehicles and impacts of charging infrastructure and generation of electricity and on-site storage of electricity in homes). The latter issues (electric vehicles and generation and on-site storage of electricity in homes) especially, in the estimation of the project stakeholders, are predicted to bring sustained and future challenge to regulatory and guidance provisions of AD B.

As the way we build constantly evolves, so do the challenges in providing relevant, proportionate and adequate guidance and regulations. The developments and pace of change are influenced by many factors: materials, construction techniques, maturity of technologies, societal factors regulatory changes (including building regulation and town planning) changes/updates and most significantly by the occupants, their requirements and needs, expectations and preferences. These preferences are unavoidably influenced by societal trends and market forces. Whilst regulations and guidance adapt through time, their evolution can have recurring themes and can be cyclical in nature. For example, Fire safety guidance and regulations have in the past been influenced by:

- Occupant preferences and tastes, such as open plan versus cellular layouts, materials and aesthetics (interior surfaces to façade choices), building use and functionality throughout the life of a building,

- Societal drivers, environmental considerations (e.g. reducing one's carbon footprint, using alternative energy, energy storage), addressing fuel poverty, accessibility, labour availability and skill levels, and
- Advances and development in product composition, manufacture and design, construction techniques (e.g. volumetric 3D system construction) and design methods and tools.

These issues resonate as current today. The following three examples are used to illustrate, in a little more detail, the diversity of only a small part of the challenge facing AD B.

Example 3 Deep dive – Electric vehicles and underground car parks

Driver: The underlying driver in this example is Government's requirement to decarbonise all sectors of the UK economy (net zero greenhouse gas emissions) including transportation by 2050 and end the sale of new petrol and diesel vehicles in UK by 2030, now revised to 2035 [21] [22].

Evidence: The evidence arises from recent fires in open sided i.e. well-ventilated car parks. These fires, involving not only EV vehicles appear to challenge some of the wider precepts of fire safety design in open sided car parks and in doing so it appears logical to consider the wider guidance around both open sided and covered car parks. The transition toward differing forms of propulsion, principally electric vehicles, in new Schedule I requirement, Part S: *Infrastructure for charging electric vehicles* (Part S) [23] and Regulation 44 (D to J inclusive, which came into effect from June 2022) [24] will lead to a change in fire load characteristics which are not currently addressed as part of the current AD B guidance.

Implication for AD B: The potential for unintended consequences of fires involving modern vehicles in covered car parks and whether the risks increase if a fire involves large numbers of electric vehicles or future alternative fuel sources, such as Liquid Petroleum Gas (LPG), compressed Natural Gas (CNG), Hydrogen or future materials will need to be considered.

Whilst Regulation 44 does not yet mandate the installation of the charge points in covered (underground) car parks (UCPs), it is foreseeable that they will be installed in UCPs, either on a voluntarily basis or by legislative intervention in the future. The future of EV parking is intended to be synonymous with EV charging.

The material challenge to AD B is whether enough is known of electric vehicles (EVs) and thermal runaway fire events, and what this means for Schedule 1 requirements B1 to B5. The second material challenge to AD B is whether in an underground car park EVs pose heightened risks and whether heightened risks occur where one or two (or tens, or hundreds of) EVs are parked in close proximity and how this mix of vehicles will develop over time.

The fire risk associated with lithium-ion batteries, particularly in e-scooters and e-bikes, is also a known issue, see Example 6 (below). However, available empirical evidence (cited in Ove Arup and Partners report T0194 – *Covered car parks – fire safety guidance for electric vehicles* (July 2023)) [25] is that non-charging (parked) EVs represent a lower fire risk than (parked) internal combustion engine vehicles (ICEVs). What the fire risk scales to, with many (parked) and charging (even fully charged) EVs, in an UCP, is unknown at this time. With data related to alternative fuel sources such as Hydrogen being undetermined at this time and may continue to grow in popularity[9].

The first mass-produced hybrid electric car, released globally in 2000 [26], paved the way for transition to fully electric vehicles, with the first mass-produced all-electric car being launched in USA in 2008. Plug-in charging may not endure, as the predominant method of charging, other technologies may emerge – battery swap technology is believed to have a global market of US$ 900 million by 2030 and induction (wireless charging and discharging) technologies are still being developed [27] [28]. The UK Government provided £30 million in funding for vehicle to grid (discharging) V2G technology research between 2018 and 2022. The Department for Business, Energy and Industrial Strategy (BEIS) launched an innovation programme in 2022 for Vehicle-to anything (V2X) bi-directional charging, with £12.6 million funding [29]. The discussion document that accompanied this launch[Ibid] makes just one reference to Building Regulations (Part L: *Conservation of fuel and power*) but no mention of fire safety research. It should be noted that other fuel cell propulsion technologies exist and may continue to grow in popularity.

Government statistics [30] show the UK moving away from ICEVs and turning to EVs, at increasing pace. In the six years 2015 to 2020, the cumulative total of new electric vehicles registered in the first quarter (Q1) in each of the six years was approximately 41,000. The number of electric vehicles registered in Q1 in 2023, alone, was 80,000. The data for Q1 in 2023 also show that the UK had 40.8 million registered vehicles – only 3% being plug-ins. Plug-ins encompasses battery electric as well as hybrid vehicles. It is reasonable to foresee that the percentage of EVs will increase year on year, and increasingly more EVs will be parked in underground car parks. If charge points are rolled out in UCPs (at some point), the unknown level of fire risk increases.

AD B Volume 2 (2022 edition) Paragraph 11.1 describes two principal cornerstones of the B3 (*internal fire spread (structure)* guidance for car parks:

a. *"The fire load [of a single car] is well defined."* and

b. "The probability of fire spreading from one storey to another in a well-ventilated car park is low".

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[9] Note that consideration of vehicles with different propulsion systems should form part of any wider review into fire risks in car parks. By way of just one example, vehicles with low temperature hydrogen fuel cells (FC vehicles) may pose an explosive risk under some circumstances. Assuming a fire begins to involve a hydrogen FC vehicle, potential exists for a hydrogen leak or hydrogen tank rupture. In the latter case, there may be the potential for a Boiling Liquid Expanding Vapour Event (BLEVE). Whilst not considered here, hydrogen FC vehicles would be included in any consideration of 'other fuel cell propulsion technologies' as need consideration along with compressed natural gas (CNG) or liquified petroleum gas (LPG). Gas FC vehicles may include coaches or lorries.

This guidance was first given 30 years ago in AD B (1992 edition) when it was also stated that:

> *"…There is some evidence that fire spread is not likely to occur between one vehicle and another, where the car park is well ventilated…".*

And points a. and b. therefore require review.

Research conducted by BRE Global between 2006 and 2010 for the Department for Communities and Local Government (*Fire spread in car parks BD 2552* [31]) considered reaction to fire properties of some component parts of vehicles, fire size and fire spread (in several different scenarios). The research considered mostly ICEVs which were 'typical-of-the-day' for the experimental work. One conclusion was that fire would spread to adjacent vehicles, even 'jumping' across an empty parking bay. Another conclusion was that in an enclosed (or UCP) there would be escalation of the fire event to as many cars as might be in the vicinity.

Significant fires at Kings Dock car park, Liverpool (2017) [32], the airport car park fire, Stavanger (2020) [33] and the airport car park fire, Luton (2023) [34][10] all challenge the notion that if a fire occurs in a well-ventilated car park, fire spread between floors is unlikely. On each occasion, fire did spread to lower floors, with 'flowing fires' being the principal mechanism of fire spread, as plastic fuel tanks melted[11]. On each occasion, fire spread between cars, even though the car parks were well-ventilated.

In addition, and with specific relevance to UCPs, fire research conducted by BRE Global in 2015 for the Department for Communities and Local Government (*Work stream 4 – Fire protection of basements and basement car parks 286858* [37]) concluded the following:

> *"[…] features intended to assist fire fighters cannot be used operationally due to uncertainties in their safe method of use"*
>
> *And*
>
> *"[…] development of […] solutions […] requires some further work and demonstration for performance in a range of different fire scenarios."*

The *Fire spread in car parks BD 2552* research should be reconsidered to include vehicles with modern propulsion systems. Modern vehicles tend to be larger and heavier than earlier models and they use innovative materials in their component parts, see also Survey Issue 1.j.2 (below) on this point. A research scenario worth considering would be the potential for fire spread where several EVs are present, and all are either at or close to full charge or all having reached full charge are discharging back to grid or

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[10] When considering underground car park fires, intense heat is a factor [35].

[11] Note that security camera video footage of the Luton fire showed a localised collapse [36]. At the time of writing, it was not clear if the footage was showing a collapse of just one floor (without preheating from below) or the result of a progressive and disproportionate collapse. The latter would signal the need to consider again the implications for old and new car parks (where it is reasonably foreseeable, they are serving more vehicles which are bigger and heavier) in order to avoid disproportionate collapse.

electrical energy storage system. This scenario would very much be a look to the future, i.e. beyond Part S 'enabled' to Part S 'fitted out'.

It should be noted that the 2.9 m headroom used in the test rig for the original 2006 to 2010 research seems quite generous by today's standards. Moreover, the thermal insulation standards, for thermal elements, are more onerous than they were at the time of the 2006 to 2010 research. The first stage in a two-step uplift to of Part L took place in 2021 (resulting a 31% improvement over 2013 standards for dwellings) and the consultation for the next uplift in 2025 was out for consultation at the time of writing.

One caveat in the Ove Arup and Partners report T0194, is that the datasets for EVs are somewhat embryonic, whereas the datasets for ICEVs are more mature. Another caveat is that more data needs to be gathered to show the difference in fire risk between EVs and ICEVs, of differing ages. Consideration should be given to undertaking a comparison of risk where EVs and plug-in (hybrids) are on charge in UCPs. As data sets become larger, it might also be possible to check if there is a heightened risk of fire with older EVs in coastal locations or with older EVs during winter months, co-incident with sea air and salt gritting of roads, respectively[12].

In UCPs, the production of fluoride gases (when a lithium-ion battery goes into thermal runaway) may need to be considered with respect to both B1 and B5, particularly in coach parks and/or where the parking bays are small. The material within a battery, or the battery casing itself, may be thrown some distance during explosive jet flaming events, potentially giving rise to secondary (or more) fires. The potential for fire growth in UCPs with a car stacker is readily apparent. Part of this work has identified that UCPs in city centre settings accommodate vans, lorries, even coaches, all of which require careful consideration for B1, B3 and B5.

Lithium-ion battery fires are difficult to extinguish potentially leading to extended duration fire events and the vehicles have the potential to re-ignite days even weeks following a fire [38]. The Ove Arup and Partners report states that to extinguish an EV fire requires 150% more water than that that required to

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[12] A Fire Safety Alert was issued by the Florida State's Chief Financial Officer on 7th October 2024 following Hurricane Helene (which occurred on the 26th and 27th September 2024) and prior to Hurricane Milton (which subsequently occurred on the 9th and 10th October 2024). The Alert stated: "In the aftermath of Hurricane Helene, we have seen nearly 50 fires caused by lithium-ion batteries with 11 of those fires being caused by EVs". "[Those] living on the coastline who own EVs are at risk of [...] saltwater storm surge which presents a dangerous fire threat to [...] homes". See *https://myfloridacfo.com/news/pressreleases/press-release-details/2024/10/07/fire-safety-alert-cfo---state-fire-marshal-jimmy-patronis-calls-on-ev-manufacturers-to-take-steps-to-protect-lives-for-milton?utm_source=sfmc&utm_medium=email&utm_campaign=RET_CON_ENG_RES_Milton+Electric+Vehicle+Safety+Alert_D000_V01_GEC0677&utm_id=278300&utm_batchid=6554&sfmc_id=290751443&soa=45466&utm_content=https%3A%2F%2Fmyfloridacfo.com%2Fnews%2Fpressreleases%2Fpress-release-details%2F2024%2F10%2F07%2Ffire-safety-alert-cfo---state-fire-marshal-jimmy-patronis-calls-on-ev-manufacturers-to-take-steps-to-protect-lives-for-milton#:~:text=%E2%80%94%20Today%2C%20Chief%20Financial%20Officer%20(,now%20a%20Category%205%20storm*
This alert echoes the concern identified by BRE Global that more knowledge is needed regarding regional factors and EVs. For example, in coastal areas, it is reasonably foreseeable that an EV may occasionally be submerged in sea water or, an EV may frequently be driven through several sea spray 'mist' events.

extinguish a fire in an ICEV, and this volume would rise where re-ignition occurs. The supply of water (correct volume and pressure) for firefighting in UCP would all seem to need consideration. A material consideration for all Approved Documents in the future, might be mitigation of environmental damage to water courses and water treatment works. Holding contaminated run-off e.g. bunds or holding tanks/drains and drain shut valves would all appear necessary considerations.

The Ove Arup and Partners report T0194 identified that an EV fire can (under certain circumstances) have two peaks of heat release, "*the first when the combustible materials ignite and the second when the battery becomes involved in the fire*" and a long decay phase. The report did not base its conclusions on evidence (potential or actual) of fires spreading to multiple vehicles. It is reasonably foreseeable that Fire and Rescue Services will (for firefighter safety) adopt defensive firefighting strategies (potentially letting the vehicle(s) burn itself/themselves out, rather than committing firefighters into UCPs). A long duration fire event would therefore become a material consideration for B3 for fire separating elements (e.g. non-loadbearing partition walls and doors) and elements of structure (including beams and columns), and in the latter case, an added complication is that modern vehicles, both EVs and ICEVs, are considerably heavier now than ever before. If defensive firefighting tactics becomes the norm in UCPs, a greater understanding of the response of both traditional and new materials to extended fire exposure conditions will be required.

By way of contrast, the following is the shipping industry's response to the fire risk associated with EVs, following a fire on a car carrier in 2023.

In July 2023, a car carrying vessel, transporting just under 3,800 vehicles (approximately 500 of which were EVs) caught fire off the Dutch coast in the North Sea. The fire resulted in one fatality and the remaining crew having to abandon ship. At the time of writing, investigations were continuing into the origin and cause of the fire. Approximately one month after the vessel was finally docked, and several weeks into the recovery process, an EV was craned from a side door of the vessel and lowered directly into a mobile bund, filled with water, to control a potential thermal runaway event, see video of this process [39].

Following this vessel fire, the International Union of Maritime Insurance (IUMI) produced best practice guidance (September 2023) [40].

The IUMI guidance is included in this review because some of the principles may, with suitable modification and consideration, be of some use in the built environment.

The preamble to the IUMI guidance states that:

> *"[…] There is only a minor difference between [the] total energy released during an [electric vehicle] EV fire and [a fire from an] internal combustion engine vehicle (ICEV)".*
>
> *"[…] Once established, vehicle fires are largely (approx. [sic] 80%) fuelled by the car body and interior parts rather than the propulsion system."*

The IUMI best practice and recommendations considers that:

> *"[for EVs] boundary cooling must be employed rapidly […]"*

Some of the best practice recommendations from the IUMI document included:

- early fire detection,

- use of thermal imaging cameras,
- artificial intelligence (AI) for monitoring fire detection systems,
- use of drencher systems for both roll on/roll off (just vehicles) and roll on roll off (passenger carrying vessels),
- carbon dioxide ‘flooding’ systems for vehicle carriers and truck carriers, and
- high expansion foam systems, to prevent heat transfer to adjacent vehicles.

At the heart of the *Automated Vehicles Bill* 2023 (for self-driving technologies) [41] is the intention to reduce the number of accidents (on our roads) caused by human error. Self-driving technologies would appear to represent another potential risk for basement car parks. Developers may sense an opportunity to maximise floor space, having vehicles parked sardine-like (and bi-directional V2X charging/discharging) with nominal space between vehicles. By using artificial intelligence (AI) in conjunction with the fire detection, it may be possible for the AI to instigate the self-driving away of adjacent vehicles, so that when the Fire and Rescue Service arrive, they are faced with a one (or two) vehicle fire.

The material challenges to AD B were discussed at more than one Phase C Technical Steering Group workshop in December 2021. Electric vehicles emerged as a concern in the Theme: *Tall buildings single stairs* under Issue 3: *Guidance on ventilation of basements* (below). Electric vehicles also appeared as a concern in Theme: *B5 review* (below) and it appeared as a concern in Survey Item 1J.2 *Sprinkler types, extent of coverage and car parks* (below). Examples 4 and 6 (below) consider lithium-ion batteries in buildings, particularly in residential purpose groups.

Challenge to AD B arising from Example 3	
B1, B3 and B5	The speed with which new Schedule 1 Part S: *Infrastructure for charging electric vehicles* has been introduced, has outpaced the speed of research and meaningful guidance available in AD B. Off-gassing prior to and during the very early stages of a thermal runaway event may be a material consideration for means of escape under some circumstances. An example of a reasonably foreseeable peak period in a car and/or coach park would be after a concert or sports event where bumper-to-bumper queueing to exit the car park is a common occurrence. Fires in car parks where vehicles have been charging for several hours may also have implications for B3: *Internal fire spread (structure)* and B5: *Access and facilities for the fire service.* There would appear to be a challenge to AD B if the Fire and Rescue Service adopts, as 'policy', defensive tactical modes of operating, when dealing with extended duration EV fire events in undercover and basement car parks. What are the implications for ventilation system(s)? The Fire and Rescue Service needs confidence in the robustness and fire resilience of structural elements **after** an extended duration fire event (i.e. during a recovery phase). When determining periods of fire resistance, consideration might be given to use of hydrocarbon fire curves (or other) during fire testing. E-coaches and or e-lorries present different challenges in terms of the fire load. Also, the location of the battery in e-coaches and e-lorries is likely to be on the roof or boot rather than at chassis level (typical for cars). This may also need to be captured in any review of B1: *Means of warning and escape* and B3: *Internal fire spread (structure)*. Automated self-driving technologies may present a future risk in basement car parks and AI technology may play a role in any solution. The Fire and Rescue Service need to be consulted on this technological development. Should AD B provide guidance on provisions to mitigate environmental damage, due to contaminated water run-off? What consideration should be given to other gas fuel cell vehicles?

Example 4

Driver: The underlying driver in this example is Government's requirement to decarbonise all sectors of the UK economy (net zero greenhouse gas emissions) by 2050, including new build construction.

Evidence: Arises from new Schedule I requirement, Part L: *Conservation of fuel and power* requirement L2: *On-site generation of electricity,* see for example AD L Volume 1 paragraphs 6.64 to 6.67. The provision of renewables e.g. photovoltaics, may become more common and widespread if this becomes a requirement under *the Future Homes Standard 2025 and the Future Building Standard* 2025 [42]. Consideration needs to be given to electrical energy storage systems becoming a co-requisite 'requirement' when implementing on-site electricity generation.

Implication for AD B: The potential for unintended consequences of fires involving on-site generation of electricity.

At the time of writing, the first of two stages of carbon dioxide (CO_2) emission reductions had already occurred. The second stage is due in 2025. This first stage came into effect on 15th June 2022, resulting in new dwellings producing 31% less CO_2 than dwellings built before 15th June 2022. The second stage is due to come into effect in 2025 (exact date to be determined) which will result in new dwellings producing between 75% and 80% less CO_2 than dwellings built before 15th June 2022. These reductions in CO_2 emissions for dwellings are all part of the Future Homes Standard, originally published in 2019 [43] and coming into full effect in 2025 (FHS 25). The equivalent standards for buildings other than dwellings are the Future Building Standards, originally published in 2021 and also coming into full effect in 2025 (FBS 25) [44].

A material challenge to AD B is whether enough is known of the potential fire safety risks associated with photovoltaic installations and solar batteries, the latter more commonly thought of as electrical energy storage systems (EESS). If a problem is identified in this sector it may prove particularly hard to monitor and control in retrofit installations where issues such as cavity protection may not be as well addressed due to age and building fabric condition. Additionally, retrofit work may also be carried out on a DIY basis. Therefore, there is a potential to miss controls being implemented because of the "*no-worsening...*" argument of Building Regulation – 4(3) (see Building Regulations 2010 (as amended)) unless captured by revised regulation or a Schedule 1 relevant requirement.

This issue may be mitigated to some extent by AD L Volume 1 at Paragraph 6.67 states that effective controls that go hand in hand with on-site electricity generation can include batteries but the matter should also be signposted in AD B.

Fire risks associated with power storage from intermittent renewables (e.g. solar and wind) in dwellings was considered in a Department for Business Energy and Industrial Strategy report *Domestic Battery Energy Storage Systems – A review of safety risks* [45]. This report referred to a collaborative report by BRE and the National Solar Centre, conducted between 2015 and 2017 *Fire and Solar PV Systems – Investigations and evidence* [46] which looked at 58 reports of fires associated with photovoltaic installations. The evidence, at the time of the study, was that there were approximately 900,000 domestic (and or other 'small') installations generating up to 4 kW. In 2023, that number had risen to 1.25 million installations [47]. The collaborative report looked at 27 incidents related to domestic PV installations and 26 incidents related to non-domestic PV installations. The evidence pointed to the DC isolators as being the most likely cause of a fire (in 40% of cases investigated). In 2016, the number of installations per month for domestic (and other 'small') installations generating up to 4 kW was on average 3,400 per month. In the first seven months of 2023, this had increased by 241% to 11,600 installations per month[Ibid]. An article in September 2023 in The Independent newspaper suggested that in 2019 there were 63 fires involving photovoltaic installations and in the first seven months of 2020 there were 66 fires [48].

The collaborative study (recorded over the three years 2015 to 2017) did not record any instances of fire in EESSs linked to the photovoltaics. It may be that the technology was so new that there were no or very few EESS installations at that time.

Should Government look to boost numbers of installations in pursuit of the net zero agenda, there is every possibility the number of installations will increase rapidly, particularly in the existing ageing stock.

Guidance on EESSs was first issued in January 2020, by the Microgeneration Certification Scheme *Battery standard (MIS 3012* [49]*)*. This guidance was revised on 20th November 2021 [50] and contains general advice regarding siting of batteries and components so as not to impede escape routes. Beyond this document, no further guidance on this matter was identified.

An EESS might typically be located in a storage cupboard or an under-stair space in a new dwelling, duplex flat (or old dwellinghouse). Such spaces are invariably framed using timber studs lined with plasterboard. The robustness and fire resilience of enclosures, to accommodate potentially explosive burning, would need to be researched. Unless substantiated by experimental work, it is not clear that separating a space containing an EESS from the escape route by just one partition and one door would provide sufficient separation and protection of the escape route. Consideration should be given to fire attack of floors from above, since an EESSs may sit on the floor, see also Example 6 (below) which describes some of the risks associated with e-bikes and scooters when they are located close to exit routes prevent escape.

Consideration of fire risk and PV systems are further explored in Example 9 *Deep dive – Roof testing and classification reports, roof terraces and Solar mounting standards* (below). Also considered in Example 9 is the Microgeneration Certification Scheme Service Company (MCS) technical standards document MCS-012 Issue 3: *The solar mounting standard* [51].

Challenge to AD B arising from Example 4	
B1, B3, B4 and B5	The speed with which new Schedule 1 relevant requirement L2: *On-site generation of electricity* has been introduced is outpacing the speed of research and meaningful guidance available in AD B regarding fire risks associated with Electrical Energy Storage Systems (EESSs). What is/are a suitable location(s) for EESSs and construction of enclosures? Are boarded ceilings vulnerable if the unit is placed close to a ceiling and are timber boarded and joisted floors vulnerable if the EESS sits on floorboards? Are ultra early fire detection and alarm systems available? Additional caution would be needed should the scope of L2 be extended to include dwellings undergoing refurbishment. Old dwellings with timber framed walls and joisted floors may be particularly vulnerable to jet flaming events and fire entering cavities. Protection of the escape route would be the first key priority. Guidance may need to consider 'prohibiting' placing EESSs in high vulnerability areas (e.g. entrance hall or landings or in cupboards opening to the entrance hall or landings.

Example 5 Deep dive – Volumetric construction, Fire testing of combustible construction, and monitoring the cooling period after standard testing

Driver(s): The first underlying driver in this example is Government's requirement to decarbonise all sectors of the UK economy (net zero greenhouse gas emissions) by 2050, including new build construction. This means encouragement of sustainable forms of construction (increasing the safe use of timber (TiC) [52]) and the use of multiple forms of off-site manufacture, more generally. The second underlying driver is Government's plan to increase the levels of new house building in England (see *Fixing our broken housing market*) [53]. The third underlying driver is Government's desire to remove barriers to acceptance of modern methods of construction (MMC).

Evidence: The evidence of the drive to zero carbon can be seen in the other examples (above and below) and the subject is high on the political agenda. The second and third drivers are evidenced by Government's desire to see off-site construction typologies play a far greater role in the supply of high quality housing, see the £72 million research award by Government to the Transforming Construction Alliance (May 2018) and the work of the Construction Innovation Hub [54]. See Survey Issues 1a and 1b (below) which consider the views of this industry sector (and its supporters in Government) who feel that the current guidance does not speak to innovative construction and ask if the time has come for separate guidance for MMC.

Implication for AD B: The first material challenge to AD B is whether it should recognise and give separate guidance for such volumetric 3D systems. The second material challenge to AD B is whether it should consider the principle of 'inherent' robustness and fire resilience for combustible construction products and end-use systems. Currently, a fire test report and subsequent classification may state a system achieved 90 minutes fire resistance for stability, integrity, and insulation but nothing of what happens 'post-test' during the cooling down period. Should the AD B consider extending guidance to make provisions that require the construction sector to know and understand the performance characteristics of the product and system in fire rather than relying solely on whether the product and the end-use system passed the test and achieved the classification.

There is a presumption that heavy massy construction (concrete, steel, and masonry) is inherently robust and fire resilient (especially in extended duration fire events) and the same cannot be said of modern combustible construction. Failure to grasp this opportunity to make provisions about the performance of construction during the 'post test' period will maintain the status quo.

Should AD B provide guidance for volumetric 3D systems if they are now 'common'?

AD B from the (2006 edition) through to the (2019 edition – incorporating 2022 amendments) has always included a statement that Approved Documents apply to "*common building situations*". The AD B (2019 edition – incorporating 2020 amendments), upon which the survey was based, stated that the AD B "*…cannot cater for all circumstances, variations and innovations*" [19]. The *Manual to the Building Regulations – a Code of Practice* (chapter 7) went even further to assert what AD B would most likely not apply to:

1. Very large or very tall buildings
2. Large timber buildings
3. Some buildings that incorporate modern methods of construction

The primary legislation, The Building Act 1984, describes the role of Approved Documents in Section 6 (approval of documents for Building Regulations purposes) as providing practical guidance with respect to the requirements of any provision of Building Regulations and Section 7 (compliance or non-compliance with approved documents). At no point in this primary 'enabling' legislation is there any emphasis on the limited applicability of Approved Documents to 'common building situations'. Should more guidance be provided for typologies which horizon scanning shows are becoming more common?

This example looks at an off-site construction typology, volumetric 3D primary structural systems (volumetric 3D systems) which is seen by Government as key in its plan to increase levels of housing supply. Government's *Modern Methods of Construction – Definition framework* [55], defines low-rise developments as those having accommodation over five storeys, mid-rise developments six to nine storeys, and high-rise developments as 10 or more storeys[Ibid]. Some of these volumetric 3D systems offer sufficient structural robustness and tie-action to allow complete buildings to be erected up to six storeys (although some suppliers of volumetric 3D systems claim their product can be used at up to 10 storeys) without the need for concrete or structural steel framed stair cores [56].

Background to fire resistance testing

Fire resistance testing, following the standard temperature/time heating regime, is acknowledged as being a proxy test (in lieu of large-scale elemental or large-scale system testing) and understood to be no guarantee of 'performance' in real buildings, in real fires (due to any number of complexities and variables that interrelate). Being 'typology agnostic', standard testing might be thought of as being a 'leveller', for the many different construction types that are available. This example suggests that Fire resistance classifications (in accordance with BS EN 13501-2: 2023 *Fire classification of construction products and building elements – Part 2: Classification using data from fire resistance and/or smoke control tests, excluding ventilation services* [57], using standard fire resistance testing to BS EN 1365-1: 2012 *Fire resistance tests for loadbearing elements Part 1: Walls* [58]), when used in isolation, without setting additional criterion, are actually counterproductive for 'innovative' constructions.

A paper by Law and Bisby [59] has the following to say on standard testing:

> *"[…] If both the structure and fire are not too unusual, uncommon, or innovative, then the lessons learned from the proxy test [i.e. the standard fire test using a standard temperature/time heating regime] may well suffice in practice."*

The Housing, Communities and Local Government Committee (the Committee) report on Modern methods of construction (MMC) (Fifteenth Report of Session 2017-19 (24th June 2019) [60] observed that there were several barriers preventing greater uptake of MMC. One barrier cited was the:

> "*Lack of long-term data or proof of resilience to […] fire.*"

Recommendation 17 of the Committee's report (24th June 2019)[Ibid] asked Government for 'additional guidance' in Approved Documents (ADs) focusing on modern methods of construction. The Government reply [61] (September 2019) gave a commitment to update the technical content of ADs to reflect the latest innovations in science and technology. For the present, however, the answer to question 18 on the Department for Levelling Up Housing and Communities AD B: Fire safety FAQ web page, describes volumetric 3D systems as not being a common building situation and therefore AD B guidance would not be appropriate. The answer to question 18 goes on to state that the fire resistance periods, and standard test methods, may not be sufficient to meet the functional requirements. See also The *Manual to the Building Regulations – a Code of Practice* which reinforces the point of disapplication of AD B for certain typologies.

<u>Adjustments made during testing for combustible construction</u>

A classification (of fire resistance) in accordance with BS EN 13501-2: 2023, using test data from BS EN 1365-1: 2012 is possible if a wall element, continues to carry the imposed test load and neither flame nor excess heat passes from the exposed surface (facing the furnace) to the unexposed surface, leading to loss of integrity or insulation. It is not uncommon for the exposed surface (facing the furnace) to be burning but neither flame penetration nor excess heat rise to be noted on the unexposed surface. *Thus, a burning wall can still be a fire resisting wall.*

During a standard fire resistance test on a wall built of combustible construction, it is likely that there will be burning visible on the exposed face (i.e. the surface facing into the fire test furnace) and/or within the wall cavity. Such burning adds 'self-heat' to the furnace. In order not to exceed the parameters of the temperature/time heating regime (also known as the standard heating curve), it is quite common to have to turn off (and on again) one or more pairs of gas burners (in the test furnace) at different points during the test. Also, it is quite common to have to adjust the furnace pressures, typically to compensate for flaring events in the furnace. Combustible construction typologies are thus (frequently) 'steered' through the test process to regulate furnace temperature and pressure – this is less likely to take place if the construction is non-combustible.

On revisiting the Committee's report on MMC on 24th June 2019 and the observation that one significant barrier to greater uptake of MMC is the:

> "*Lack of long-term data or proof of resilience to […] fire.*"

One can see an immediate problem with combustible construction, give the adjustments that need to be made during standard fire resistance testing. Resilience implies an ability to *recover or withstand an 'event'*. Combustible construction cannot *recover* if the 'self-heating' results in layer(s) of the fabric being consumed. It is hard to say combustible construction can *withstand* a fire event if, during the fire event, the wall itself becomes the fire event and continues to remain involved during the post test period. The same cannot be said of heavy massy non-combustible typologies, which experience shows tend to withstand fire events, even extended duration fire events.

Unconscious bias – Traditional construction vs Volumetric 3D systems

Massy non-combustible typologies have, in the main, proved themselves to be inherently robust and fire resilient, even when fires are of extended duration (see the Windsor Tower, Madrid 2005, (below)), some remain standing (with suitable propping) and go on to be repaired (see Broadgate (phase 8), London 1990 (below). Modern typologies, including volumetric 3D systems, which may have a satisfactory fire resistance classification are not being viewed as being of comparable resilience to the massy non-combustible typologies. The following example shows how a six-storey block of flats, requiring 60 minutes fire resistance would likely be considered by an AHJ.

If traditional construction were proposed: It is reasonably foreseeable that a block like this could be designed with a cast in-situ concrete core or a cross-braced and steel framed core. A cast in-situ concrete stair core (with walls in the region of 180 mm-thick) is a realistic proposition for a building of this height. Equally realistic would be a core constructed from structural steel 'H' and 'I' sections with cross-bracing. In the latter instance, a realistic proposition for the infill walls (between the steels) would be to use 215 mm-wide masonry (aerated concrete). Structurally, the cast in-situ concrete or the braced steel frame would satisfy the considerations to address wind load and racking. In terms of the fire resistance, the cast in-situ concrete walls or the infill masonry (aerated concrete) would exceed the 60 minute fire resistance requirement, by some margin. The BRE report *Guidelines for the construction of fire resisting structural elements (1988)* [62] Table 1, entry 3 and entry 10[13] shows that both wall constructions would likely achieve 240 minutes fire resistance, if tested.

If a volumetric 3D system were proposed: It is also reasonably foreseeable that a block like this could be designed using a combustible volumetric 3D system typology. This typology is widely used up to six storeys (some suppliers of volumetric 3D systems claim their product can be used at up to 10 storeys) without a concrete or structural steel framed core [63]. An AHJ is likely to ask for proof of the 60 minute fire classification, based on BS EN 13501-2: 2023 drawing data from BS EN 1365-1: 2012 for the walls.

The massy non-combustible constructions would be capable of achieving 240 minutes fire resistance, by default, and they would not contribute to fire growth during testing. Moreover, the performance of massy non-combustible construction in fires (including in extended duration fires) is well known. The combustible volumetric 3D system would likely be offered with studs and linings capable of achieving 60 minutes (or perhaps 90 minutes fire resistance if the designer wanted to 'go further' than AD B guidance). Without a fire test report, one would not know if a system contributed to fire growth during fire resistance testing and presently this is not a pass/fail consideration. The performance of combustible volumetric 3D systems in an extended duration fire event is, at best, not known and at worst likely to be consumed by the fire event. Some non-combustible volumetric 3D systems comprising light gauge steel may also become compromised during an extended duration fire event, should the light gauge steel studs become exposed to the fire for extended periods.

Whether a stair is enclosed in massy non-combustible construction or lightweight boarded construction would be of particular concern to the Fire and Rescue Service, particularly during complex and extended-

[13] At Table 1, it is also noted that at entry 7, 190 mm concrete or calcium silicate bricks will also achieve the four hours fire resistance.

duration fire events. This is a realistic concern for some of the office buildings that may undergo a change to residential use in our major cities.

Heavy massy construction – Extended fire event at the Windsor Tower, Madrid

A well-known extended fire event occurred at the 32-storey Windsor Tower, Madrid, on 12th February 2005. A fire broke out on the 21st floor and burned for approximately 26 hours [64] spreading to all upper floors and spreading down to the second floor. The Windsor Tower was an office building undergoing refurbishment, which had two thick concrete transfer slabs. One transfer slab at the 17th floor was identified as having played a significant role in preventing widespread disproportionate collapse during the fire event. The official report into the fire also highlighted the role of the concrete core in maintaining stability during the 26 hour fire. The report suggested there was a lack of knowledge regarding the behaviour of reinforced concrete during the cooling phase, following fire events, and suggested further research on this point.

Heavy massy construction – Extended fire event at Broadgate, London

Another widely reported fire event occurred at a 14-storey new build office development known as Broadgate – phase 8 (above Liverpool Street station) London, in 1990. The fire broke out on the first floor in a large 40 m by 12 m contractor's site hut. The hut and its contents burned for four and a half hours. Structural steel beams of the second floor and columns supporting the second floor had only been partly fire protected at the time of the fire. Principal and secondary steel beams deflected, as did the second floor concrete slab which survived the fire unfractured, but it had a centre span deflection between 1.15 m to 1.2 m. Subsequent research at BRE's Cardington fire test facility on an eight-storey office building showed similar results to the Broadgate findings, in that simply supported steel beams with composite floor slabs seemed to efficiently distribute loads during fire tests, without disproportionate structural collapses occurring.

AHJs and the industry will be alert to the possibility that volumetric 3D systems may either contribute to fire load, if fire gets to combustible elements of a wall or, suffer from excessive deflection if steel framing gets too hot (potentially leading to integrity failure) but not fully appreciate the implications.

Should AD B consider 'implicit' robustness and fire resilience?

It is therefore suggested that fire resistance classifications in accordance with BS EN 13501-2: 2023, using data from BS EN 1365-1: 2012, when used in isolation, may inadvertently be a barrier to entry to market for volumetric 3D systems.

Neither the fire test report nor the resulting classification tell the user of a fire test report anything about the resilience of a wall at the conclusion of a fire test. The details within the report solely address the performance of the product under test. For industry to begin to have more confidence in innovative construction and innovative systems, fire engineers and Authorities Having Jurisdiction (AHJs) need to have more insight into the degree of involvement the product and systems had during and post test such as: Did the test sample cool or continue to burn? Did the temperature in any cavity and on the unexposed face rise rather than cool? Did the wall collapse during the 'cooling' phase?

Neither the test report nor the resulting classification tell the end users about how a structure may continue to perform during the decay phase of a fire and thereafter. The Fire and Rescue Service's needs do not end when the fire is extinguished. The Fire and Rescue Service will continue to work in a building after a fire event, to establish cause and origin and facilitate other emergency responders' access to the fireground. These 'others' may include ambulance personnel (during any recovery phase) and Local Authority Building Control staff (and their emergency response contractor(s)) should such a response be needed under dangerous structures legislation. All these other tasks can take place over a protracted period.

At present the Schedule 1 requirement B5 (1) requires:

> *"…reasonable facilities to assist fire fighters in the protection of life."*

A consideration for Schedule 1 is whether to broaden the scope to a B5 to a B5 (3) requirement, that requires that a building be reasonably robust during and after a fire event. Research work by Wiesner et al (March 2022) *Structural fire engineering considerations for cross-laminated timber walls* [65], reveals that even after flaming is extinguished, structural failure may occur due to continued heating of the timber at depth by conduction.

Standard (proxy) fire resistance testing establishes a baseline value for stability (R) integrity (E) and insulation (I). These values enable a construction to be compared against other constructions. The baseline values are 30, 60, 90 or 120 minutes.

If a construction in its end-use system achieves 90 minutes (R:E:I) the extended monitoring will point to potential robustness and fire resilience.

Fire testing is no guarantee of actual performance in real fires, but the proxy test has thus far been successful in enabling one end-use system to be compared with another. The observations of the cooling period will not be a guarantee of outcomes of actual cooling after a real fire. The proxy cooling observations will enable one end-use system to be compared with another.

At the conclusion of a fire resistance test (with gas burners off and ventilation 'managed'), data could continue to be collated (as though the test was continuing – thermocouple readings, deflection readings and visual observations). These data and visual observations would provide indicative evidence of how construction might perform after a real fire event. Pass/fail criterion could be devised for the cooling phase. If desired, reference or 'control' forms of construction could be the baseline to compare each typology against.

For constructions comprising a single cavity, the period of cooling may be shorter than constructions formed with multiple layers and more than one cavity. Wall, floor or roof modules formed with multiple layers and more than one cavity need to be monitored for longer because of the potential for smouldering combustion deep within cavities. There have been many instances in England where Fire and Rescue Services have left a fireground, believing a fire to be 'out', only to have to return when the fire flared again – see NHBC Foundation report (2013, Section 2.2 regarding the 'cavity fire incident' that occurred following one of the BRE Global's fire experiments on a six-storey timber framed building, as part of the Timber Frame 2000 project) [66]. This incident highlighted that smouldering, glowing or intermittent flaming brands, if not completely 'out', have the potential to bring about flaming combustion of linings and framing members several hours after a fire is deemed to be 'out'. In the case of the Timber Frame 2000 research project, the re-ignition was noted at three and a half hours after the principal fire was believed to have been fully 'out'.

This extended period of monitoring could become a 'classification' that AD B may or may not refer to. It could apply to certain purpose groups, building heights (and distance to boundaries) and occupancy profiles. It would not be a substitute for a full-scale test (which might also be referenced in AD B in the future). A full system test may be to a standard such as the Loss Prevention Standard LPS 1501: Issue 1.1 *Fire test and performance requirements for innovative methods of building construction* [67], or other.

What does Government want?

The Housing, Communities and Local Government Committee, in its fifth report of session 2019-2021 *Pre-legislative scrutiny of the Building Safety Bill* [68] made the following recommendation at paragraph 201:

> *"We recommend that the Government make provision, either in the Bill or in secondary legislation, for a testing regime that treats products as parts of systems, perhaps by mandating the provision of a certificate confirming how the product performs when combined with other products."*

Paragraph 160 of the Government response to pre-legislative scrutiny by the Housing Communities and Local Government Select Committee (July 2021) [69] acknowledged the intent of the recommendation but rejected it on the extreme interpretation that the committee was recommending testing one product with every other product on the market and every other product which comes to market. The response said:

> *"The Government agrees that testing of multiple products and products as part of a system should be required."* But
>
> *"[…] it would be unreasonable and impractical for [manufacturers to have to] test their products in combination with every product on the market."*

The suggestion may have gained more traction if it said:

> *"[…] how the product performs when combined with other [appropriate] products [envisaged as being suitable end-use application]."*

The Secretary of State commissioned the report *Testing for a safer Future – An Independent Review of the Construction Products Testing Regime (April 2023)* [70] to look at:

> *"How […] the UK system for testing the safety of construction products and the use of data from the system be strengthened, to inspire confidence that those products are safe and perform as labelled and marketed when incorporated into construction work?"*

Part V of the report looked at options for reform:

> *"[We agree with] the Government response to the scrutiny report [on the matter of] the impossibility of testing every product in combination with every other product with which it might ever be associated […]"*
>
> *"[…] the Government response refers to the duty of building designers […] the obligation to meet the requirements of the Building Regulations […] the increased accountability, assurance and enforcement introduced by the new regulatory regime […] These propositions […] illustrate the problem: for the most part they relate to the development and checking of competent design, rather than how design proposals might be assured by the evidence of testing."*
>
> *"Given the critical importance of some elements […] and the stark demonstration of the consequences of failure […] it must be wrong to assume that there is no value in additional testing."*

> *"[…] where the performance of an assembly is adjudged to be safety-critical, and where judgement or feedback from incidents points to a particular vulnerability in its make-up, then there is an argument for requiring it to be tested as an assembly in accordance with suitable standards."*

> *"[…] safety will depend upon the competence of the designer [who] appl[ies] both the general principles of their profession or trade and the information garnered from testing, and understanding (and being fully informed about) the limitations of such tests."*

It is understandable that not every conceivable situation can be tested, and this is why reliable proxy tests such as fire resistance and most other physical characteristic tests e.g. the bomb calorimeter (used to determine gross heat of combustion of material) even though they do not replicate what will happen in the real world are still vitally important to the designer and fire engineer. The report states this of good reliable [proxy] evidence that it:

> *"[…] provides a basis for deciding whether that material is suitable for a particular use in a particular location […] That confidence comes from the fact that the test should produce consistent results, wherever and whenever conducted, and therefore a reliable basis for comparing the performance of different products that might appear suitable for that particular use."*

As discussed above, there appears to be merit in observing the cooling phase. Observations could be formalised as an additional (at first voluntary) classification off the back of fire resistance tests.

If the report clearly stated that a cooling classification could not be given because, during the cooling period, the sample continued to combust until it consumed itself, this type of information in conjunction with guidance in AD B could provide end users with a sound evidence basis for decision making.

Owners of modern methods of construction may take advantage of this additional information before deciding on whether to proceed with a full-scale system test, once such test protocol(s) can be agreed.

Challenge to AD B arising from Example 5	
B1, B3, and B5	Consider how AD B will know when volumetric 3D systems (and other ‘Modern Methods of Construction’(MMC)) have become ‘common’ and what to do in the interim. If AD B does provide guidance for volumetric 3D systems (and other (MMC)) would the guidance be extended to a few sentences and paragraphs in existing Volume 1 and Volume 2, or new section(s) and appendices, or a new AD B Volume 3 document? Interim evidence pointing to robustness and fire resilience could be gathered after wall and floor fire resistance tests (BS EN 1365-1: 2012 and BS EN 1365-2: 2014, respectively), i.e. during the cooling phase. Consideration to be given to cooling phase ‘thresholds’. Consideration could also be given to whether AD B should stipulate that such construction, when used for high risk buildings, achieve a ‘cooling classification’. A protocol for this would be needed. The cooling phase could also be observed and reported on for reaction to fire testing i.e. cooling following some but not all tests necessary to achieve classifications under BS EN 13501. Ultimately, consideration could be given in the AD B guidance to large-scale test(s) for the seven typologies described in the MMC Definition Framework. For 3D volumetric construction, consideration could be given to Loss Prevention Standard 1501: Issue 1. *Fire test and performance requirements for innovative methods of building construction.* Is this an acceptable test to be referenced in AD B? If it is not acceptable, how should it be modified or what other test(s) could be adopted? If thresholds are not exceeded and the constructions achieve ‘cooling classifications’ might this then be a green light to advance to a large-scale test where robustness and fire resilience can again be observed during and after the fire test?

3.2 Trends and challenges

3.2.1 Introduction

The Objective A work strand was completed in parts, in parallel with the Objective B and Phase C work strands to enable the collation of as many issues as possible.

Information and input for Objective A was assembled by:

1. Reviewing potential drivers for change in the way the UK (England) designs, constructs and uses buildings (within the scope of AD B), namely analysing existing literature, opinion pieces, considering future funding priorities of UK investment policies and horizon scanning of other emerging legislation and studying condition/status reports, and press releases.

2. Consulting and exchanging with networks, stakeholders, multi-disciplinary experts and the Technical Steering Group as well as obtaining perspective from historical learning.

3. Considering findings of initial reviews of other current DLUHC research projects and the previous MHCLG Call for evidence.

4. Analysing survey feedback.

5. Bringing all challenges together, reviewing and adding insights from Technical Steering Group members and exploring high priority issues.

3.2.2 Overview of findings

It is clear that feedback and evidence provided was broadly subdivided into three categories:

1. Current, known issues with provisions as they stand. These findings tended to be detailed or very detailed focusing on the provisions as they are now and perceived gaps. As such, the feedback was very specific, arguably narrow in scope and not future-focused, in the main.

2. Issues influenced by societal changes which are already evident in build/use practices of today. For these issues, drivers identified would point to increasing volume and challenge to AD B over time and therefore, a clear potential for greater impact on inadequate provisions.

3. Issues which are considered hypothetical at this stage but through assessment of societal changes and drivers, assessed as increasingly likely over time. These issues were discussed with the Technical Steering Group.

For the last two categories, additional evidence was included which related to ‘historical learning’ where previously similar drivers led to near identical innovations in the built environment, prefabrication to reduce assembly on site (LPS (Large Panel System) and RAAC (Reinforced Aerated Autoclaved Concrete) buildings) and bringing particular learning to the assessment, here specifically the vulnerability to poor detailing and poor site supervision and the importance of jointing to avoid disproportionate damage. These issues were also discussed with the Technical Steering Group.

These were combined and together with the Technical Steering Group members, discussed, organised and added to during an online interactive meeting session.

3.3 Drivers for challenges

3.3.1 Introduction

BRE Global and the Technical Steering Group looked to establish the driving forces behind potential challenges to AD B, by reviewing societal changes and trends affecting the built environment (initially irrespective of scope of AD B coverage). The assembled overview of possible future drivers for the construction industry (below), was not intended to provide a comprehensive, in-depth, review of opinion and publications in this field at this time, but rather to guide on the constantly evolving picture to showcase further the scale and diversity of this project and distil some key points to reflect back to stakeholders, including the Technical Steering Group meetings. The Examples in this section are selected to be thought provoking to reinforce the scale of diversity of this research project.

The societal and associated trends described in literature tended to be solution-focused, rather than driver-focused. BRE Global and the Technical Steering Group sought to identify the drivers and leave case by case solutions to later consideration. The issues (below) were guided by industry publications, Government papers and observation of trends in construction as advised by BRE Project Partners and through exchange during DLUHC and industry networking interactions. The drivers and topics highlighted in this section are to canvas wider societal challenges that are likely to impact the built environment.

These were guided and informed by the following:

- Government funding priorities and policy,[14]
- Trends in housing and living,
- Modern buildings (incorporating materials, products, components and assessments) design and uses, and
- Historical perspective (learning from the past), see also Example 5 (above).

In addition, a number of drivers have been, and remain, prevalent in the industry over the past years. These have been an engine for innovation and adaptation of material, system and design solutions developed and available in the industry today. Further developments are certain in these areas as innovations will continue to evolve as these global challenges remain, including:

- Changing skills and labour market resources,
- Building methods and the use of cost cutting technologies which seek to address the shortage of and reliance on skilled labour,

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[14] See Government's intent to embrace new construction technologies, in the Cabinet Office sponsored publication [71] *The Construction Playbook Government Guidance on sourcing and contracting public works projects and programmes* (version 1.1 September 2022). It states on two occasions that it '…[builds] *on the presumption in favour of offsite construction* [to create] […] *a dynamic market for innovative technologies*…'

- Sustainability, net zero greenhouse gas emissions, thermal performance optimisation and the drive to more sustainable materials and buildings,
- Health, wellbeing and safety of occupants and an ageing population,
- Changes in procurement[15] and commissioning,
- Digital asset management: potentially leading to extended service life of existing assets, and their timely repair and refurbishment,
- Shortage of homes and increasing inequalities (see [72] for statistics),
- Increased use of electrical vehicles, and
- New Town Planning Regulations as well as citywide guidance (e.g. the London Plan) and new Schedule 1 Building Regulation requirements e.g. conservation of fuel and power, overheating in residential buildings and infrastructure for charging electric vehicles and other legislation.

Other drivers, as shown (below), are more recent and less established but have clearly had a marked and immediate effect on the way buildings are constructed and used:

- The COVID-19 pandemic. In addition to Example 1 (above), where the challenge to AD B was brought about by Government reaction to COVID-19 (see section 3.1 (above)) the pandemic has shifted the use patterns of buildings and their functions, with emptying high streets and difficult trading conditions [73] [74][16], as well as unused offices. Only time will tell if buildings (particularly offices) are no longer viable in their current use and require re-purposing. Equally, buildings that are the subject of a formal planning application are reconsidered and their conceptual design revisited so as to allow for speedy adaptation and conversion in the future. This has driven an appetite for more flexible building uses and a shift from predetermined end-use expectations, e.g. [75]. Flexible and adaptable buildings here mean those which can be repurposed more easily, at pace. By way of example, such repurposing might be said to be more readily facilitated where elements (such as the façade) are constructed on a modular grid and internal spaces are formed using pods.

[15] Determining design liability in traditional design and build schemes can be complex, particularly projects that are reliant on sub-contract tasks, and where terms and conditions are not explicit. Clients now have an opportunity to engage with the ‘owner’ of a construction technology, to undertake design, building (in a factory) and assembly on site, thus clarifying lines of accountability and liability.

[16] The Centre for Retail Research shows a rise in online sales. In 2006, 6.6% of all retail sales were online sales, rising in 2013 to 12.7% and 2021 to 26.5%. The research also shows that some retailers are now disposing of stores to slim their property portfolios. The total sales from stores in Oxford Street, London, fell from the usual £10 billion per year to £2 billion in 2020 (Clearly this latter statistic does not analyse wider economic or London-centric pressures, nor does it consider the lasting effect of purse-tightening due to the pandemic). However, taken with the growth of online sales, perhaps it serves as a portent of change.

- BREXIT. The impact of the UK exiting the European Union Single Market on access to materials, and access to labour and, over time, potential applicability of product performance information and validation processes should National standards begin to depart from European Normalised standards.

3.3.2 Life safety vs Property protection

Is it acceptable in the mid-2020s that building occupancy types that would have suffered significant fire damage (e.g. to one or two compartments) but were 'recoverable structures', are increasingly suffering total or near total building loss? This point is covered in Survey Issue 1b (below) and considers the fires at, Premier Inn, Bristol, July 2019 [76], Beechmere, Crewe, August 2019 [77], Richmond House, Sutton, September 2019 [78], Pankhurst Avenue, Brighton, September 2019 [79] and The Cube, Bolton, November 2019 [80], all of which involved significant elements of combustible construction. Following four of these fire events (Premier Inn, Beechmere, Richmond House and Pankhurst Avenue) the remains of each building had to be demolished.

See also the fire at Petworth Court, Wembley (January 2024) [81] which began on a balcony or the space adjacent to it, and, to all intents, gave the impression of being a one or two compartment fire. The fire became an extended duration fire event. It spread to the roof via a studwork parapet (resulting in localised collapses, and then down to various parts of the fourth floor), the external timber framed walls and parapets (with evidence of dropping fires in various locations and loss of 'strips' of the external wall) and several balconies.

In all of the above cases, the ambition of the Building Regulations, to prevent loss of life was achieved, but clearly combustible forms of construction now come at an increased personal, societal, community environmental and carbon cost. These considerations are not recognised in the Schedule 1 functional requirements B3: *Internal fire spread (structure)* and B4 *External fire spread*. Moreover, these fires are increasingly placing a burden on Fire and Rescue Service resource. At the height of the Richmond House and Petworth Court fires, 125 firefighters and approximately 20 pump appliances were deployed. The scale of Fire and Rescue Service resource needed at extended duration fire events also appears ready for review.

In the case of heavy massy construction, the loss of the contents of one or two compartments has hitherto been considered 'the price one may have to pay', and this was societally, politically and environmentally 'acceptable' – clearly for the affected people such a fire event represents a personal tragedy, but the building occupants clean up and move on, together. The community remains intact. By way of contrast, in the case of some innovative and essentially combustible construction (also discussed in Example 5 (above), the loss (or near loss) of entire buildings would appear, in the mid-2020s, be too high a price to pay and this may no longer be societally, politically and environmentally acceptable. Where previously families of the directly affected flats and those on the floor above (smoke damage) and those on the floor below (water damage) were displaced after a fire, the scale of damage means entire populations of building become displaced after such fires. The community becomes displaced.

3.3.3 Construction skills

The Farmer Review of the UK Construction Labour Model: Modernise or Die (Time to decide the industry's future) (2016) [82], drew attention to the measures necessary to tackle the lack of skilled tradespeople available to the construction sector. Among the conclusions, the report made clear that new ways of working were required and that skills still need to be nurtured. The review favoured off-site construction as a way to accommodate skills shortage and to ensure accuracy, consistency, and quality.

This concept of off-site manufacture and on-site assembly/placement is not new. An Historic England Blog [83] reveals that in the UK, after the Second World War, 156,000 prefabricated buildings were built and the intention of the 'prefab' was that it was to be considered as a stop-gap measure:

> *"…an interim [post war] solution until the country could return to constructing permanent homes with traditional building materials. They were intended to last no more than a decade."*

The off-site construction model that we see in the mid-2020s is revolutionised, and buildings built using this typology are intended to have a design life of circa 60 to 80 years. Traditional bricks and mortar construction is known to have a useful life well in excess of 100 years, with cities like London and Bath having many Georgian properties, and very many other English cities and towns having Victorian and Edwardian properties. The tower block 'new urban vision' was predominantly a post-1950s typology, accordingly, it is now nearly 75 years old.

The Farmer review (2016) was conducted at a time when the housing industry was capable of building circa 140,000 homes per year. The Government's housing target in the mid-2020s is for 300,000 homes per year. It appears that there are not enough medium and large sized firms anymore with skilled workers who have 'time served' experience in this field to get close to the target of 300,000 units. The construction sector began to fragment from the 1980s. Many large contractors, who had their own workforce, slimmed down in the 1980s and 1990s to become specialised management contracting entities. Design and build management contractors now use sub-contractors who, in-turn, may be tempted to further sub-contract out work packages.

Skilled staff clearly exist in off-site factories, but the question is whether there is the requisite skill on-site to install and construct the growth in off-site manufacturing increasing complexity of on-site system builds. Moreover, are there the skilled knowledgeable firms in the market that can adapt these structures in the future? In years to come, there may be fewer 'general' contractors, and more specialist system build contractors. Specialised off-site manufacturers, may in time take ownership on site.

Might an unintended consequence of the post Grenfell construction market be less testing with other manufacturer's products to prove compatibility and a more closely guarded 'own systems' mentality. Such specialised system builds may then need building control specialists to control the installation and adaption of the systems.

The drive for increased upskilling and competency management across the construction sector in the post Grenfell era provides opportunities for development and recognition of the skill sets required at all levels in the sector to deliver the required levels of building performance but in the period whilst the development and delivery of these schemes is taking place the shortfall in skills and associated consequences needs to be recognised.

3.3.4 Government funding priorities and policy

A review of Government funding priorities [84], specifically the industry strategy challenge fund, confirm the societal challenges prioritised by UK Government under a few key areas (see Figure 2) relevant to the remit of this study:

- Clean growth, for the built environment specifically covering innovations in low carbon technologies systems and services, reducing the carbon footprint of heavy and energy intensive industries (including construction), smart manufacturing, energy systems, transforming construction to shift towards a manufactured-based approach, digital technologies and value-based outcomes.

- Ageing society, specifically relevant for the built environment developing products and services that help people remain independent and active into older age.
- The future of mobility, specifically relevant here with regard to investment in electrification technologies, including electric vehicles, bikes and scooters and advanced robotics in manufacturing (link to 'smart' manufacturing above).

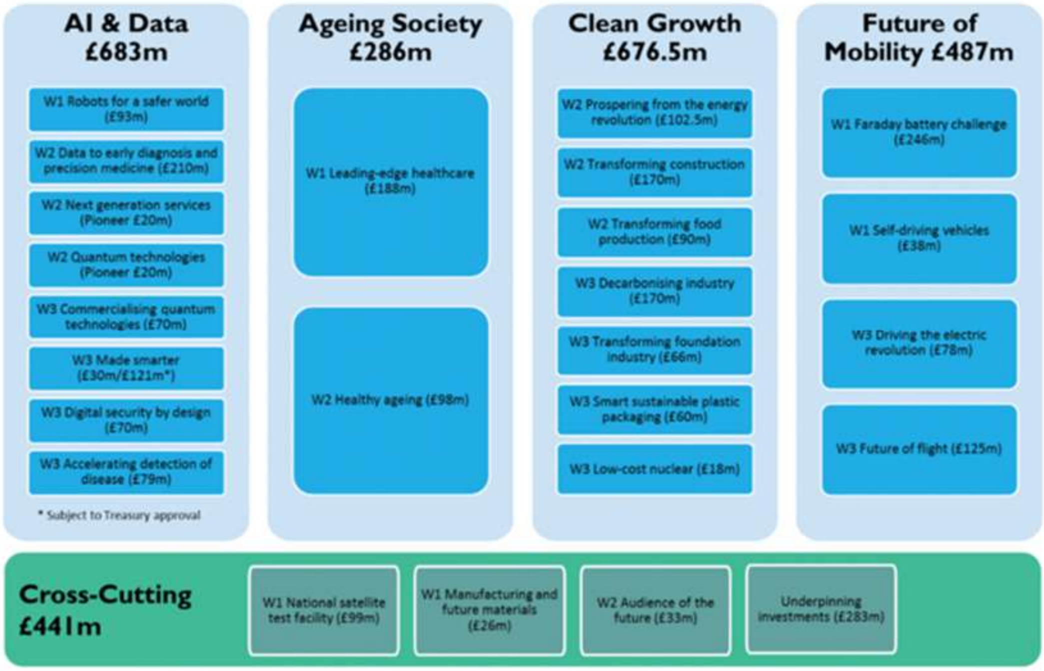


Figure 2 – Government funding priorities for societal challenges – source [84]

3.3.5 Trends in housing and living

Housing is one of the UK's biggest challenges, and, in turn, a key focus for AD B. To keep housing affordable, over 300,000 new homes are estimated to be required every year [85]. The need to provide decent modern homes at affordable prices is a key driver for the UK built environment.

The need to build quality, reliable homes, at speed, is also one of the main drivers for alternative forms (including modern methods) of construction. The intensification of effort [86] to meet the Government's stated target of achieving net zero greenhouse gas emissions by 2050 ripples down through the construction and building materials sectors the UK (see section 3.1.1 and Example 4 (above): and the introduction of a new Schedule 1 relevant requirement L2: *On-site generation of electricity*, and Example 5 (above) which considers the use of modern methods of construction (focusing on volumetric 3D systems) to boost housebuilding.

According to a BRE Briefing paper (2121) *The cost of poor housing in England* is costing the NHS (National Health Service) about £1.4 billion a year and remains a focus for successive Governments due to its marked impact [87]. The report states that the UK has the oldest housing stock in Europe and most likely in the world. The report shows that in 2017, there were about 28.5 million homes in the UK, with the vast majority of these being in England, see Figure 3 and that housing remains one the biggest challenges for Government with overall housing shortage and inequalities in living conditions throughout the UK but especially in cities.

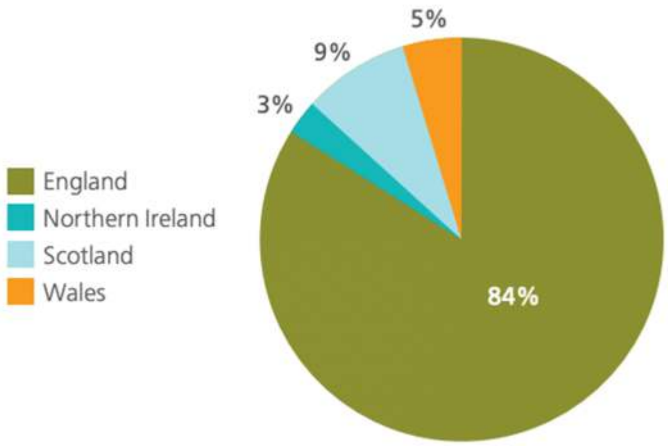


Figure 3 – Distribution of housing stock in the UK, 2017 (from Figure 2.1 in [87])

The English Housing Survey [88] enables a better understanding of the existing building challenge, focusing on residential buildings, the single largest building use in the UK building stock. It has been reviewed in this context to complement and provide additional guide on trends, specifically in relation to:

- Type of ownership in residential occupation
- Occupation density
- Duration of occupation

The stock profile (Section 2.4 of headline report) for 2021 to 2022, shows an estimated 23.7 million households in England living in self-contained accommodation. Of the estimated 23.7 million households in England, 15.5 million or 65% were owner-occupiers; the private rented sector accounted for 4.3 million (18% of households in England). Renting is more prevalent in London and 16% of households lived in the social rented sector in 2021 to 2022.

The trend in type of tenure (owner, buyers, private and social renters) in London and outside London is shown in Figure 4. This shows that there is a mix of tenure models in London and a higher percentage of ownership tenures outside London.

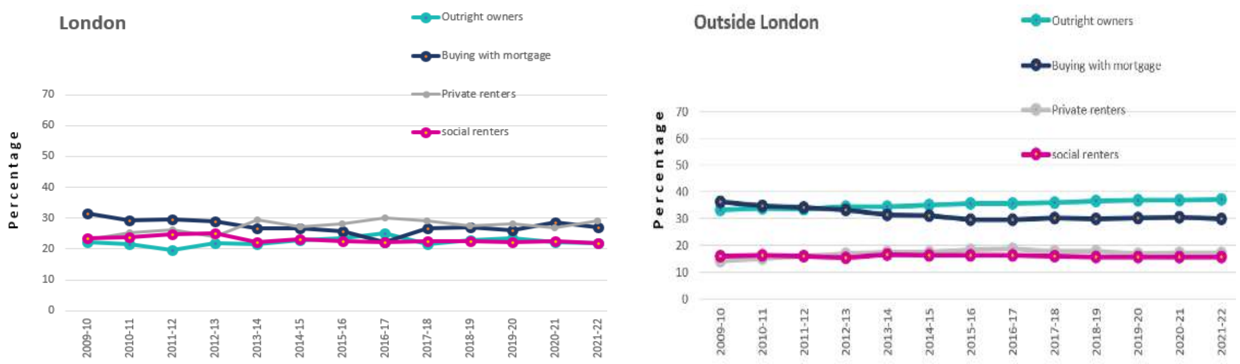
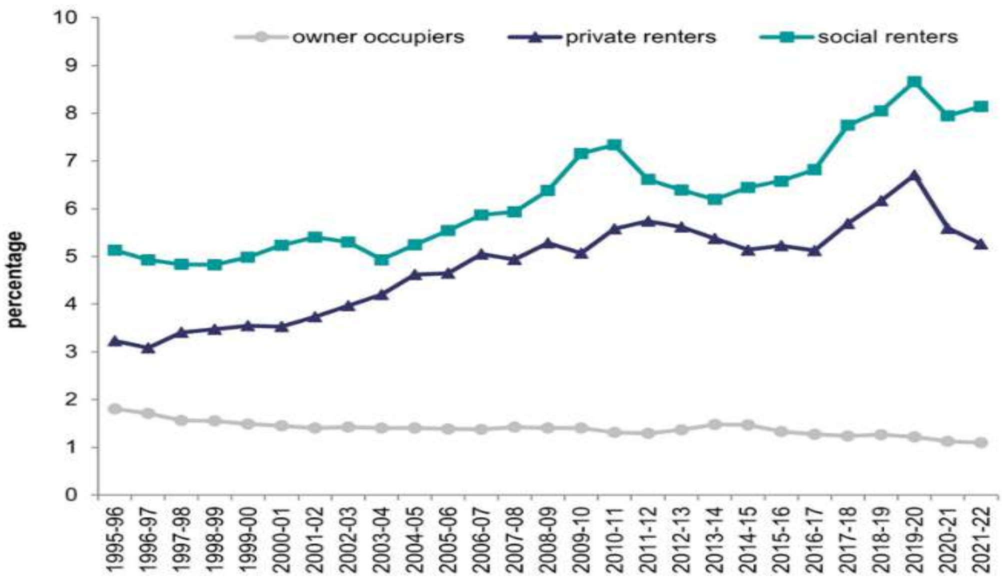


Figure 4 – Trends in tenure, London and outside London (2009/2010 to 2021/2022) from Section 1: households annex tables [88]

On average, owner-occupied homes are larger and are more likely to have outside space than rented homes, with the average usable floor area of dwellings in 2021 being 97 m^2. Homes in the social sector tended to be 8 m^2 smaller than homes in the private rented sector (~670 m^2 compared to ~75 m^2). The size of some modern homes (including microflats in inner-city settings) is considered further, below. Owner-occupied homes (~111 m^2) were, on average, larger than social and private rented homes. The majority (81%) of dwellings in England had a private plot and a further 13% had a plot shared with other dwellings. The remaining 5% did not have a plot at all.

Overcrowding remains at the highest rate seen in the social rented sector and has reached its highest level in the private rented sector. In the social rented sector, overcrowding has increased to the highest it has been since 1995 to 1996 when data collection began. Overcrowding also increased in the private rented sector, also the highest it has been since 1995 to 1996, see Figure 5.



Base: all households
Notes:
1) data are based on three-year averages, which are the average of the three years up to and including the labelled date
2) underlying data are presented in Annex Table 1.24
Sources:
1995-96 to 2007-08: Survey of English Housing;
2008-09 onwards: English Housing Survey, full household sample

Figure 5 – Overcrowding by tenure 1995/1996 to 2020/2022 [88]

Overcrowding was more prevalent in the rented sectors than for owner-occupiers. In 2021 to 2022, 1% of owner-occupiers (170,000 households) were overcrowded compared with 8% of social renters (325,000) and 5% of private renters (237,000). Overcrowding was more prevalent in the social rented sector than in the private rented sector. In the social rented sector, overcrowding is at the highest it has been since 1995 to 1996 when data collection began. Overcrowding in the private rented sector although down for 2020/2021 and 2021/2022, when the last five years is averaged it remains the highest it has been since 1995 to 1996. The number and proportion of overcrowded households in the owner-occupied sector has remained relatively stable over the last 20 years or so.

In 2021/2022, owner-occupiers had lived at their current address for an average of 17.6 years. There has been a decrease in the average number of years that owner-occupiers have spent in their current address, from 18.1 years in 2018 to 2019 to 16.0 years in 2020 to 2021 and 17.6 years in 2021 to 2022. While social renters lived at their current address for an average of 12.7 years, this masks variation between local authority and housing association renters. Households that rent from local authorities lived at their current address for 14.3 years, higher than housing association renters, where the average was 11.6 years.

Example 6

Driver: The two underlying drivers in this example are first, Government's requirement to decarbonise all sectors of the UK economy (net zero greenhouse gas emissions) by 2050, including transport and the role micromobility devices can play in this (whilst at the same time reducing traffic congestion, and improving air quality in cities) and second, the intention of Schedule 1 requirement M4(2) and M4(3) to make dwellings more accessible, adaptable and usable.

Evidence: E-devices/vehicles (e-d/v's) have a role to play in the Government's vision for urban strategy (Future of mobility) [89] [90]. The Local Government Association report *Shared micromobility within the UK* [91], describes how micromobility can be an effective tool in helping decarbonise transport. The Approved Document M: *Access to and use of buildings* (AD M) guidance [92] at paragraph 3.25 for requirement M4(3) in *'wheelchair user'* flats describes the need for a space:

> *"… Preferably close to the principal private entrance [of the flat]…[with] a power socket [in] the space"*

The AD M guidance goes on to describe the space as needing to be wide enough to accommodate two wheelchairs (charging) one being an outdoor e-scooter chair and the other an indoor chair.

AD M provisions for M4(2) *'Accessible and adaptable'* flats is that there can be a 'meanwhile use' for the space e.g. a cupboard. The cupboard will still need to be close to the principal entrance, have a double gang power outlet and be large enough to accommodate two wheelchairs, when the cupboard walls are removed.

Implication for AD B: This example considers unintended consequences. The AD M guidance introduces a fire risk that threatens the safety of the occupant inside an M4(3) 'wheelchair user flat'. This cannot be allowed at base build without some Part B: *fire safety* consideration. A fire in a lithium-ion battery that spreads to two wheelchairs, located inside the flat's entrance hall will, in all probability, be impassable, see also Example 4 (above).

The AD M guidance points to a 'meanwhile use' (for the dedicated space, in an M4(2) '*Accessible and adaptable'* flat) as a cupboard. It is therefore, reasonably foreseeable that in the mid-2020s, there is a risk that other domestic appliances (even a mobility bicycle/scooter) with a lithium-ion power supply will be on charge in the space (since the space will incorporate a double socket outlet). The 'Catch 22' is that AD M expects the walls around such a cupboard in an M4(2) flat to be removed, at the point the resident needs an electric outdoor and indoor wheelchair. When the walls are removed, building Regulation 3(1)(c) will trigger a consideration under 3(2)(a) by virtue of 3(3) and the worsening of B1 – but this is only likely to be raised if there is guidance in AD B on it.

The first material challenge to AD B is whether it could provide guidance during the meanwhile cupboard-phase use and then when the cupboard walls are removed. The second material challenge to AD B concerns the suitability of a flat front door given it is so very close to the wheelchair charging point and rated at just FD 30(s).

Lastly, with cramped living conditions and ever smaller accommodation, the danger is that e-d/v's can be left charging in common escape routes.

Background

E-d/v's are modes of transport which are cited as having a role to play in the Government's vision for urban strategy (Future of mobility) [89] [90]. In addition to the Local Government Association report *Shared micromobility within the UK* [91], the Organisation for Economic Co-operation and Development's (OECD) International Transport Forum report *Micromobility, Equity and Sustainability* [93], concurred that micromobility can play a role in decarbonising transport as well as reducing traffic congestion, and improving air quality in cities. The OECD report considers that micromobility will lead to a reduction in the number of short car journeys and less reliance on cars in general. Micromobility is also an aspirational vision of local living, in cities, that the Royal Town Planning Institute endorses. The vision is sometimes described in terms of the 20-minute neighbourhood, where residents can meet all their day-to-day needs by making a 20-minute walking journey or a seven to 10-minute e-mobility or e-micromobility journey [94].

The risk associated with these e-d/v's is compounded when an occupant of a flat, which has very limited storage space, locates an e-d/v (and charges it) in the common corridor, see section 3.3.5 *Trends in housing and living* (above). Corridors in flats should be fire sterile spaces, capable of being safely and effectively used at all material times. Placing and charging an e-d/v in a common corridor introduces a fire hazard which is a potential fire ignition source and a threat to all users of the corridor. AD B calls for suitable and sufficient protection to common parts to allow occupants to escape…"s*hould they choose to do so*". Placing an e-d/v in the corridor renders the corridor unsuitable and insufficiently protected, and residents can become trapped in their flats. A fatal fire that highlights this exact fire risk occurred on New Year's Day 2023 in South Bermondsey, London, when the battery on a converted bicycle caught fire. The bicycle was left charging in the entrance lobby, at the bottom of the stair. The intensity of the fire, and its location, prevented the occupant of the second floor from being able to use the internal staircase. The fire spread to and destroyed the second floor flat [95].

Research [96] and media coverage [97] has shown a reduction in usable living space provided in modern homes, see Figure 6 (below). Smaller usable floor areas in flats including studio flats represents a challenge for planning authorities and other regulators (e.g. the Fire and Rescue Service and local authority housing services). Diminishing floor spaces was a matter that Government hoped to address in March 2015 with the introduction of *Technical housing standards-nationally described space standard* – it remains a challenge today [98].

An observation from London Fire Brigade inspections suggests the pressure of living in cramped conditions (in some modern, small flats) is such that some residents are prepared to move storage to 'outside' spaces/communal areas [99]. This can lead to cluttering of escape routes. The London Fire Brigade issued Guidance Note 84 (GN84) in 2018 [100] following a spate of fires in communal areas.

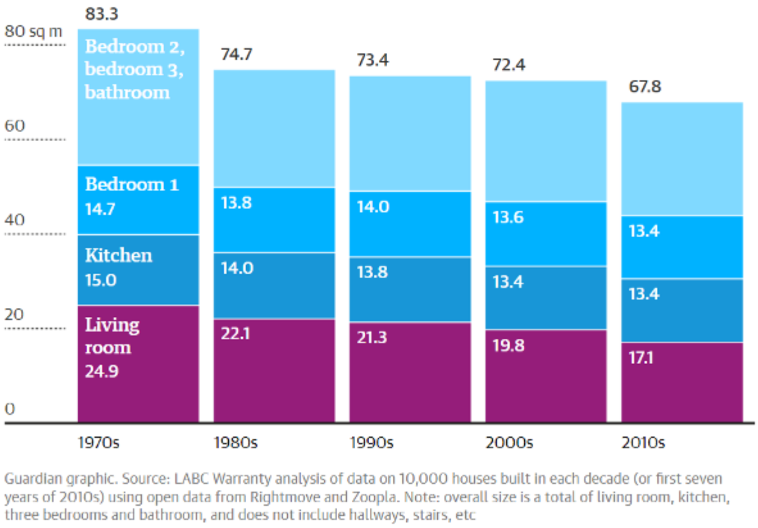


Figure 6 – Declining size of homes built in each decade [96]

Fires may occur in e-d/v's when the wrong charger is used for the battery and/or when the battery or the charger is substandard (or damaged) and/or where the battery is fully charged but left charging e.g. overnight.

Meanwhile phase when the space is used as a cupboard and or when the cupboard is removed

Authors of AD B need to be aware of the guidance in Approved Document M: *Access to and use of buildings* (AD M) paragraph 3.25. The guidance in paragraph 3.25 is for wheelchair user/adaptable flats to have charging and storage 'facilities' for two wheelchairs. It is important AD B is cognisant of this guidance and the Fire and Rescue Service warnings of the dangers of fires in e-d/vs and of resident(s) on occasion not being able to get to their flat front door where an e-d/v has gone into thermal runaway in close proximity to a flat's front door. A National Fire Chiefs Council (guidance note) [101], see case study in 2008 (Lincolnshire), described a blowtorch effect associated with a mobility scooter "*… burning through a 60-minute fire resisting compartment ceiling…*" This appears to require closer consideration.

There have been multiple instances when an e-bike (sometimes an e-scooter) located in the internal hall of a flat or in a room close to a flat's front door, has gone into thermal runaway and burst into flames, trapping the occupant(s) in the flat [102][17], see also [99] [103]. In the first nine months of 2023, there had been six separate fatal fire incidents with nine fatalities in England [104] and many narrow escapes. In London in 2023, there were a total of 155 fires attributed to e-bikes [105]. AD M paragraph 3.25 (d), for new builds requires that the space for a cupboard in a wheelchair adaptable M4(2) flat will be 1.1 m by 1.7 m. At such a size, it is entirely feasible the space could accommodate more than one e-bike (whilst charging) with considerable storage space above. This introduces a fire hazard which is a potential fire

[17] Residential block of flats, February 2024. Fire and Rescue Services were called to a fire at 04:44 in a third floor flat of a five-storey block, on John Fisher Street, Whitechapel, on 7th February 2024. Two people escaped using the internal stair but two firefighters could not get past one or more e-bikes, charging in the internal hall of the flat.

ignition source and may be a new threat to all users of the corridor. AD B calls for suitable and sufficient protection to common parts to allow occupants to escape…"*should they choose to do so*".

A video was made by Dorset and Wiltshire Fire and Rescue Services of fire growth, originating in a battery compartment of a mobility scooter. This video was made as part of a public awareness campaign, on safe charging of mobility scooters following a real fire event that Dorset and Wiltshire Fire and Rescue Services dealt with, circa 2013. On that occasion, circa 2013, a mobility scooter was left charging in a passageway, of a block of flats when it caught fire – it was fortunate that there were no injuries. The video shows not only the speed of fire growth but the smoke production [106] in a conventional scooter, i.e. one with an old lead acid battery. Had the battery been a lithium-ion battery and had it gone into thermal runaway the flaming current experience suggests the event could have been significant. The thermal runaway nature of fires involving lithium-ion batteries is not a challenge that AD B currently considers or provides guidance on. In 2016, BRE Global conducted research, in partnership with Lewisham Homes and the London Fire Brigade, into mobility scooter fires (both in sprinklered and unsprinklered spaces) [107]. It is worth noting that although the cover of a lithium-ion battery was involved in one of the experiments, it was not recorded that the battery went into thermal runaway during the experiment. There are many examples of small bespoke studies in this area but the lack of a central evidence data set suggests a much larger focused research programme is required to understand the risks and consequences.

The challenge to AD B, in this example, can also come from other motorised mobility e-d/v's including general use scooters and hoverboards. The batteries in e-d/v's are mostly lithium-ion. Lithium-ion battery (thermal runaway) fires are characterised by the production of highly toxic fluoride gases and explosive jet flaming events. The building type most at risk are dwellings, particularly flats (although there is evidence of some hotels now having a similar risk, where the hotel is being used as 'contingency' housing for asylum seekers [108].

Suitability of a flat front door adjacent to the wheelchair charging point

The current guidance on internal planning of flats is that they have protected hallways, or they are arranged as open plan, with the risk room (i.e. the kitchen) sited as remote from the flat front door as possible. When this guidance was drafted, e-d/v's were not in common use, and they were an unknown risk. The fire risk in the meanwhile use, discussed above, considers the potential for a fire to occur in a large cupboard located adjacent to the flat front door.

A fire that occurred in 2021 in a tower block is of note. Fire and Rescue Services were called to a fire at 08:54 in an eighth floor flat of a 19-storey block at New Providence Wharf, Fairmount Avenue, Poplar on 7th May 2021. A resident discovered a fire in a fuse box in a cupboard (one of two adjacent cupboards) adjacent to the flat front door. On opening one of the cupboard doors to investigate the smoke, the resident observed that the fire had spread to various belongings within the cupboard, some of which fell out, onto the floor. As the resident stepped over the material on the floor to escape, it is believed some items became trapped in the front door's threshold thereby preventing the door from closing properly. On this occasion, the fire spread into the common corridor and residents of some other flats (opposite and adjacent) had to be led to safety by the Fire and Rescue Service using fire hoods. The point of note is that even with a 'normal' fire (not burning explosively) the location of the cupboard immediately adjacent to the flat front door created a problem for the resident evacuating the flat [109] [110].

When the cupboard walls and door are removed, the space becomes open plan to the internal hall. It is therefore reasonably foreseeable that a fire in one e-wheelchair may spread to involve the second e-wheelchair and given their proximity to the front door, fire or smoke may pass via the doorset into the common parts, even when the door is closed. The ability of a common corridor to remain a fire sterile area in the face of one (or two) e-wheelchairs being on fire, on the other side of a flat entrance door, is a risk that needs to be better understood particularly with just FD30s flat front doors. However, another threat to the corridor will occur when the front door is opened. It is reasonably foreseeable that a resident escaping the flat in a wheelchair may be doing so more slowly than a non-wheelchair user might. When a lithium-ion battery goes into thermal runaway, it is known that burning material can be thrown from the battery, or its casing or adjacent material. Whilst it is expected that the flat front door will self-close, given the propensity of lithium-ion batteries to undergo jet flaming events, there is a chance of secondary fires occurring in the corridor during the time that flat front door is open. If the flat front door does not close fully, fire and smoke will enter the common parts.

See also Survey Issue 1j.1 (below) which explores whether AD B could give better guidance so that a reader of AD B could determine if a corridor as ‘designed and built’ rather than ‘subsequently managed’ was ‘*fire sterile*’. The concept of not being fire sterile has implications for sprinkler provision in the common parts, and it would be useful if AD B could provide clarity on this point.

Research may be needed as to whether some forms of construction, periods of fire resistance, very early fire detection, fire suppression and or active fire containment may assist in helping mitigate the risk when there is no cupboard.

All the foregoing suggests that further guidance in AD B is required. AD B could provide guidance in most of these scenarios. With the growth in cordless technology e.g. power-tools, laptops telephones etc. (all of which may use lithium-ion batteries) this means that the problem in the home is escalating.

Lastly, and following Example 4 (above), the location of battery pack(s) for the storage of electricity from renewable sources, and this example (Example 6) suggesting issues with rechargeable e-d/v’s, thought should be given to the need for a dedicated cupboard in new build and converted flats. How close to the front door is another matter and may need to be discussed with the authors of AD M.

Challenge to AD B arising from Example 6	
B1, B3 and B5	E-scooters, e-devices and electric vehicles are affecting means of escape in flats and common parts. Future direction: Part M guidance for the hall inside an M4(3) 'wheelchair user' flat is that there should be suitable space for charging two e-scooters. What part might early detection, active containment and local suppression play in the fire safety package of measures? Consideration could be given to the effect of toxic gases inhaled as a resident tries to leave their flat during a thermal runaway event, or as neighbours try to pass the door of the flat of fire origin. Consideration could be given to the risk of secondary fires (in the corridor) as the flat front door is opened. Thermal runaway events are characterised by explosive flaming. A slower exit will increase the chance of jettisoned material being thrown into the common corridor. Consideration could be given to the fire resistance of front doors. Will jet flaming events result in quicker burn through? Will smoke and toxic gas be driven, with greater force around door edges, into the corridor? Should toxicity and quantity of smoke produced (adjacent to the front door) be considered? Would smoke produced during a lithium-ion fire overwhelm a natural shaft or powered shaft? Would it affect CFD modelling assumptions? What consideration to be given to stay put in combustible construction, where a plausible fire scenario is an e-scooter fire (x 2no) adjacent to the flat front door? How would one conduct a test of a floor with its fire exposure condition being from above rather than below? When determining periods of fire resistance, if there is a chance the cupboard could accommodate a scooter or e-bicycle or e-hoverboard, consider use of hydrocarbon fire curves (or other) during fire testing. Are there other considerations, like the use of innovative firefighting tactics, e.g. use of ultra-high-pressure lance or is AD B guidance needed? Would it be preferable to fight such a fire by staying in the corridor in defensive mode? Consideration to be given to fire safety measures relating to the cupboard for a 'meanwhile use'.

Example 7

<u>Driver</u>: The first underlying driver in this example arises from the Government's desire to increase housing supply. The second driver relates to the popular trend for the co-living (community living) typology.

<u>Evidence</u>: This housing type is a very different proposition to the 'general needs' typology. The London Plan, Policy H16 describes Co-living schemes as:

> *"…large-scale purpose-built shared living […] developments [will comprise] at least 50 units [and] a concierge [and] outside communal amenity space (roof terrace and/or garden)"* [111].

Shared large-scale accommodation can include a gymnasium, one or more lounges, group kitchens, themed dining rooms, workspaces (with collaborative working opportunities) lecture/debate spaces, theatres and TV/cinema rooms. This accommodation is not required to be located at basement level; it can be located at various floor levels, throughout the height of co-living tower block. The outside communal amenity space is increasingly a mid-height accessible terrace and a roof garden. Policy H16 also requires that laundry services are available for washing/cleaning of towels/bed linen and caretaker service is provided which in some cases has been observed that it is a 24/7 provision. The quality and array of communal spaces marks out co-living as being different from HMOs. Some believe apart-hotels are an offshoot of co-living but the accommodation with apart-hotels is self-contained and the form of tenure is hotel-like (i.e. purchased by the night).

<u>Implication for AD B</u>: The first material challenge to AD B is whether this form of accommodation has been studied and the risks quantified and understood. AD B could provide practical guidance on fire safety for such accommodation. The second material challenge to AD B is whether the dual evacuation strategy of simultaneous evacuation and stay put is appropriate for this typology.

Background

The co-living typology is suited to a post university demographic, as graduates take their next steps into work. The typical population is young and professional. A Savills UK survey shows that 79% of tenants in co-living schemes are between 18 and 35 [112] and an e-news article [113] shows the average age of a co-living resident has risen from 24 (the majority of whom remained resident for 12 months) in 2017 to 28.2 (the majority of whom remained resident for 18 months) in 2020. The communal spaces make the accommodation feel quasi-hotel/private club 'like'. The minimum length of tenure must be 90 days or more.

Nationally described space standards (introduced in 2015) dictate that a one-bedroom studio apartment in a general needs block should not be less than 37 m^2. This standard is in place to prevent conversions (in the main) producing unacceptably small accommodation [114] [115] [116]. Exceptions to this general rule are allowed, where a building's designer can convince the local planning authority that there is mitigation; this is frequently the case with co-living schemes. Bedroom and ensuite shower and WC facility is less than this on the basis that the communal parts are very well appointed and very generous. Thus, for co-living schemes the designers of new buildings providing more communal spaces and completely changing their approach to the provision of leisure and amenity spaces within residential blocks more generally. BRE Global is aware of some co-living schemes having bed-sit accommodation as small as 19 m^2.

The reduction in the size of homes is a theme covered before in section 3.3.5 *Trends in housing and living* and Example 6 (above) which looks at e-devices and electric vehicles which may be a threat if left in the common parts of flats. In well run co-living schemes, the risk of clutter and fire risk in the common parts will be mitigated by good housekeeping and management intervention(s)

Technical challenges (bedroom clusters, communal spaces, escape strategies)

A common design for co-living is to have several bed-sit rooms clustered and accessed off a private ante corridor. This ante corridor is accessed from the principal escape corridor. Private ante corridors usually give access to a small communal kitchen serving the cluster of flats.

The balance of own space and communal space is seen as one of the key drivers for the increase in multi-functional high-rise living. Local planning authorities look favourably on new housing incorporating generous amenity space. For high-rise developments on tight inner-city sites, the stepping or terracing of the building (along with provision of private balconies) may be the only way to achieve such amenity space. See Example 9 (below) which considers the risk of fire spread over such roof construction.

The mix of communal and private spaces will probably result in the need for two escape strategies, one for the studio-flats and one for the communal spaces.

The sheltered housing sector (typically comprising accommodation over less than six storeys) has, for some sixty years, run with dual evacuation strategies of simultaneous evacuation (from communal parts) and stay put (in individual flats). This sheltered housing model requires that if a resident is in a communal area when a fire alarm sounds then they know to exit the building. If the resident is in their own flat when a fire alarm, in a communal area, is sounding, the resident knows to remain in their own flat and to await instruction from the Fire and Rescue Service.

Can the model used in mostly low-rise specialised housing (sheltered housing) apply successfully to high-rise housing? Expecting the dual strategies to operate in high-rise, would, break new ground. Is it reasonably foreseeable, in a co-living block (say, 20 storeys tall) that residents fleeing a fire in a communal area (say, on the 10^{th} floor) might first journey up or down the building to their cluster flat in order to alert co-living friends? Another factor to consider is the potential for alcohol to be consumed in some of these communal spaces when an event/function is taking place. With the age profile of the residents lying between 18 and 35, and the array of communal spaces available in modern co-living schemes, it is reasonably foreseeable that alcohol may play some part in these social events. The possibility that two escape strategies will be required in co-living accommodation especially in mid-rise and high-rise buildings, needs more consideration.

Guidance for construction of communal terracing has not historically been provided in AD B, probably because communal terracing was not a common occurrence in the early 2000s. The increased use of terracing could result in a range of materials being used e.g. timber or plastic timber-effect decking, fabrics, artificial grass and other surfaces which may be constructed above inverted roofs (which themselves may include a considerable thickness of thermoplastic insulation), see Example 9 (below) and consideration of the fire that occurred at an office building, under construction in Reading, Berkshire, in November 2023. The fire occurred on a roof terrace, which was being constructed at the time. The fire was severe enough to result in a flame plume rising between 3.0 m and 6.0 m above the terrace, over approximately three quarters of the length of the terrace and in so doing, it prevented a worker from making unaided escape off the roof [117]. Although full details of exactly what was burning are unavailable, it serves as a reminder of the risk of fire spread across roof spaces.

The need to restrict fire spread over terraces is indicated in Figure 7. This is especially relevant since Government has stated its intention to require new residential buildings to have two stairs [118].

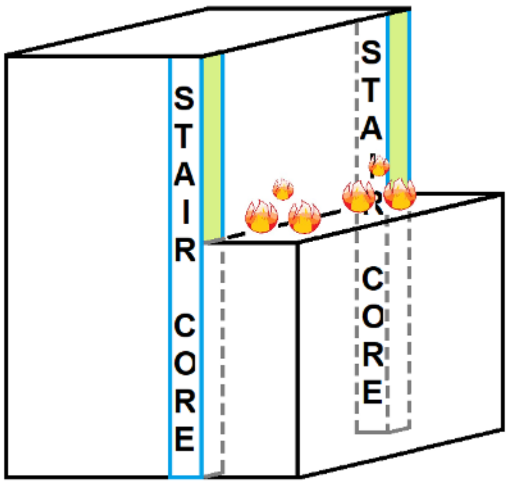


Figure 7 – Sketch depicting fire spreading over a mid-height communal terrace. Flames 'threaten' the façade of the upper floors and the glass (shown green) of both stair cores.

The first 'limb' of Schedule 1 requirement B4 (2) requires that a roof shall *"…adequately resist the spread of fire over the [it]…"*. Typically, single stair buildings would have the stair core located in a centrally i.e. away from terraces. The issues considered in Example 9 (below) are of fire spread over roofs and they become especially relevant if the terrace links the stairs as shown in Figure 7 (above).

Through BRE's network of partners and contacts is it clear that some authorities having jurisdiction (AHJs) find that these co-living schemes with large function rooms/lounges and communal terrace(s) located at mid or upper floor levels in high-rise accommodation are very challenging to regulate. Questions concern B1: *Means of warning and escape* and human behaviour during an evacuation event, as well as management's role in an evacuation, B4 *External fire spread* and B5 *Access and facilities for the fire service.*

Challenge to AD B arising from Example 7	
	Much of the consideration under Example 6 applies here.
B1, B3, B4 and B5	How suitable is a single stair for such a Typology? Management's role is unclear. Might management be expected to control/manage functions taking place in communal spaces, including controlling alcohol consumption? What is management's role during a fire event? Can the principle of simultaneous evacuation (for those who find themselves in common parts when an alarm sounds) and stay put (for those in their flats when an alarm sounds elsewhere in the building) be implemented for a younger demographic in high-rise? Is this typology more akin to hotel design? A review of purpose groups (and the guidance) more generally, would assist in this regard. What is the role of compartmentation (in cluster flats) in such a building? What guidance is appropriate for smoke ventilation in cluster flats' common corridors? Might this ventilation cause problems with the ventilation in the main corridor? Can the fire risk associated with non-bedroom parts (including community spaces, terraces, and roof gardens) be reviewed? The use of modern materials, in combination, on roof terraces is a concern. If fire begins on a communal terrace and involves timber (or composite timber) decking, seating, screening, planters (and other combustible material) and spreads to involve the roof build-up, there could be significant fire spread over the roof. Where a building continues to rise above a terrace, flaming could rise against a vertical wall of apartments and, depending on the location of the stair(s), jeopardise means of escape and access and facilities for firefighters. Consider all aspects of access and facilities for the Fire and Rescue Service for this typology.

Example 8

<u>Driver</u>: The driver for this example is the need for better care in the community, so that people who may have had a short spell of institutionalised mental health care treatment, are not consigned to long term institutionalised care, wherever possible. This very short example deals with the changing 'offer' in housing provision and considers a typology which may be slipping under the radar of control and therefore this typology needs further scrutiny.

<u>Evidence</u>: The challenge to AD B arises from the NHS Firecode guidance document (Health Technical memoranda 88 *Guide to fire precautions in NHS Housing in the Community for mentally handicapped (or mentally ill) people* (HTM 88) [119]. The NHS website for current documents reveals that HTM 88 was last revised in November 2001 and as of December 2008 is no longer an NHS supported document [120].

<u>Implication for AD B</u>: The material challenge to AD B is that it is quoting an out-of-date guidance document.

Group homes are an essential stepping stone for people needing assistance with day-to-day living before returning to live, unaided, in the community. These group homes, sometimes called supported housing, are frequently formed in large 'converted' dwellinghouses. The previous guidance in AD B used to refer to these group homes as being suitable for up to six persons living together in a single dwelling. The debate made clear that some of the most vulnerable people in society live in supported housing group homes.

Residents living in this housing typology were given a voice in the Levelling Up, Housing and Communities Select Committee *Exempt Accommodation* debate (27th October 2022). The debate was selected to coincide with the date of the publication of the report *Exempt Accommodation* (Third Report of Session 2022-2023). The report was damning about the failings of the assisted living sector [121]. The report only touches on constructional standards in these homes and does not address Building Regulations or building control. The report is damning of the quality of the accommodation generally. The debate looked at the 'raft' of regulators in this space, which included the Care Quality Commission, the Charity Commission and even local authority housing and planning services. All these actors acknowledged to the Select Committee that they had no teeth and no 'grip' and therefore felt unable to regulate this sector.

The challenge to AD B is twofold. Firstly, to establish whether HTM 88 is the correct guidance document given that it appears to have been unsupported for 15 years. Secondly, if the committee report claims the sector is uncontrolled and residents are often taken advantage of by unscrupulous landlords, then there is a very strong probability the constructional standards behind such conversions are likely to be equally poor. A review of the guidance would assist in determining what is to be expected when properties are converted into such group homes for assisted living.

Challenge to AD B arising from Example 8	
B1, B2, B3 B4 and B5	It appears HTM 88 is no longer supported but it is still cited in AD B. This typology is clearly a challenge to building design and building use and up to date guidance would be welcomed.

3.3.6 Modern buildings (materials, products, components and assessments) designs and use

In order to understand where AD B is not keeping pace with 'modern' building types, we need to define what 'modern' means and how it differs from previous approaches. A 'modern' building has no single definition. Indeed, many if not all, intrinsic features of buildings, are in principle unchanged and would be recognisable without challenge by a constructor from previous centuries.

However, the way we live (not only in buildings but also how we move, shop and work), the materials available to us as well as the building technologies and construction processes are markedly different. The planning, purpose and use of buildings, procurement and ownership models all evolve constantly too. These many factors influence the modern way of living, constructing and designing buildings.

Many studies and publications and information sources are available on the subject and investigate particular facets of the interacting issues and consequences. An internet search on the subject led to around 35 relevant references, shown in section 10.1 (below).

Generally speaking, the main changes are gradual in nature, albeit a few accelerated step changes have been observed, especially in recent years with key Government funding initiatives (e.g. the Construction Sector Deal, 2018) [122] which strongly supported ideas and innovation in construction. In the UK, this is partly driven by regulatory changes driving down the UK's carbon emissions through more efficient building envelopes, addressing skill shortages and a need for more homes (circa 300,000 homes per year are needed). Other drivers have been surveyed and are shown in Figures 8 and 9 (below) [123] [124].

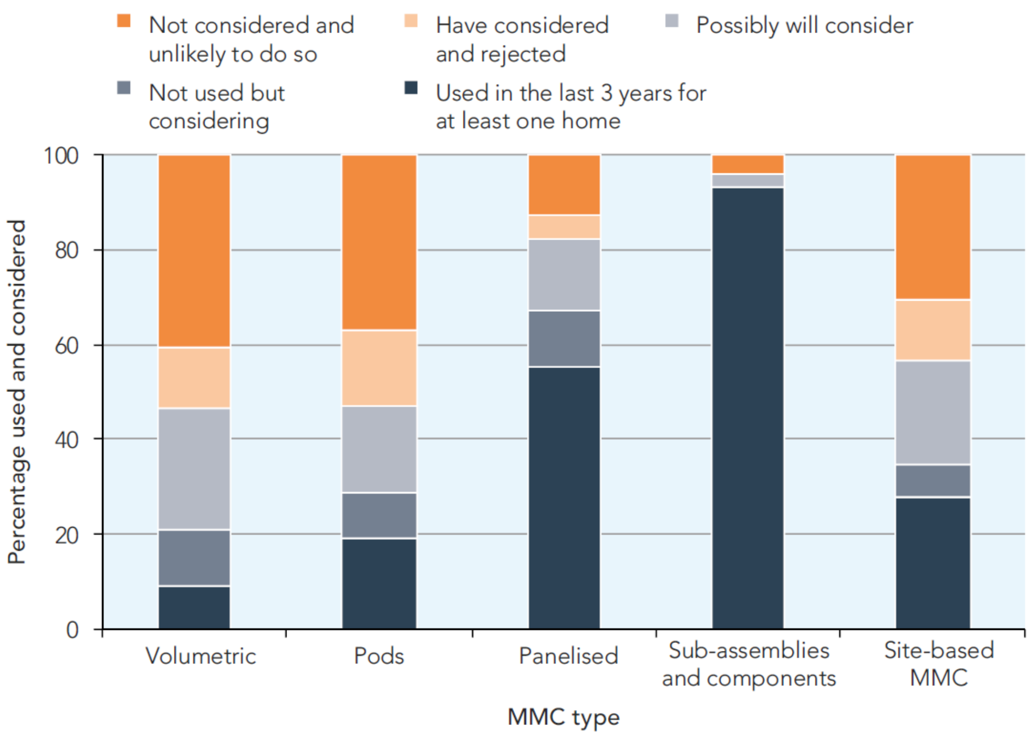


Figure 8 – Percentage of Modern Methods of Construction (MMC) type used and considered between 2013 and 2015, taken from [123]

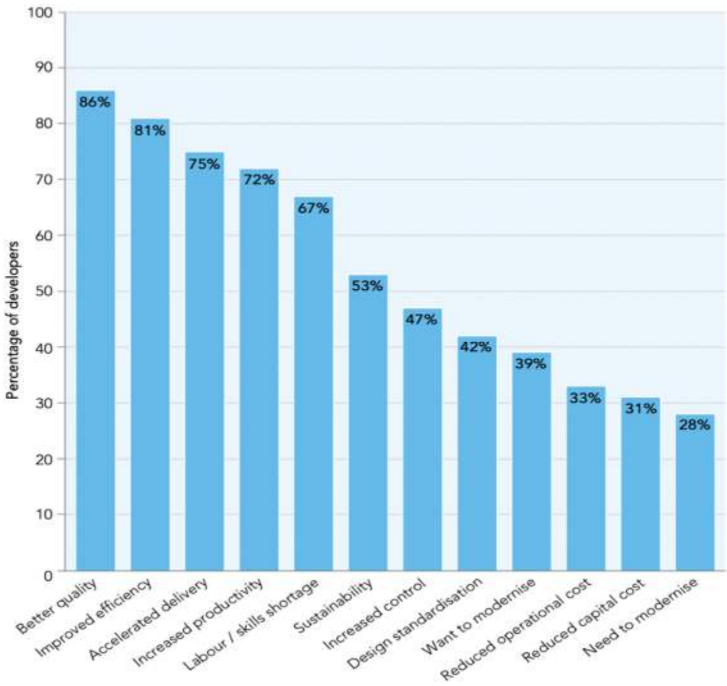


Figure 9 – Drivers for changes in construction delivery taken from [124]

As identified in section 3.1.2 (above) and in Example 5 (above) proponents of unitised/modular buildings may be looking for lightness in construction, ever longer spans, smaller foundations, greater flexibility in use of underground spaces and building shapes, and the ability to optimise land use.

Challenges to AD B can include consideration of the appropriateness of fire test standards – in the face of technological change (e.g. thermal insulation technology) and change in how some parts of buildings are being used differently to how they were in the 2000s.

In the 2000s, it was most likely that that the roof of a residential block would not have been accessible to residents. In the 2020s, it is highly likely that the roof would be a communal garden and either the plant would be located behind a screen and softened by planters and foliage or located in the basement. The roof test may not have kept up with technology creep and design and use creep.

3.3.7 Consideration of the Fire Protection Research Foundation Final Report *Fire Safety Challenges of 'Green' Buildings and Attributes* (2020)

During the background research phase for the project the Fire Protection Research Foundation Final Report *Fire Safety Challenges of 'Green' Buildings and Attributes* (2020) [125] came to light. It was felt that many of the technologies listed in the publication are relevant, or could be relevant to future development, to the construction industry in England and should be taken a signposting for the need for AD B to be using a horizon scanning approach to gain foresight of potential upcoming challenges to the guidance. This section cites the technologies listed in the publication and a brief appraisal of what each entails. There is no direct comments in relation to implications to AD B in this section.

Additive manufacture This is 3D printing. The publication states:

> *"The application of 3D printing in the construction industry is not, […] limited to cementitious materials and can include both polymer printing (including bioplastics) and metal printing or [Composite] material."*

Stabilised Aluminium foam panels The publication states:

> *"Stabilised Aluminium Foam, […] represent[s] a new material technology that can be used in a number of construction applications including as aesthetic façade finishes, interior walls, acoustic panels on ceilings, displays, signage and lighting."*

PET for Buildings The publication states:

> *"Material recycling is a strong societal trend.[…] Polyethylene terephthalate (PET) is [a highly] recycled polymer today at a rate of just over 20 percent (Brownell, 2019). […] It is important to keep in mind the combustibility of plastics material (whether recycled or not) and their fire performance in the specific application to ensure that safety is maintained while sustainability is improved."*

Interactive printed graphene. The publication states:

> *"[…] Graphene has a myriad of interesting properties that make it an attractive material for building applications. […] Printing circuits directly onto paper or facades can create interactive applications in the future. There are, however, clear fire safety implications given that carbon is accessible to oxidation at high temperatures through combustion."*

Novel biological material. The publication states:

> *"[…] new research into biofaçades could pave the way to additional carbon capture technology using algae or microbial cellulose.[…] the use of mycelium-based substrates to grow rather than manufacture building materials is [emerging as a new technology]."*

Phase changing material. The publication states:

> *"Phase Changing Materials (PCM) can be divided based on their chemical composition (organic, inorganic or composite) or their phase range (solid-solid, solid-liquid and liquid-gas).[…] PCM building material has mainly been developed for wall applications. […] Despite the high level of interest, there are still unresolved questions, including the level of fire safety due to the potential for toxic emissions during a fire from some PCMs and the flammability of certain PCMs […]."*

Organic insulation types The publication states:

> *"[…] the sustainable building industry has increasingly turned their interest towards natural, potentially biodegradable, insulation materials. Different types of material have been considered, including but not limited to, cork, straw, flax, hemp, sawdust, corn husks, sheep's wool and other natural products and by-products. […] natural (e.g. reeds, bagasse cattail, corn cob, cotton, date palm, durian, oil palm fiber, pineapple leaves, rice, sansevieria fiber, sunflower and straw) or recycled (e.g. glass foam, plastics, textile fibers and others).*
>
> *[…] They […] pose serious challenges in terms of poor or varied material quality, anisotropic performance and flammability."*

Non-traditional window framing members The publication states:

> *"Materials that are increasingly under consideration include: different types of composite material […] [or those with] enhanced thermal performance with aerogels to reduce heat losses"*

Ultra-High Performance Concrete (UHPC) The publication states:

> *"[…]The compressive strength of UHPC is greater than 150 MPa, […] Significant fire safety challenges remain given the tendency for beams and girders with narrow cross-sections to spall under fire exposure."*

Double skin façades The publication states:

> *"Double skin façades, […] offer some fire safety challenges, […] the space between the layers of glazing can facilitate fire propagation unless proper attention is placed on fire partitioning within the façade structure […].*
>
> *[…] Fire or smoke spread potential [is] a concern [under some circumstances]."*

Building Integrated Photovoltaics (BIPV) The publication states:

> *"[…] The main defining feature of BIPV is that it is a construction element within the building, i.e. if the BIPV module were to be dismounted, it would have to be replaced by an appropriate […] construction product […]. The BIPV differs from building attached photovoltaic systems (BAPV), which are photovoltaic systems that are attached to the building envelope".*

Solar concentrators The publication states:

> *"Traditional solar concentrators often rely on the concentration of direct solar energy and can be complex and require a large area reducing their attractiveness. […] Such systems can use glass (or polymer) window systems to generate electricity from sunlight when attached to a PV cell, effectively turning otherwise passive glazed façades into electrical power generators.*

Densification The publication states:

> *"[…] In parts of the US, these higher density developments can be characterized by tightly spaced, timber-framed structures, in some cases with vehicle access only from the back. […] Means to minimize fire spread along adjacent housing units should be assured."*

Example 9 Deep dive – Roof testing and classification reports, roof terraces and Solar mounting standards

Driver: The example addresses five drivers:

- The first underlying driver in this example is Government's desire to reference the European classification system, for reaction to fire set out in BS EN 13501-5: 2016 *Fire classification* […] *using data from external fire exposure to roof tests* [126]) (BS EN 13501-5) in AD B.
- The second driver is Government's requirement to decarbonise all sectors of the UK economy (net zero greenhouse gas emissions) by 2050. The focus on this driver is thermal insulation and inverted roof construction detailing.
- The third driver is local planning authorities seeking developments, within their purview, to incorporate communal terraces and roof gardens.
- The fourth driver considers green and sustainable development with highly insulated pitched roofs and
- The fifth driver considers the growing popularity of surface mounted and integrated photovoltaic panels.

Evidence: The evidence for the first driver can be seen in AD B (2019 edition) which now favours the European classification system for reaction to fire set out in BS EN 13501-5 (which draws its data from DD CEN/TS 1187: 2012 (t4) *Test methods for external fire exposure to roofs* [127] ((DD CEN/TS 1187: 2012 (t4) test). The evidence of the second driver to zero carbon can be seen in previous examples above and is high on the political agenda. The evidence of the third driver can be found by viewing the Royal Town Planning Institute's ten-year corporate plan [128] and their vision:

> *"[to have] Ambition […] to promote […] socially inclusive […] sustainable places"*

Developments that take place in the mid-2020s on inner-city sites, (often cramped with complex footprints) rarely have the spare land at ground level for landscaping for communal use. Increasingly, therefore, it is the building that has to be designed to include multi-functional communal space, this is translating to communal roof gardens and terraces, see also Example 7 (above). Evidence of the fourth and fifth drivers are both the driver to net zero and the growth in demand for renewables on developments and generation of electricity using photovoltaic panels.

Implication for AD B: The first material challenge to AD B is whether it continues to give practical guidance on ways to meet the first 'limb' of Schedule 1 requirement B4(2). The second material challenge to AD B relates to accessible terrace design and considers the choice of roof membranes, the provision of thermal insulation, the demand for communal terraces generally and by local planning authorities, and whether the current guidance provisions in AD B and the detailed test conditions of DD CEN/TS 1187: 2012 (t4) test are sufficient to address the risk these terraces appear to pose. The third material challenge to AD B considers whether AD B continues to provide practical guidance on ways to meet the second 'limb' of Schedule 1 requirement B4(2) for a highly insulated pitched roof build-up. The fourth material challenge considers whether AD B gives practical guidance on ways to meet both 'limbs' of Schedule 1 requirement B4(2) for integrated and above roof photovoltaic panels and whether above roof photovoltaic panels introduce new fire risk(s) that AD B does not currently consider.

The first material challenge to AD B, whether it continues to give practical guidance on ways to meet the first 'limb' of Schedule 1 requirement B4(2).

The result of the national standard test BS 476-3: 1958 [129] (BS 476-3) was a two-letter designation. The first letter of the two-letter designation denoted the time taken for penetration by fire, by the appearance of glowing or flaming on the underside of a test specimen. The exact definition of 'underside' of the test specimen was not defined in the 1958 edition of the standard (which remains the case today) and is the subject of the third material challenge to AD B (below). The second letter denoted the extent of flame spread down the pitched roof/flat roof specimen.

When the second letter was an 'A', that meant no fire spread occurred over the test sample, a 'B' designation meant flame spread occurred, but the extent of the spread was less than 21 inches, and a 'C' designation meant flame spread occurred in excess of 21 inches down the pitched/or flat roof specimen.

Since AD B (1985 edition) and up until AD B (2019 edition) the guidance for flat roofs in Appendix A: Table A4 (Table A5 from 1992) (Notional designations of roof coverings) always focused on constructions that achieved an 'A' for spread of flame. The AD did not provide guidance on forms of construction which could achieve an AB or an AC designation and Table A5 was removed in the AD B (2019 edition). In BRE Global's experience, between 1985 and 2019, manufacturers of roof covering waterproof systems, universally placed product on the market which achieved an AA designation – it is fair to say that during these years, there was little to no appetite to bring to market AB or AC products.

Going back further, the same was noted with the Building Regulations 1965 [130], i.e. the regulations only focused on notional designations that achieved an 'A' for spread of flame. Therefore, between the 1965 regulations and AD B (2019 edition), the only Building Regulations guidance available in England in relation to fire spread over flat roof coverings (with the exception of metal sheets or mastic asphalt) related to bitumen felt roof coverings. The assumption being that if bitumen felt was finished with ½ inch deep bitumen bedded stone chippings or bitumen bedded non-combustible (pedestrian) tiles, the flame spread designation would be 'A'.

To understand the context and development of spread of flame ratings it is necessary to reference the Building Regulations 1965[Ibid]. Building Regulation E15(2) stated that BS 476-3 designations 'BA', 'BB' and 'BC' 476-3, were acceptable 'equals', where a building was located > 20 feet from a boundary – the first letter 'B' denoting that fire penetration took longer than 30 minutes but less than 60 minutes to occur. This passed into the Building Regulations 1985 with a change, which reflected the adoption of the metric system, from 20 feet to 6.0 metres.

We were unable to find in the Building Regulations 1965, a specific regulation that grouped BS 476-3 designations AA, AB and AC as being acceptable 'equals' if the building was < 20 feet from a boundary. This may have been an inferred outcome based on Regulation E15(2), and the reference appeared in the AD B (1985 edition). No underlying research could be identified which introduced AA, AB, and AC as equal designations in the AD B (1985 edition) where a building was located at < 6 m from a boundary.

It was not until AD B (2006 edition) Table 16: *Limitations on roof coverings* that there was a harmonised European alternative to the national standard BS 476-3 for determining the performance of roof coverings when exposed to an external fire exposure roof test. The alternative to the national designation was a European classification. The classification was BS EN 13501-5: 2005 [131], and the roof tests referred to came from the DD CEN/TS 1187: 2012 (t4) test. This new option was also described in AD B (2006 edition) in Section 14, paragraph 14.4, which was titled: *Classification of performance.*

Table 1 sets out how the AD B guidance changed between the AD B (1985 edition) and the AD B (2019 edition).

Table 1 – Principal changes to AD B from the (1985 edition) to the (2019 edition) for Schedule 1 relevant requirement B4(2)

AD B	Principal changes in the guidance for roofs	Notes
1985 edition	Paragraphs repeated, for each purpose group (i.e. 1.15, 2.15, 3.15, 4.15, 5.17 and 6.15) and directed the reader to Appendix A and Paragraph A3 and Table A4. Paragraph A3 cited National Standard BS476-3:1958 as the performance standard. Tables repeated, for each purpose group (i.e. 1.3, 2.3, 3.3, 4.3, 5.3 and 6.3) and were titled (**Limitations on roof constructions**). Appendix A: Table A4: was titled (**Notional designations of roof coverings**)	Table A4 Considered metal sheets, asphalt and vitreous enamelled steel on substrates. Table A4 Considered bitumen felt with four surface treatments. In all cases, the focus was achieving an AA designation.
1992 edition	The six paragraphs and Appendix A: Paragraph A3 were consolidated to new Section 14 titled (**Roof Coverings**) paragraph 14.3. Paragraph 14.3 rather than Paragraph A3 cited National Standard BS476-3:1958 as the performance standard. The six tables consolidated to Table 17 (**Limitations of roof coverings)** Note: coverings not constructions Became Appendix A: Table A5 same title, slightly expanded content	Table A5 added Lead/tin and zinc/aluminium alloy coated steel and pre-painted coil coated steel and liquid applied PVC coatings of steel. The focus remained achieving AA designations.
2000 edition and **2002 edition**	Section 14 and paragraph 14.3 became Section 15 (**Roof Coverings**) and paragraph 15.4. Paragraph 15.4 still cited National Standard BS476-3:1968 as the performance standard. Remained Table 17 (**Limitations of roof coverings)**. Remained Appendix A: Table A5 same title and more content on decks.	Table A5 as above. More guidance was given on decks beneath bitumen felt. The focus remained on achieving AA designations.
2006 edition *Volume 2 Buildings Other Than Dwellings*	Reverted to Section 14 (**Roof Coverings**) and paragraph 14.4. Paragraph 14.4 cited two routes to 'linear compliance': National Standard BS476-3:2004 *(Note this was the 2004 edition)* or European classification BS EN 13501-5:2005. Becomes Table 16 (**Limitations of roof coverings**) with the first column listing National classes to BS 476-3 the second column is a read-across to the European Classification. National Classes AA, AB or AC are equal to B_{ROOF} (t4) and National Classes BA, BB or BC are equal to C_{ROOF} (t4). Remains Appendix A: Table A5 same title, same content as before.	Table A5 adds European Class B_{ROOF}(t4) alongside each reference to a National Class (designation) i.e. AA. The AA designation is cited first.
2019 edition Volume 1 Dwellings Note Dwellings not Dwellinghouses. The third of seven main changes in this edition was the intention to adopt European classifications	Becomes Section 12 (**Resisting fire spread over roof coverings**). There is no equivalent to former paragraph 14.4. Table 16 becomes Table 12.1 (**Limitations of roof coverings**) which Refers to the European Classifications B_{ROOF} (t4) through to F_{ROOF}(t4) only. Guidance moved to Appendix B. Paragraph B15 reaffirms the intent to consider fire penetration and fire spread Paragraph B18 states: *"This [AD] uses the European classification […] BS EN 13501-5; however, there may be some [historic] products […] using the [national] classification system set out in previous editions. […] Table B2 can be used for the purposes of this document."* Table B2 (**Roof covering classifications: transposition to national class**):	Table A5 (Notional designations of roof coverings) Removed. Paragraph B15 is contradictory since the change in favour of the (t4) test removes the ability to classify fire spread. Table B2 lists the BS EN classification first, in the left hand column and then, alongside, the transposed National Class.

The DD CEN/TS 1187: 2012 (t4) test (stage 2 for penetration with burning brands, wind and supplementary radiant heat) utilises a heat flux of 12 kW/m^2 over the entire area of a test sample. This test requires that the sample receives preheating for 300 seconds (at 12 kW/m^2) prior to application of the burning brand. Should surface spread of flame occur during this test, it is not recorded and does not become part of the DD CEN/TS 1187: 2012 (t4) test report 'evidence', for the purposes of the BS EN 13501-5 classification.

AD B (2019 edition) marked the point from which the European standard took primacy, although there is still a mechanism to enable reference back to the National Standard, but this can only be found in Appendix B. The wording used in Appendix B Paragraph B18 suggests BS 476-3 would have a waning influence:

> *" […] There may be products lawfully on the market using the classification system set out in previous editions. Where this is the case, Table B2 can be used for the purposes of this document."*

Table B2 (in both Volumes 1 and 2 of AD B (2019 edition)) were titled Roof covering classifications: transposition to national class. These tables remain in both Volumes of AD B (2019 edition with 2020 and 2022 amendments) (both Volumes of AD B). Although, this position is now superseded by both volumes of AD B (2019 Editon including 2024 Amendments) which take effect March 2025).

Some roof covering membranes, when placed in their end-use condition, and subjected to the DD CEN/TS 1187: 2012 (t4) test, have been observed to develop flaming which encompasses the whole surface of the sample, engulfing the test facilities burners. It could therefore be expected that if the test samples were subjected to the spread of flame test described in BS 476-3 (utilising burning brands and supplementary radiant heat) the spread of flame designation may be recorded as 'C'. In addition, during the DD CEN/TS 1187: 2012 (t4) test, flames have been noted to rise over and beyond the test apparatus' surface combustion heaters. See Figure 10 (below). Depending on the type and thickness of insulation material and decking, it is possible that these systems would go on to achieve a European Classification B_{ROOF}(t4). Nothing in a test report would tell the professional relying on it anything about the extent of flame spread, nor the flame extension, nor the duration of the flaming event. These are key outcomes that all actors specifying roof systems in their end-use condition need to be aware of.

Figure 10 – A fire penetration roof test, with the flame plume having risen just above the surface combustion heaters (see left pair). Some samples tested result in taller flame plumes.
Note that the entire surface area is burning but this will not be included in the report as it is not a reportable characteristic.

The title change in AD B (2019 edition) Section 12 (Volume 1) and Section 14 (Volume 2) to *Resisting fire spread over roof coverings* is incongruous, given that there is now no longer guidance on the second 'limb' of B4(2). Even prior to considering if today's roofs are more complex than they were in 2005/2006, the start position is that AD B no longer provides practical guidance as to how "*The roof of the building [can] adequately resist the spread of fire over [it]".*

To address this anomaly reintroduction of a spread of flame test is required. This could be achieved by the revision of the guidance to make reference to BS476-3 or through consideration of the development of a new test methodology. An interim measure might be no more than an adjunct i.e. a companion statement to accompany <u>but not be part of</u> the BS EN 13501-5 fire classification. Figure 11 shows some indicative possibilities using (very approximately 1/3, 2/3 and 3/3 'margins') for consideration. Using this simple observation of fire spread associated with the test, shown in Figure 10 (above), one might state in the adjunct that:

"… flaming occurred over 3/3 the width of the sample for X seconds".

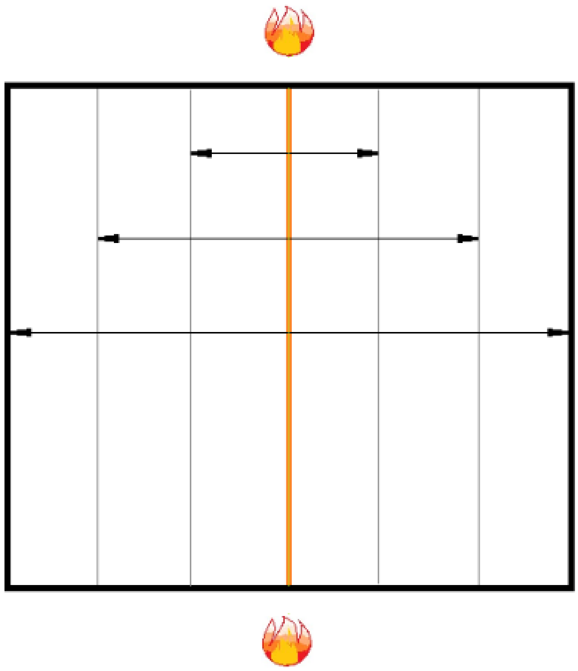


Figure 11 – Plan view of a test sample. The 'margins' (and arrows) are indicative of potential parameters to describe the extent of flame spread away from centreline.

The second material challenge to AD B relates to accessible terrace design and considers the choice of roof membranes, the provision of thermal insulation, the demand for communal terraces, including by local planning authorities, and whether the current guidance provisions in AD B and the detailed test conditions of DD CEN/TS 1187: 2012 (t4) test are sufficient to address the risk these terraces appear to pose.

Three generic flat roof typologies are currently recognised in the market cold deck, warm deck, and inverted roof. The warm and inverted roof technologies have developed at pace, over the last two decades, whilst the cold roof technology has not developed to the same extent. Warm deck and inverted roof systems are now highly specialised manufacturer-specific constructions. This example considers mostly inverted roofs which typically comprise of a water flow reducing layer (WFRL), on thermoplastic insulation (mostly), on a fleece geotextile on a waterproof membrane. Some systems omit the fleece geotextile.

Choice of membrane and thermal insulation

At the time of writing this report, it appears that there is a great choice of roof covering options, than was the case when AD B (2006 edition) was being considered and drafted. Single ply waterproof systems and liquid roofing waterproof systems were already established pre AD B (2006 edition). The single ply membrane typology emerged from USA in the 1960s, and grew in popularity in the USA and Europe because of the oil crisis of 1973 [132]. These membranes became increasingly popular in Europe, from the 1980s [133], and now the choice of roof coverings is broader than ever – at least seven known ‘families’ of single ply membranes [134][18] and 11 known ‘families’ of liquid roofing waterproof systems are now available [135][19].

The underlying driver behind Schedule 1 requirement Part L: *Conservation of fuel and power* is the desire to reduce CO_2 emissions from the built environment. One aspect of Part L considers the need to limit heat gains and heat losses in buildings – principally, by the provision of thermal insulation. Part L was revised in toto, and guidance issued in AD L (Volume 1 Dwellings and Volume 2 Buildings other than dwellings - 2021 editions) [136]. The 2021 uplift was the first step on the way to the launch of new constructional standards (The Future Homes and Buildings Standards (FHBS)), expected in 2025 [42]. The uplift to Part L with the 2021 revision was designed to achieve a 31% reduction in CO_2 emissions compared to Part L 2013. Part L is due to be revised again (this being the second step) and timed to be co-incident with the launch of FHBS in 2025. The combined uplift of Part L 2021 and 2025 is intended to result in buildings achieving a 75% to 80% reduction in CO_2 emissions, when compared to buildings built to Part L 2013 standards. This second step and final uplift is expected to make homes and other purpose groups easy to achieve net zero without any further uplift(s).

At the time of writing, Government had issued its technical consultation on what was required to ensure the FHBS were net zero ready and what support was needed to make this a reality from Part L (and Part F: V*entilation* [137]) perspectives. On fabric insulation and the potential for further uplift in 2025, the Government has signalled its intention not to change the building fabric standards for homes, because there is some emerging evidence from the University of Salford’s *Energy House 2.0 project* [138], that suggests the 2021 fabric minimum standards provide a good basis for the FHBS. What is clear is that the consultation needs to run its course before Part L changes can be finalised, and there is always the possibility that the Government’s position on this may change.

One recommendation the Government sought views on was around the concept of thermal performance testing. When contractors are faced with a ‘pass’ or ‘fail’ outcome, for any performance characteristic, they are likely to seek an element of ‘over provision’ in design, to avoid last minute non-compliance surprises. It is therefore reasonably foreseeable that some contractors may choose, voluntarily, to add additional insulation to avoid any ‘fail’ results due to workmanship or detailing issues.

An inverted roof construction, common in the early 2000s (needing to achieve a 0.25 $W/m^{-2}\cdot k$ U-value) may have used approximately 160 mm-thick thermoplastic insulation. An inverted roof (on a concrete deck) constructed to achieve a U-value 0.11 $W/m^{-2}\cdot k$, (to comply with Part L 2021) may be formed using

[18] The following single ply membranes are now represented by the Single Ply Roofing Association (SPRA): Chlorinated polyethylene (CPE) Ethylene Propylene Diene Monomer (EPDM), Flexible Polyolefin (FPO), Polyvinyl Chloride (PVC), Thermoplastic Polyolefin Elastomer (TPE), Polyisobutylene (PIB) and Vinyl ethylene terpolymer (VET).

[19] The Liquid Roofing and Waterproofing Association (LRWA) represents manufacturers of liquid (seamless) coating systems that include the following technologies: polymer modified bitumen emulsions, glass reinforced resilient unsaturated polyester resins (GRP), flexible unsaturated polyester resins, polyurethanes, poly methyl methacrylates (PMMA), methyl methacrylates (MMA), acrylics, polyureas, thermoplastic block copolymers, hot applied polymer modified bitumens (hot melt) and silane terminated polyethers.

approximately 300 mm-thick thermoplastic insulation. Should Part L (2025) not be uplifted beyond the Part L (2021) provisions, one might think inverted roofs will continue to be formed using approximately 300 mm-thick thermoplastic insulation. However, it is common to see architects designing with slight over-provision in one thermal element (e.g. the roof) to mitigate a slight under-provision in another (e.g. the walls). It is also common to see over-provision in thermal elements and airtightness (beyond the guidance provided in AD L (2021) to achieve a specific client brief. Moreover, for more than a decade, when Part L required airtightness standards of 10 $m^3/m^2 \cdot h$ @ 50 Pa for new buildings, industry was actually bettering this and building to an airtightness of 4 $m^3/m^2 \cdot h$ @ 50 Pa, or lower.

What the above clearly shows is that when it comes to conservation of fuel and power, the construction industry has a record of going further than the minimum provisions set out in Part L. Initially, going further than the guidance provisions set out in AD L, may have been forced on developers as a condition, of grant of planning permission. However, and to an increasing extent, clients are becoming more discerning on reducing carbon emissions. Clients seek buildings that will demonstrate lower carbon emissions and want more than just 'minimum provision' for their buildings. In BRE Global's experience, for an inverted roof (on a concrete deck) constructed in the mid-2020s, it is not uncommon for industry to be using anywhere between 400 mm-thick and 600 mm-thick thermoplastic insulation. Going further than the minimum provisions as set out in Part L, may have unintended consequences if the insulation under consideration is combustible as this will result in a greater potential fire load being placed on the roof.

Demand for communal terraces, including by local planning authorities

Whilst terraces were a common feature at the time the AD B (2006 edition) was being considered and drafted, it is clear that roof terrace constructions seen in the mid-2020s are far more complex because of the materials used in combination. An accessible roof terrace serving an office or restaurant/bar, residential development or hotel which is located above an inverted or warm deck roof, may include some of the following features: decking, conventional seating, bleacher step-seating (which is likely to result in long continuous voids beneath the seats and risers), planters, pergolas (with solar shading blinds), privacy screens, PV installations, synthetic grass (and plants), self-draining resin bound gravels and rubber crumb soft surface play areas. Whilst conducting research for this worked example, BRE Global encountered designs of roof terraces using both patio heaters and fire pits.

An example that showcases the scale of ambition for modern roof gardens/roof terraces, is a new office building in Kings Cross with its multi-stepping, 300 m long roof [139]. It is reasonably foreseeable that this will serve to encourage and inspire other architects to become more adventurous when conceiving their own accessible terrace designs, see also Figure 7 in Example 7 (above) which sets out the risk associated with fire spread over an accessible terrace.

Survey Issue 1b (below) makes the point that in the mid-2020s, developers in London are noticing a shift in Local Authority planning departments' preference when considering proposals for redevelopment of brownfield sites. The planners' preference in the mid-2020s is for the repurposing and adaptive re-use of existing buildings over demolition. There is a presumption against demolition if the form of construction for the replacement building is to be heavy massy construction. Where a developer can make a case that the redevelopment must involve demolition, the observation is that securing planning permission is much harder, if one is not intending to use mass timber or offsite-manufactured units as the form of construction for the new building. Given the risks associated with the roof terrace, on a concrete roof deck, it is probable that some AHJs will consider the risk is greater still if the building structure is combustible.

For communal terraces in cities like London, the London Plan's inclusive design policy D5 and design standards policy D6, drive the expectation that apartment buildings require communal roofs or communal terraces. Birmingham has an outdoor amenity space policy LW13 [140] and it is likely that other Core cities and Combined Authorities either currently have, or are likely to adopt, policies on amenity space in the future.

The Royal Town Planning Institute's ten-year corporate plan expects its members' to have:

> *"[…] Ambition […] to promote […] socially inclusive […] sustainable places*"

Local Authority planning departments see communal spaces as key to achieving social inclusivity, and a vital ingredient in ensuring developments thrive as sustainable communities.

The Royal Borough of Greenwich, in 2023, served an enforcement notice on a developer of two blocks of flats that had been built circa 2020. In this widely reported case, which may yet go to appeal, the Local Authority's Planning service alleges that the developer failed to comply with the approved plans and planning conditions. Of the 26 alleged contraventions, one alleged a failure to step back the top storey of one of the buildings and another alleged the failure to provide roof gardens for residents and the public and children's play areas and green roofs [141] and [142]. The decision to demolish two residential tower blocks is an exceptionally rare occurrence and provides an example of Local Authority planning departments approach to the value of communal space such as roof gardens.

The current guidance provisions in AD B

The guidance in Appendix A: *key terms,* is that an accessible roof/terrace is a 'storey'. The guidance in AD B Volumes 1 and 2, Table B3, entry 4(b), suggests that where the roof performs the *function of a floor* it will need the same minimum periods of fire resistance as the main building (described in Table B4 (both Volumes 1 and 2)). Consideration could be given in AD B to make it clear what the expectations are if a roof garden/terrace is considered a storey.

For some purpose groups this will mean that the roof needs to be considered as though it was a compartment floor, and this will have ramifications for penetrations and the need for proprietary seals to seal against all elements of the roof/terrace build-up and not just against a typical concrete roof slab. If a fire does develop within the depth of a roof /terrace build up, should the 'storey' resist downward fire spread i.e. back down to accommodation below? This latter hazard is considered in BS 476-10 [143] which observes that:

> *"The fire scenario supporting BS476-3 […] concerns the hazard that exists from fires spreading to the roof of a building from a nearby fire outside the building."*
> and
>
> *"The key area of concern is that these types of fires have the potential to extend over large surfaces of multi-compartmented structures. They therefore have the potential to bypass any compartmentation controls […] allowing fire re-entry to the structure via the external surface."*

It would not be uncommon for the structural concrete slab of a roof or a roof terrace to be formed from cast-in-situ reinforced concrete, over permanent profiled steel shuttering, i.e. a composite slab. A cast-in-situ reinforced concrete roof/terrace slab (say 170 mm thick) would need to be jointless (to be waterproof) accordingly, and irrespective of the waterproof layer's propensity to suffer from surface spread of flame during a DD CEN/TS 1187: 2012 (t4) test, it is implausible that there would be flame penetration during a DD CEN/TS 1187: 2012 (t4) test to the lower surface of the steel shuttering. Paradoxically, the system may fail the preliminary (stage 1) test were flaming of the membrane to occur for > 5 minutes and spread > 381 mm; but failure due to penetration through the concrete slab is unlikely.

The detailed test conditions of the DD CEN/TS 1187: 2012 (t4) test

During a DD CEN/TS 1187: 2012 (t4) test, concrete pedestrian tiles of an inverted roof, 'shield' both the WFRL and the thermoplastic insulation beneath, from the 12 kW/m^2 heat flux, which is delivered by the test apparatus' surface combustion heaters. The greater the air void beneath the tiles, the greater the 'shielding' effect. The void is achieved using adjustable height pedestals that sit on the WFRL and support the tiles. For residential developments, warranty providers require upstands between the WFRL and DPC level (beneath a door cill) to be 75 mm-high, to prevent rain penetration during periods of inclement weather [144]. If a test sample is presented to reflect this warranty requirement, the resulting distance between the surface of the concrete pedestrian tile and the WFRL will be approximately 95 mm. It is clear that this arrangement will result in a much lower heat flux falling on the WFRL than on the surface of the concrete pedestrian tiles. The adjustable height pedestals that allow these voids to be created, have spacer nibs which result in the pedestrian tiles being typically 3 mm to 5 mm apart. BRE Global's research reveals that the warranty providers typically require the slabs to sit 6 mm to 8 mm apart – this is problematic if the test evidence does not consider a difference in gap sizing.

It is not known what the outcome might be if the heat fluxes were of a different order, e.g. if the roof terrace, seating, steps, or other promenade surfaces (and constructions) are the cause and origin of a fire? BRE Global has been unable to identify any large-scale testing which has taken place, to consider whether the combination of heat flux, conduction and radiation from such a fire would result in the inverted roof becoming involved in a fire as the pedestrian tiles slump and gaps between slabs open up.

Where the insulation layer is 400 mm-thick to 600 mm-thick, the possibility exists that the concrete slabs could slump differentially, potentially exposing the WFRL and the thermoplastic insulation to the fire.

Additionally, the potential mechanism of fire spread via the WFRL and the thermoplastic insulation should be considered due to their potential to melt and flow when exposed to heat sources, see BS 476-10 regarding the potential to bypass compartmentation controls where a fire spreads over a roof surface. Consideration may need to be given to sunken rainwater drainage outlets on inverted roofs to prevent fire spread via flowing liquid into the rainwater down pipes.

Another potential mechanism of fire spread of note in these scenarios would be the effect of wind, and its potential to drive a flame plume against the full depth of an inverted roof build-up (i.e. resulting in side-on fire spread, involving all the combustible elements of the inverted roof).

In the case of a terrace construction above a gravel ballast layer, comprising timber or timber-effect decking and furniture and planters, it is likely that the 50 mm-deep layer of stones would be brushed aside to allow the placement of adjustable height pedestals to accommodate joists to which the decking and furniture would be fixed. It is likely some in the industry will not consider these elements to be part of the roof covering and others will.

The term roof covering was not defined in either of the BS 476-3 editions (1958 or the 2004 edition). The AD B (2019 edition) describes roof covering loosely as:

> *"one or more layers of material, but not the roof structure as a whole"*

However, AD B (2019 edition) Volume 1 Paragraph 12.3 and Volume 2 Paragraph 14.3 refers the reader to Commission decision 2000/553/EC of 6th September 2000. This decision describes roof covering as:

> *"[…] the product which constitutes the top layer of the roof assembly"*

The expression 'assembly' may lend weight to those in industry that might consider all the elements to be part of the roof covering.

- What elements constitute the roof covering?
- What elements constitute the floor or 'storey'?
- What test would be appropriate, in order to see the effect of all the materials acting in combination?
- How might protection against fire spread via penetrations to storeys below, be achieved?
- How can storeys above a terrace be protected from a flame plume rising over their external wall (windows and private balconies) and any glazing around a stair core(s) which may also overlook the terrace, see Figure 7 in Example 7 (above) which illustrates some of these risks.

It is clear that the definition of the roof and its assembly need clarification to ensure the risks and mitigations are clearly defined.

A recent fire occurred on the roof terrace of an office building, which was under construction, in Reading, Berkshire, in November 2023. The fire was severe enough to result in a flame plume rising between 3.0 m and 6.0 m above the terrace, over approximately three quarters of the length of the terrace. (This was determined by BRE Global, based on video footage of the fire and its aftermath). The speed of fire spread prevented a worker from making unaided escape off the terrace. Whilst the fire was notable for the part played by the crane driver in the rescue of a worker (trapped on the terrace) the reaction to fire properties and arrangement of materials involved in this inverted roof are relevant to this project. Media footage of the fire [145] showed flames rising from the surface of the terrace. The investigation into this fire was ongoing at the time of writing so BRE Global could only make reasonable assumptions as to what could burn in a similar scenario. Our working hypothesis behind the fire spread was that one (or more) layers of the inverted roof build-up and possibly *some other combustible material(s) (pallets and plastic work-zone barriers)* were burning, but the concrete paving slabs (loading layer) were not placed on pedestals at the time of the fire. At the time of writing, nothing was known of the waterproof products on the roof at Reading, but it is cited on the basis of the precautionary principle, flagging this as a risk for AD B to consider.

Arising actions

Large-scale research is required to s understand the mechanisms of fire spread and risks associated with fire spread over large and complex roof terraces.

This discussions presents the challenges in this sector, showing that industry has a wide range of waterproof materials that it can now select from, some of these materials facilitate rapid flame spread (but this will not form part of any DD CEN/TS 1187: 2012 (t4) test report or subsequent 13501-5 European classification), thermal insulation can be in the region of 400 mm-thick to 600 mm-thick, constructions above the inverted roof proper may include a plethora of features, voids and materials. Local planning authorities desire accessible terraces, with increasing frequency and the current testing protocols are unsuitable to quantify the risk of materials in their end-use condition, at scale.

The third material challenge, whether AD B provides guidance on ways to meet the second 'limb' of Schedule 1 requirement B4(2) for a highly insulated pitched roof.

This third challenge considers highly insulated pitched roofs with inter-rafter insulation and the point at which fire penetration and therefore 'failure' is determined to have occurred, during a BS EN 476-3 or DD CEN/TS 1187: 2012 (t4) test. Comparing roofs, common at the time AD B (2006 edition) was being considered for revision and those common in the mid-2020s, does not reveal the extent of the 'creep' that has occurred with roof construction testing and why the test methodology for fire penetration needs to be reconsidered to ensure it is fit for purpose. This example therefore shows how a typical roof of the late 1950s, for which the 476-3 test was envisaged, is completely different to mid-2020s version. Even though we now have the DD CEN/TS 1187: 2012 (t4) test, it is based on the BS 476-3 test methodology and so the point is relevant to the European test. The Building Regulations 1965 required no more than one inch of thermal insulation, and this was most likely to be placed between ceiling joists.

The reaction to fire tests, BS EN 476-3 and DD CEN/TS 1187: 2012 (t4), are no guarantee of performance in a real fire because of the number of variables that can occur in a real fire event. Both tests are intended to be good proxy tests, that are indicative of likely performance in fire, and also, they are a way of comparing constructions, using a standard set of test conditions.

This challenge shows that as the point of penetration and therefore 'failure' has shifted, from the top surface of a roof to the bottom surface, this potentially gives rise to larger fire scenarios for Fire and Rescue Services to tackle than would have been the case in the 1950s and 1960s. This material challenge asks whether AD B needs revision to prevent major roof conflagrations and the risk of downward fire spread into compartment(s) and voids below (See BS 476-10 (above)).

The second limb of Schedule 1 B4(2) is:

> *"The roof of the building shall adequately resist the spread of fire […] from one building to another […]"*

If the first letter of a BS 476-3 designation was an 'A', this meant fire penetration did not occur in less than 60 minutes, a 'B' meant penetration occurred between 30 minutes and 60 minutes and a 'C' meant penetration occurred in less than 30 minutes.

In terms of fire penetration, BS 476-3: 1958 made the following observation:

> *"The time at which any glowing or flaming […] appears on the underside of the specimen shall be the time of penetration and shall be recorded, and normally such penetration is the end of the test."*

Comparison of a roof common in the late 1950s with its mid-2020s counterpart

An example of a typical roof construction in the late 1950s might be 12 mm-thick (nominal) interlocking tiles, on 22 mm-thick (nominal) tile battens on 100 mm-deep rafters.

With this build up, the test engineer, looking up through the 'mica' window at the underside of the test specimen would have had a good view of the full depth of the rafters and the underside and edge of all the tile battens and the underside of all the tiles. The point of penetration would most likely have been marked by glowing or flaming, on the top face or the top edge of the tile batten(s).

In this example 'failure' equated to the first few millimetres of combustible material (i.e. the tile batten) combusting.

A mid-2020s pitched roof equivalent construction might comprise 12 mm-thick (nominal) interlocking tiles, on 25 mm-thick tile battens, on breathable flexible underlay (with a 10 mm drape), on 19 mm-thick counter battens, on 300 mm-deep engineered timber 'I' rafters (spanning between purlins), with 300 mm-thick thermoset insulation board placed between the 'I' rafters. The test engineer would look through the observation window at the underside of the test specimen and see the bottom flange of the 'I' rafters and the foil face of the thermoset insulation board. In this example (with 300 mm-deep insulation) between the 'I' rafters, failure would equate to approximately 345 mm of combustible material (tile batten, flexible underlay, counter batten, 'I' rafters and insulation) combusting.

This position has the potential to lead to a position where virtually the entire depth of a roof construction could be burning, and the construction still achieve a (t4) 'pass' and therefore should be the subject of further discussion. It seems inappropriate that a 340 mm-depth of roof build-up could be on fire, and yet reasonable provision could be claimed with respect to the second limb of Schedule 1 requirement B4(2).

How has this come about?

Building Byelaws were superseded when the first nationally applied Building Regulations came into effect on 1st February 1966. The thermal insulation requirements in the Building Regulations 1965 (at Section 11) were very similar to the earlier Byelaws. A builder, in the late 1950s or the 1960s, constructing a traditional close couple cut roof, with interlocking single lap tiles, would most likely have provided the requisite 1 inch depth of loose laid vermiculite, gypsum or polystyrene beads between the ceiling joists as that would have been the simple, easy, and cheapest option. The provision of insulation between rafters, was not a common practice at this time.

We can be confident the roof samples offered for the BS 476-3 test in late 1950s and the 1960s are unlikely to have included inter rafter insulation.

Other considerations regarding BS 476-3 or the 1187 (t4) – heat flux, wind and smouldering combustion and edge seals

Heat flux

The radiation intensity of 12 kW/m^2 used in the BS 476-3 or the 1187 (t4) test can be regarded as:

> *"[…] the [heat flux] intensity incident on a roof 7.6 m above ground level from a fire 13.7 m away in a building with a facade of 15.2 m × 15.2 m and 50% window openings."*

If the first and third challenges to AD B (as set out above) result in a re-consideration of the test methodology, it would also be worth considering if the radiation intensity in the DD CEN/TS 1187: 2012 (t4) test is still as suitable in the mid-2020s as it was in 1958.

Wind

Another consideration of the original test was the effect of wind during a fire:

> *"Because wind will tend to carry any surface flames through any fissures in a roof, provision is made in the test to simulate the effect of a wind of 6.7 m/s (15 miles per hour) by applying suction to the lower side of the roof specimen during the test."*

It was clear that roof test samples, constructed in the 1950s and 1960s (without flexible underlay) would have resulted in multiple air leakage paths between and under the tiles on test. A roof construction with tight fitting insulation board or spray applied foam between the rafters will seal the construction. At worst, air cannot be drawn into the simulated roof void (the specimen cover void) or at best, it will be less effective than it was intended, when envisaged in 1958.

Even samples made using flexible underlay would have allowed air leakage from outside into the simulated roof void (the specimen cover void). One lap in the sarking would have facilitated air flow. No laps would have reduced the air flow.

Any review of the test standard should consider how air flow could be better represented given the new challenges.

Smouldering combustion

The airtightness of all construction is a key consideration for compliance with Schedule 1 requirement L: *Conservation of fuel and power*. If rigid thermal insulation boards (with gaps sealed using expanding foam) are substituted entirely in favour of an expanding foam (open or closed cell) the construction will be even more airtight.

Initial experimental research conducted at BRE suggests that if expanding foam is subjected to the heat flux from the test apparatus surface combustion heaters, this may lead to unseen smouldering combustion of the foam. If the roof covering achieves good surface to surface contact (tile to tile, or slate to slate) without gaps, insufficient oxygen may enter the space under the tile or slate, and smouldering combustion may then occur. This is significant because, like BS 476-3, the moment a DD CEN/TS 1187: 2012 (t4) test is deemed to have failed the penetration stage:

> *"[…] there is appearance on the underside of the specimen of […] glowing or flaming […]."*

The initial research suggests there may be a problem with identification of some types of smouldering combustion because the surface discolours rather than shows the direct impact of combustion. Moreover, the smoke production may obscure the view into the simulated roof void (the specimen cover void). More research is needed on different application of insulation materials to see if the test can be a reliable indicator of failure due to hot spots and/or smouldering. This theme also aligns with the cooling period (see Example 5 above) in which the ongoing combustion of the roof from unseen smouldering and deep seated hot spots can occur sometime after the formal testing protocols have been completed and reported on.

Edge seals

The negative pressure on the underside of the test sample will not be possible to maintain if the perimeter seal fails. It is therefore critical that this is maintained which for some sample designs can present difficulties.

Representative samples

Another concern is around the scale of the test in relation to the sample sizing and construction and how well this represents end use application.

Whilst consistency, for example in the case of sprayed foam is not a precision skill, there can be considerable variance in the depth of the applied foam. A pass or fail can then be seen as a subjective result due to the variability of thickness of sprayed foam.

All the foregoing suggests that the guidance and the fire penetration test itself need to be reconsidered.

The fourth material challenge considers whether AD B gives practical guidance on ways to meet both 'limbs' of Schedule 1 requirement B4(2) for integrated and above roof photovoltaic panels and whether the above roof photovoltaic panels introduce fire risk(s) that AD B does not currently consider.

Integrated PVs on a pitched roof

As integrated PVs fulfil the role of the waterproof layer (or part of it) they would need to be classified in accordance with BS EN 13501-5 using the test data from the DD CEN/TS 1187: 2012 (t4) test. The AD B (2019 edition) only considers fire penetration, and not spread of fire over the surface, discussed in the first material challenge (above). Whilst the DD CEN/TS 1187: 2012 (t4) test is no guarantee of performance in a real fire, because of the number of variables that can occur in a real fire event, the penetration test is intended as a proxy test, indicating likely performance in fire, and enabling comparisons to be made between similar constructions.

Anomalies and considerations for DD CEN/TS 1187: 2012 (t4) testing include: the effect of some test panels having joints and others, on account of their modular size have none, some PV panels may be larger than the test apparatus' specimen holder, the effectiveness of the edge seal (where the test specimen abuts the A1 fire rated calcium silicate) board, whether photovoltaic panels should be tested without the panels being energised and lastly whether the effect of solar pre-heating of the glass surface should be a consideration.

- A roof test comprising only double lapped plain clay tiles, would have resulted in air (wind) being pulled through the 36 gaps between tiles and the nine layers into the simulated roof void (described as the specimen cover) in the 476-3 tests. A test panel comprising integrated PVs, tested in the mid-2020s with no joints (or just a couple of joints) would at worst, result in no air being drawn into this void or at best, result in a considerably reduced air flow entering the void. Thus, with some integrated PV installations, there is no mechanism to draw air through gaps and fissures between the PV 'tiles'.

  The Met Office research [146] points to a greater prevalence of winter windstorms in the future. In contrast, the Met Office also reports on a long-term decline in average wind speed, but cautions against relying on this 'observation' without context. The context being that this 'observation' may be attributable to, in part, changes in instrumentation and exposure of the observing network [147]. Given the certainty of climate change but accepting some uncertainty in predicting, with accuracy, average wind speeds over the next 50 years, it would be appropriate to adopt a precautionary principle approach when considering the wind speed during testing.

  The simulated wind speed of 6.7 m/s is defined as a 'moderate breeze', wind force 4 on the Beaufort scale. An option might be to consider using a higher wind speed, another might be to retain the base wind speed at 6.7 m/s but to introduce simulated gusts. A non-precautionary principle approach would be to do nothing. By introducing simulated gusts it may make the test more reflective of realistic wind conditions during what is otherwise a 'moderate breeze'.

  The third material challenge to AD B (above) looks at the DD CEN/TS 1187: 2012 (t4) test and considers *heat flux, wind, smouldering combustion, edge seals, and representative samples*. Highlighting the need for a complete review for the test and therefore the associated guidance in AD B.

  Sample sizes

  The DD CEN/TS 1187: 2012 test, at paragraph 7.4.2.2.1 *Installation into the test specimen holder* makes allowance for larger specimens to be mounted into a bespoke frame provided the bespoke frame can fit into the DD CEN/TS 1187: 2012 (t4) test's 'specimen holder' frame, such that the required reduction in pressure to the underside of the test specimen can be maintained for the duration of the test.

It is challenging to mount and test using bespoke test frames and as such DD CEN/TS 1187: 2012 (t4) consideration should be given to reviewing the test standard and how wind (including wind gusts) could be delivered across the surface of the roof covering so that larger panels and test elements could be accommodated.

- It is reasonably foreseeable, that on some occasions, integrated PVs may be energised at the time of a fire. The voltage can be high when wiring PVs in series and the current can be high when wiring PVs in parallel. The DD CEN/TS 1187: 2012 (t4) test does not consider testing roof covering materials when they are energised. This element of the system performance should also be considered as part of reviewing the test procedure.
- It is reported in PV industry literature [148] [149] that solar radiation can cause the surface of PV panels to reach approximately 65°C on a summer's day (this may occur at noon, when air temperature is at 30°C, and there is no cloud cover, and only a light breeze is blowing). The literature also suggests that this temperature may be affected by the mounting height. Beneath the PV panels will, in most instances be a flexible underlay and possibly inter-rafter and/or over-rafter insulation. This may affect the surface temperature of the PVs. The DD CEN/TS 1187: 2012 (t4) test does not consider raising the temperature of the roof covering before the test begins, nor does it consider the void beneath and any inter-rafter and/or over-rafter insulation. Again these elements should be addressed as part of any review of the standard.

Photovoltaic panels located above a conventional roof covering

The traditional approach in the PV market has been set out in the Microgeneration product standard MCS 012 scheme *Pitched roof installation kits.*

The MCS standard (not referred to in AD B) states:

> *"If the solar system is only used on roofs whose outer covering is non-combustible, as defined in the Building Regulations, then in general no external fire test is required, otherwise the solar system, together with the outer roof covering shall be tested in accordance with BS 476-3: 2004 or DD [CEN/TS] 1187: 2002 Test t4. The certification body is to specify whether an external fire test is required in consultation with the manufacturer.*
>
> *An external fire test is required on the fixings into the roof if these are perceived as increasing the fire risk to the roof, for instance by large increases in the gaps between roofing components."*

Non-combustibility is not defined in the Building Regulations, but it was defined in AD B prior to the 2019 edition coming into effect. Prior to AD B (2019 edition) the classification could be found in Table A6 as materials which satisfied criteria when tested to either BS 476 Part 4: 1970 [150] or BS 476-11: 1982 [151]. Under European (EN) testing, materials classed as A1 are also regarded as non-combustible for the purposes of AD B guidance. A roof covering e.g. clay tiles without organic content could easily be non-combustible, but BRE Global believes the purpose of the DD CEN/TS 1187: 2012 (t4) test is to determine whether, when installed in their end-use condition (including all joints) the installation passes the 60 minute fire penetration test. It is highly probable that AHJs will require some reassurance that the presence of a PV array will not result in fire penetration and fire spread (AD B does not currently give guidance on fire spread).

The MSC standard suggests the fire testing and certification body is to:

> *"[…] specify whether an external fire test is required in consultation with the manufacturer".*

The MSC standard also goes on to make this statement about the need for testing fixings:

> *"An external fire test is required on the fixings into the roof if these are perceived as increasing the fire risk to the roof, for instance by large increases in the gaps between roofing components."*

The testing body should not 'specify' whether a test is required, nor should the perceived level of increased fire threat drive the need for testing, as this is subjective and should form part of the guidance provided in the AD B.

Photovoltaic panels located above a conventional roof covering introduce new risks that neither BS 476-3 nor the 1187-(t4) test were ever intended to address. If a fire occurs in a building (with an array of PVs on the roof), and breaks out of the roof, it is possible for flames to enter the gap between the roof covering and the PV array and undergo flame extension. Neither the current BS 476-3 nor the 1187-(t4) test, which both utilise a negative pressure beneath the test sample would not address concerns over flame extension, fanned by wind. The combination of the roof pitch, size of gap, presence of any combustible material(s) on the soffit of the PV array and wind speed could result in flame extension, impinging on the surface of a neighbouring roof including roof windows. The intensity of heat flux occurring over the neighbouring roof would be of a different order to that envisaged in either the BS476-3 or the 1187-(t4) test. This 'breakout' is a potential new mechanism of fire spread which AD B could consider in the future.

Some research into PV modules on steep and low-pitched roofs has been conducted at the Underwriters Laboratories (UL) in USA [152]. Whilst the standards used in USA are different [153] [154] to those used in England (i.e. the 1187-(t4)) the research confirms there is a problem regarding flame spread that needs to be addressed. The UL study was conducted in two phases – reported on in 2010 (Phase 1) and 2012 (Phase 2) and both phases are of relevance to this project:

The Phase 1 work March 2010 revealed:

> *"The presence of [above roof] PV module[s] … has an adverse effect on the fire performance of the roof regardless of the fire rating of the roof or the Class rating of the PV panel based on Spread of Flame."*

The Phase 2 work revealed:

> *"Some PV modules mounted at angles (positive and negative) to steep and low sloped roofs impacted the fire classification rating of the supporting roof assembly. The extent of the impact was dependent on the angle of the module relative to the roof and the type of roofing system."*

In conclusion, whilst it is unlikely that a burning brand landing on a photovoltaic panel located above a conventional roof will lead to fire penetration, however, there may be certain roof coverings and certain mounting arrangements when tested in combination where this could occur in less than an hour. Some PV arrays may burn with more intensity than others and the DD CEN/TS 1187: 2012 (t4) test does not consider fire spread over the surface (as discussed above) nor in the void between the panel and the roof covering.

The microgeneration product standard MCS 012 scheme *Pitched roof installation kits* relies on products being tested to BS 476-3: 2004 and DD CEN/TS 1187: 2012 (t4) but the lack clarity in the guidance and application of test methods are increasingly causing a back log in registrations under the scheme.

3.3.8 Assessments in lieu of testing, challenges for recycled materials, carbon-based insulations, low-carbon concrete, low carbon steel, thin/lightweight floors and highly engineered materials and spaces

This section builds on themes covered in Example 5 *Deep dive – Volumetric construction, Fire testing of combustible construction, Monitoring the cooling period after standard testing* (above) and considers: Assessments in lieu of testing, challenges for recycled materials, carbon-based insulations, low carbon concrete, low carbon steel, thin/lightweight floors, and highly engineered materials and spaces.

Assessments in lieu of testing

The provision of evidence for compliance with the Schedule 1 relevant requirements has often involved the use of modelling and computing techniques and professional justifications. The system of assessment (in lieu of tests) (AILOTS) for determining compliance with the functional requirement(s) has existed in AD B guidance since the first edition in 1985. Following the Grenfell Tower fire, Government consulted widely on what should happen with regard to this piece of guidance.

When consulted on assessments in lieu of testing, the National Fire Chiefs Council made this comment [155]:

> '*Well-prepared assessments in lieu of tests with direct reference to primary test evidence i.e. extended application and classification report still have a legitimate place within fire testing safety design'*.

The Government Final Impact Assessment: *Assessments in Lieu of Tests* [156] stated the following:

> '*An AILOT should be an extrapolation or interpolation of relevant, existing test data, not an estimate'*.

Both volumes of AD B make the above clear. Accordingly, unless there is sufficient directly applicable, and directly relevant test evidence of a new technology, reasonable provision should involve testing of the new material in its end-use condition, to prove it meets the requisite performance classification.

Challenges for recycled materials

Advances in material science, manufacturing processes and adhesive technologies, the use of binders and waste products (often from other industries) have all combined to result in a very diverse range of both raw ingredients and finished construction materials/products and components. The manufacturing process appears, in large part, to be driven by a desire to be more sustainable and to reduce carbon footprint. These advances, processes and technologies can lead to fresh challenges in relation to reaction to fire characteristics of finished materials, products, and components.

These challenges can become markedly apparent when the constituent parts are made from recycled products, which by their very nature will be highly susceptible to variation from batch to batch. This variability underpins a move away from materials of known and established performance (in relation to durability and fire performance) to a position where, the only way to know the performance would necessitate testing. Without extensive testing, there is risk that not all performance issues can be known. This suggests there are known unknowns, due to the inherent variability of the raw ingredients and performance of material in combination.

AILOTS would not be suitable for systems where individual component parts are manufactured using recycled materials. If the recycled material is from a single source, one might reasonably expect consistency in the material properties. Using multiple sources of recycled material will likely mean multiple variances to the ingredients. This may mean the resulting product can have variable reaction to fire properties between batches, and between batches made at different manufacturing plants in different regions of the UK, and between manufacturing plants, globally.

Carbon based insulations

The range of new low carbon insulations and building blocks include materials: shredded paper, shredded clothing (cotton, linen, denim), coconut fibres, reeds, discarded sacks, wood wool, cork, hemp, mycelium, seaweed and eelgrass, animal wool, expanding foams, foam glass, gels, expanded clays, multi-foils, bubble insulation, straw, cob, vermiculate and perlite and probably more. Low carbon blocks for solid walls include cellulosic material and concrete with various substitute products.

Some organic materials may appear to be easily extinguishable at the end of standard reaction to fire and fire resistance tests but have the potential to either re-ignite or undergo smouldering combustion for some time before eventually transitioning to flaming combustion. As a minimum, it should be possible to obtain more information following standard reaction to fire testing BS EN ISO 11925-2: 2020 *Reaction to fire tests – Ignitability of products subjected to direct impingement of flame* [157] and BS EN 13823: 2020+A1: 2022 *Reaction to fire tests. Building products excluding floorings exposed to the thermal attack by a single burning item* [158]. More consideration t would be needed where the material may find its way into masonry cavity walls. Diagram 5.3 in AD B Volume 1 and diagram 9.2 in AD B Volume 2 at note 1 states:

> *"Materials used to close the cavity in this arrangement do not need to achieve a specific performance in relation to fire resistance."*

Fires where smouldering combustion has occurred in a cavity wall resulting in the Fire and Rescue Service needing to be called back one or more times to deal with hot-spot flare-ups are well documented. Repeat visits to a fire ground, to chase fire(s) in hidden voids, represents both a risk to building occupants and is an unacceptable burden on Fire and Rescue Service resource. See also the work cited in Example 5 (above) regarding the research work by Wiesner et al (March 2022) *Structural fire engineering considerations for cross-laminated timber walls* [65], which revealed that even after flaming is extinguished, structural failure may occur due to continued heating of the timber, at depth, by conduction. These issues may be exacerbated if further smouldering or unseen combustion is also present.

Until relevant data for innovative construction typology can be obtained from testing at scale, the reaction to fire classification as well as any additional easy-to-obtain evidence (see Example 5 *Deep dive – Volumetric construction, Fire testing of combustible construction, Monitoring the cooling period after standard testing* (above)) could provide useful additional indicative data as to the material's fire robustness but should be considered in the wider context of missing large scale performance data.

Low-carbon concrete

Low-carbon concrete can entail substituting some of the Portland cement and/or aggregate and potentially all the steel reinforcement. Portland cement (which has the biggest carbon footprint of concrete's ingredients) can be substituted, in part, by fly ash (from pulverised coal), pozzolana (from volcanic material), calcined clays rich in kaolinite and ground limestone. The dredged (or quarried) aggregate can be replaced in part by recycled crushed construction (or industrial) waste. A range of paper have been published, by others on these topics such as alternatives for concrete, including the use of rubber crumb as a replacement for some of the sand quotient in concrete [159]. Steel reinforcement replaced by innovative materials like basalt rods and or polypropylene (or other) fibres[160] [161].

A precautionary approach (in the short to medium term), to fully understand the fire characteristics of low-carbon cements and low-carbon concretes, might entail monitoring market uptake of the different technologies. This monitoring work could be undertaken in conjunction with extensive medium to long-term test programmes.

Test programmes in the medium term might catalogue the reaction to fire properties and fire resistance properties of concrete comprising different low-carbon technologies and compare these new low-carbon technologies with concrete made from ‘traditional’ mixes, incorporating steel reinforcement. The treatment of joints and connections in low-carbon concrete technologies, and their performance during fire testing, would merit research. Outcomes of such research could be compared to the performance of joints and connections in traditional concrete.

The programme of research could extend to a detailed study of the effect of both gradual cooling and rapid cooling events on low-carbon concrete and traditional concrete for comparative purposes. Rapid cooling events would simulate the effect of thermal shock caused by the application of firefighting water to the structural element including where possible mechanical/adhesive (if these become popular) forms of joints. More data would always be useful, to further industry’s understanding of spalling and cracking in traditional concrete.

An aspirational long-term research and testing programme could give consideration to the effect of ageing, accidental (long term) wetting events and or high humidity events on low-carbon concrete, to determine if there is any diminution of performance when subsequently subjected to reaction to fire and fire resistance testing, including gradual and rapid cooling event testing.

See also Example 5 (above) on how heavy massy construction has proven itself during extended duration fire events. These test programmes should set out to show if any of the low-carbon concrete technologies perform differently to traditional heavy massy reinforced concrete.

AD B guidance could be amended depending on the outcome of such research.

Low-carbon steel and protective coatings and encasements of steel

Steel has traditionally been made using a blast furnace which utilises coal and coke to melt iron ore. This is the blast furnace-basic oxygen method of steel making, which produces very high carbon emissions. Steel made using the blast furnace-basic oxygen method (can utilise up to 30% scrap steel). Steel made using this method is often referred to as being primary path steel.

The modern furnaces are electric arc furnaces. Steel made in the electric arc furnace uses 100% scrap steel, which is melted in the furnace and mixed with carbon [162]. The resulting steel has slightly higher carbon and nitrogen content than the steel made using the blast furnace-basic oxygen method. Steel made using the arc furnace method is referred to as secondary path steel.

Primary path steel contains less impurities than secondary path steel although the resulting strength can be the same and the view expressed by the steel industry, is that steel made using the electric arc furnace method is ‘infinitely’ recyclable [163]. The quality of secondary path steel does depend on the quality of the scrap supply to eliminate ‘unwanted effects’ caused by ‘residual elements’ in the scrap material [164]. The two grades of steel most commonly used in construction in England are S275 and S355 however, many different grades of structural steel could find their way into construction in England (S195, S235, S275, S355 and, specialist higher strength structural steels e.g. S420 and S460). Structural steel now also comes in multiple subgrades (JR through to QL1) which refer to increased resistance to brittle fracture. It is not clear how many of these grades were available when AD B (2006 edition) was being considered and this point should form part of future considerations for revisions to the AD B.

It would be reasonable for AD A and AD B to seek evidence to challenge or endorse the claim that secondary path steel is 'infinitely' recyclable (with no loss in consistency of the finished steel time and again). The 'Key statistics' data for annual crude steel production in the UK show steel made by the secondary path method has stood at approximately 20% of the total tonnage produced, from mid-2000s through to the mid-2020s. To meet CO_2 emissions reduction targets, it is reasonably foreseeable that the majority (possibly near 100%) of streel production, in the UK in future years, will move to the secondary path method of manufacture. AD A and AD B should keep this under consideration and what it may mean (if anything) for research and both guidance documents.

Some construction products can be identified by markings, for post installation identification. By way of example, aerated concrete blocks can be identified by the number of scratch marks on their fair faces, thereby allowing identification after installation. Our research suggests that imported steel is marked at one end of stock lengths, which can be of the order of 15 m or longer. Once fabricated any CE or UKCA marking may be inaccessible for post installation identification. Given the variability of the grades and subgrades some form of legible (recurring) marking would seem to be a relevant consideration for fabricators, constructors and AHJs.

AD B previously provided guidance on fire protection of steel when it referenced the Association for Specialist Fire Protection guide, The Yellow Book *Fire protection for structural steel in buildings*. The Yellow Book was not referenced in the AD B (2019 edition) or subsequent editions. The Yellow Book, current at the time of writing, is the fifth edition (July 2014). The removal of this reference raises reasonable questions such as:

- Was the omission of the reference to the Yellow Book an oversight, or intentional?
- Does Government intend to conduct research, and / or issue new guidance on fire protection for structural steelwork?

If a short review takes place, the Association for Specialist Fire Protection (ASFP) four Advisory Notes (issued in July 2020) in relation to fire protection of structural steel, would appear to be relevant. If a wider review is considered relevant perhaps a deep-dive literature review could be conducted of academic research as well as technical guidance.

Advice could be sought (from experts in steel design and fire protection) as to whether consideration should also be given to fire resistance testing of the different grades and subgrades of steel when protected using different types of fire protection materials and systems.

Similar to the considerations and underlying reasons for research and testing in the medium to long term for low-carbon concrete, structured research and testing should be conducted on different grades and subgrades of steel (including 'infinitely' recyclable steel, since it is reasonably foreseeable that the majority of steel manufacture in UK is likely to be secondary path in the future) and that the research and testing could look at gradual cooling and rapid cooling events of steels and their fire protection coating systems.

An aspirational long-term research and testing programme could give consideration to the effect of ageing, accidental (long term) wetting events and or high humidity events on fire protective systems. The results may show differences in performance of different protective systems.

A visible difference in the type of beams used in building design in the mid-2020s, when compared to those in common use when AD B (2006 edition) was being considered, is the extent of use of cellular beams (previously called castellated sections). Cellular beams are intended to span further than their parent-section solid-beam equivalents, and the apertures in the webs allow services to pass through.

How these beams should be fire protected and tested is something that AD A and AD B should consider and address. It is reasonably foreseeable that damage is likely to occur to some of the paint applied fire protection systems when ducts, pipes, cable trays etc, are threaded' through the openings overtime and use.

AD B may wish to consider horizon scanning in the short to long term for any research or industry guidance around steel manufacture involving technology changes and use of recycled materials. If it emerges, over time, that there are any concerns over the quality of the scrap steel giving rise to undesirable 'residual elements', or if the manufacturing process changes (e.g. hydrogen-based steel production) [Ibid], or if imported steel is found to not meet our requirements then early testing, investigation and advice in both AD A and AD B would be better than a reactive response.

Thin/lightweight floors

As part of this project, it has been noted that new innovative, structural floor systems are coming to the market which are very thin. One system used 'thin shell' vaulted concrete (with a raised service void above) [165] and another was a sandwich plated system (SPS) – comprising steel facing sheets with a rigid polyurethane elastomeric core [166]. Example 9 (above) considered how, to an increasing extent, clients are becoming more discerning, when it comes to reducing carbon emissions and how they are more prepared to demand that their buildings demonstrate lower carbon emissions. The 'thin shell' vaulted design boasts that it uses 75% less concrete than a traditional concrete floor slab and the SPS system claims to be 75% lighter than a conventional reinforced concrete floor. These numbers speak to the debate on making significant carbon reductions. Whether either or both technologies (or new entrants) will play an increasing role, as industry gets closer to the 2050 deadline for achieving net zero, will remain to be seen.

The question is whether AD B views ultra-thin floors as being uncommon and therefore outside of the scope of the guidance or, that it adopts a precautionary conservative approach until more is known. A precautionary approach may involve more monitoring of the scale of uptake of ultra-thin floors, and research into the performance of buildings with ultra-thin, ultra-light technologies in general. A clear opportunity for the ultra-thin, ultra-light sector is described in Survey Issue 1f (below), which raises the concern that the 11 m threshold could be gamed, by lowering storey heights in order to secure a fifth storey. The considerations explored in Example 5 (above) regarding the need to demonstrate robustness would appear germane when considering all forms of light and ultra-thin typologies.

AD B (2000 edition) gave new guidance in on insulating core panels at Appendix F: *Fire behaviour of insulating core panels used for internal structures*. The AD B (2019 edition) removed Appendix F in its entirety, and consolidated some parts of it into a single section, under Schedule 1 relevant requirement B2: *Internal fire spread (linings)* (requirement B2). The concept of SPSs, when used as elements of structure, could have been dealt with in an expanded Appendix F. Investigating the application of these designs, as part of this project, has revealed that SPSs have been used as structural floors in England for office buildings and for sports stadia. The exact scale of uptake is not known since there may be more than one manufacturer/system in the market. The precautionary principle would suggest revised and expanded guidance is needed in AD B on precautions to take when SPS's are intended as floors and where, and under what circumstances, they can and cannot be used, safely.

The guidance introduced in AD B (2000 edition) at Appendix F made clear that during a fire event, certain cores will produce considerable quantities of smoke and delamination can occur, resulting in loss of strength. Both these observations are highly relevant material considerations for fire safety, when the panels are used as a floor.

AD B is silent on structural SPS panels under schedule 1 relevant requirements B1, B3, and B5. Considerations might include whether SPS floors can be used in all or only some situations, and whether there are limitations on their use in certain buildings due to their size or their occupancy levels. Consideration should be given to the guidance relating to sports stands and this guidance should dovetail with the Sports Grounds Safety Authority *Guide to Safety at Sports Grounds (Green Guide)* [167].

The classification for floorings (fl) to BS EN 13501-1 does not extend to consideration of the potential smoke generation arising from a laminated product of this type as the tests that are referenced in BS EN 13501-1 for floors is only designed to look at the performance of the upper surface finish. It is also of note that the classification for flooring products to BS EN 13501-1 only addresses s1 and s2 classes of smoke production, where s2 means that there is no upper limit set for smoke production.

This project has not been able to consider structural integrity of these SPS's since structural fire resistance data was not readily available.

The same precautionary considerations could apply to masonry units where core material is, in part, replaced by either cellulosic or other recycled material. If there is material substitution, testing should be conducted. Like the suggestion for low carbon concrete above, industry should know by testing whether low carbon masonry units exhibit different properties as the units age. For masonry, exposed to the elements, it would be advisable to consider testing to discover the effects of long-term exposure to sunlight and weathering and sea air in coastal locations.

Highly engineered materials and spaces

Engineers continue to develop sophisticated tools for understanding of structural loading scenarios (load paths and redundancies). This understanding is a key driver in spatial optimisation, and this builds competitiveness: increasing areas available for rent/sale, reducing 'dead' space, increasing the profitability of schemes.

Observations on commercial buildings are that open plan uncompartmented space is still popular with a desire for interconnected places and circulation spaces. Visual separation techniques can create a sense of dividing space without physical barriers.

Some examples were collated with input from partners, the Technical Steering Group and experts and networks through interviews, meetings and interactive discussion sessions.

The interviews were broadly scripted and addressed typical experiences in broadly three categories of 'innovative' reach in relation to AD B:

- Construction technology
    - The new materials/products/components currently in use
    - The new systems that these new materials/products or components become part of
    - The nuances of construction sequence/type (perhaps preventing assessment)
- Design
    - The designs believed to be commonplace for which AD B is no longer keeping pace
    - The type of analysis considerations e.g. Computational fluid dynamics believed to be commonplace for which AD B is no longer keeping pace. The use/inappropriate use of design evidence: supporting commonplace designs for regulatory submission

- Building use
    - What building uses and complexities are considered commonplace for which AD B is no longer keeping pace
    - Difficulties with the definition of 'common building'
    - Client expectations and any other considerations thought relevant

Some typical and specific innovative, modern construction technologies, building design and building use examples of these developments are shown in Figure 12.

Figure 12 – Typical and specific examples of modern building use, construction technologies (materials/systems) and building design
Montage of cropped images from © Lukas Pelech (left), © Matthew Millman (centre) and other unknown source (right)

3.3.9 A historical perspective

Some of the societal drivers are not unique to the mid-2020s. The solutions sought by this generation of construction professionals, engineers, manufacturers, constructors and innovators are not unprecedented in their entirety, and some of the lessons learnt are of relevance for considerations today and in the future. One such example is the use of prefabricated, panelised construction, of varying levels of prefabrication, addressing the lack of skilled work force and a shortage of homes in the 1950s. Large Panel System buildings (LPS) became popular in the UK in the 1950s enabling a construction boom, providing modern dwellings for families, maximising useable space and offering open plan, spacious interiors for occupants seeking high-rise living, near urban areas with good transport links and amenities. Examples of Large Panel System buildings can be seen in Figure 13.

Figure 1: Bison LPS dwelling block *(courtesy Sandwell Metropolitan Borough Council)*

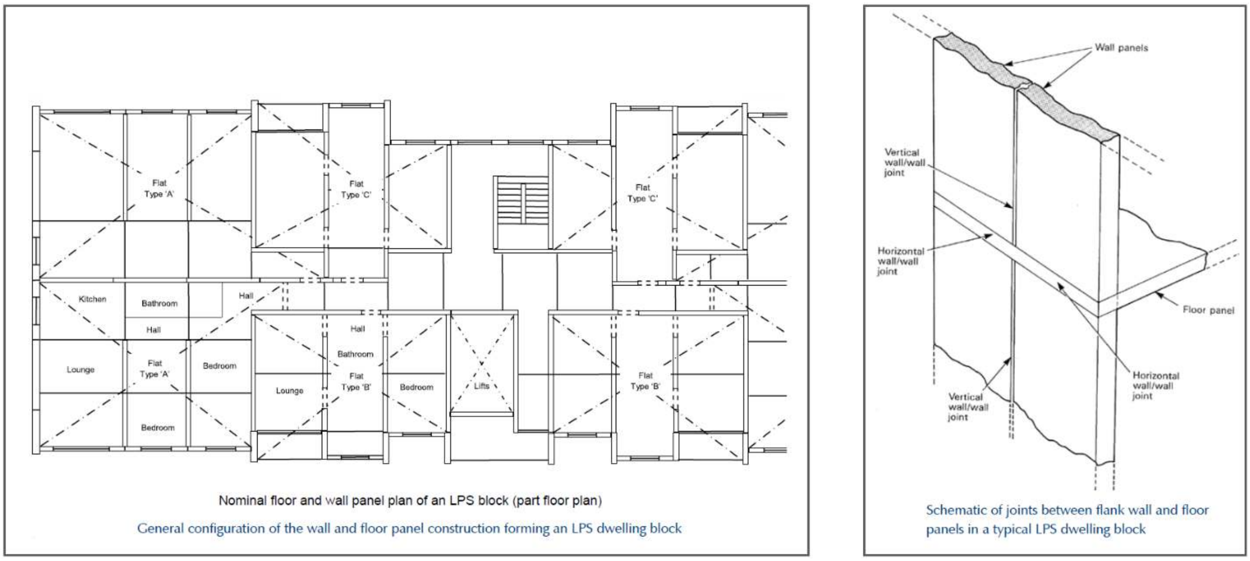
Figure 2: Reema Conclad LPS dwelling block *(courtesy Leeds City Council)*

Figure 13 – Examples of Large Panel System buildings [168]

The advances of the prefabrication process were seen to increase quality control and leave only few on-site activities at predictable skill requirements. The LPS system buildings were considered at the time to have delivered on the key prerequisites of achieving faster construction times and repeatable quality. These prerequisites have remained popular through the decades and are arguably as relevant to today's industry challenges. Another parallel, borne out and confirmed by this work, is the importance of detailing, specifically jointing as a function of construction sequencing, which has been a constant concern throughout this time.

The partial collapse of Ronan Point in 1968, a 22-storey LPS structure, caused by a minor gas explosion in one flat, highlighted the importance and vulnerability of the jointing of these prefabricated and site assembled systems. Both design approach and site execution were highlighted as key requisites for achieving appropriate robustness, a term introduced as the learning emerged and used worldwide since then. The traditional forms of construction commonly used, in construction sequence and materials/systems, allowed for constitutive provisions of redundancy, the structure's way of finding alternative loadbearing paths to sustain accidental events.

The change in construction approach put more reliance on the joints connecting units, see right hand image in Figure 14. The capacity of the joints (their strength and ductility) was seen to be the overriding factor in preventing failure, disproportionate to any originating cause.



Nominal floor and wall panel plan of an LPS block (part floor plan)

General configuration of the wall and floor panel construction forming an LPS dwelling block

Schematic of joints between flank wall and floor panels in a typical LPS dwelling block

Large Panel System structures typically comprising precast reinforced concrete floor and roof components Spanning onto storey-height structural precast concrete wall panels. Connections use various site-made

Figure 14 – Standard layouts and site made joints [168]

The concept (and definition) of 'proportionality' of damage to an event, foreseen or unforeseen, was also introduced in the aftermath of Ronan Point and has remained key to engineering design and decision-making in the structural engineering realm. Schedule 1 Requirement A3 Disproportionate collapse – see extract in Figure 15 was introduced after Ronan Point and has stood the test of time and forms a key provision of design codes throughout the world.

DISPROPORTIONATE COLLAPSE **A3**

The Requirement

This Approved Document deals with the following Requirements which are contained in the Building Regulations 2010.

Requirement	*Limits on application*
Disproportionate collapse	
A3. The building shall be constructed so that in the event of an accident the building will not suffer collapse to an extent disproportionate to the cause.	

Figure 15 – Approved Document A showing Schedule 1 Requirement A3 Disproportionate collapse [169]

The concept of guarding against a disproportionate outcome in relation to a fire event is considered in this project. In Example 5 (above), heavy massy construction is described as being inherently fire resilient and robust and not associated with disproportionate fire outcomes from reasonably foreseeable fire event(s). This is in direct contrast to the themes discussed in Survey Issue 1b (below) which suggests combustible construction is vulnerable to disproportionate outcomes from reasonably foreseeable fire events; because the building frame can become consumed during an extended duration fire.

The impact of construction detailing, workmanship, performance, and overall reliability has also been considered in other, non-structural aspects of building performance where a need for regulatory compliance exists. Schedule 1 Requirement E: Resistance to the passage of sound is such an example, where the Robust details scheme is an alternative to pre-completion sound testing for satisfying Part E: Resistance to the passage of sound, of the Building Regulations, see Figure 16.

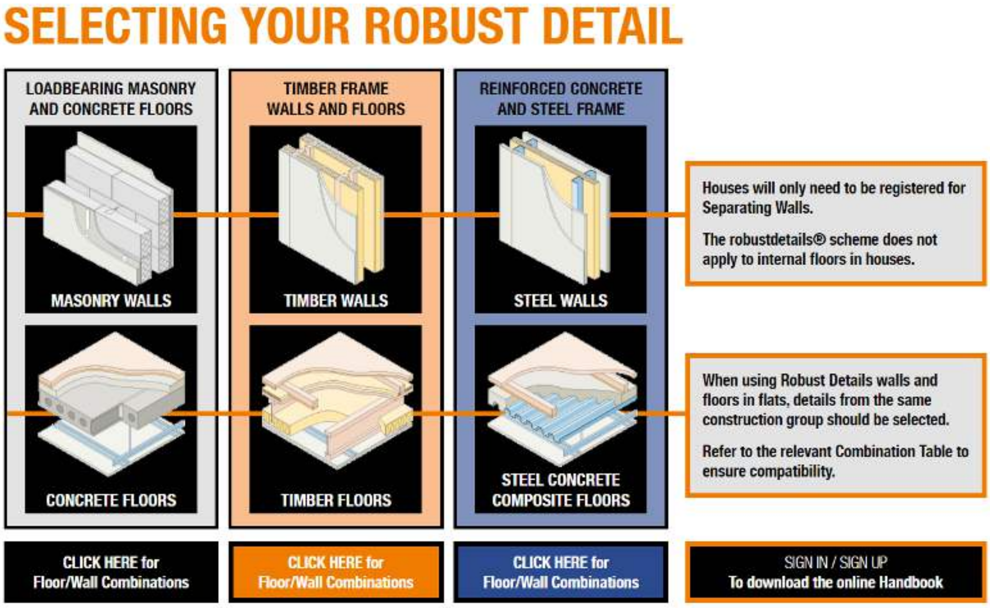


Figure 16 – Robust details scheme options for various forms of construction [170]

3.4 Other DLUHC research and previous MHCLG consultation

Note that the text in this section was completed in May 2021 and as such relates to initial (headline) information that was collected on other current DLUHC research projects at that time. This section raises questions that are not necessarily being specifically addressed in these other projects. It is understood that these projects have progressed, and research directions may have altered. For definitive information about these projects, refer to each of the respective Final reports, as and when they become available.

3.4.1 Introduction

A number of DLUHC research projects (Part B workstreams) covering different related subject areas were undertaken in the early 2020s. The ones identified as being directly relevant to this project included:

- Specialised housing and care homes
- Means of escape for disabled people in buildings other than dwellings.
- Trigger heights and thresholds
- Structural fire resistance and fire separating elements
- Balconies, spandrels and laminate glazing

Another project relevant to this study was the MHCLG/DLUHC Investigation of real fires project.

Feedback was sought via review of available reports and meetings on main observations with project leads (see sections 3.4.2 to 3.4.6). A general overview is provided for each project and, where relevant, specific modern construction technologies, design and building use. A number of other ongoing projects with potential relevance to this work had not sufficiently progressed at the time of writing this section of this report.

The essence of each Part B workstream seen to challenge a modern building technology, design or building use (covering AD B Volume 1 and/or Volume 2) was fed into the interactive Technical Steering Group session (see section 3.6).

3.4.2 Specialised housing and care homes

This Part B workstream aimed to assess the provisions in AD B relating to specialised housing – sheltered, extra care, supported housing and other forms of accommodation for elderly and or vulnerable people. The project also considered what could be done for vulnerable residents living alone in dwellinghouses. The scope of the specialised housing workstream entailed looking at whether AD B caters for inclusive design and whether specific provisions might be helpful.

This workstream considered the degree of engagement of building management with disabled people and pre-planning of and resourcing evacuation strategies.

This workstream aimed to identify the latest anthropometric data, the range of impairments, demographics (both current and predicted), evacuation alerts/aids and technologies.

Initial considerations following discussions with the project lead suggested:

Challenges relate to the Introductory sections in AD B

- The project team felt that consideration could be given to operational and management practices in the early stages of an evacuation, prior to the arrival of the Fire and Rescue Service – see also guidance in AD B (2020 and 2022 editions) at paragraph 0.6. The initial thoughts of the project team were that there needed to be a discussion around residents' speed of reaction during the pre-movement stage, and speed of movement during the horizontal evacuation stage. The project also hoped to look at vertical evacuation – see also both volumes of AD B at paragraphs 0.8 to 0.11).

Challenges relate to B1: *Means of warning and escape*

- BRE Global has been unable to identify any specific research looking at whether older, more frail persons (including those with medical or other considerations) need to take a rest when traversing escape corridors during fire evacuation. This may be particularly relevant during a larger evacuation event, and the speed of evacuation will vary from resident to resident. In AD B there is no guidance about sub-division of common corridors, in housing typologies in purpose group 1(a), for the purpose of providing respite for persons en route to stair enclosures. This is in contrast to AD B Volume 2 (paragraph 2.35 – for care homes) which does give guidance on progressive horizontal evacuation for residents to access adjacent protected area(s) providing relative safety and respite, before they commence their vertical evacuation. The conversation that might emerge from this study (for care homes) is whether consideration should be given to the less mobile people or people with other less apparent disabilities, rather than only making provision for people unable to leave their beds.

- See Example 7 on co-living (above) and Example 10 on extra care and Example 11 on dignified escape from flats (below) for more discussion. From initial discussion, it is clear that there has been considerable growth in new housing typologies and user expectations regarding escape in case of fire. In terms of expectations during a fire event, this relates to the freedom to 'choose' to escape as opposed to merely being 'facilitated' to stay.

- A question that may be addressed in the study relates to the size of refuges (at landings in stair enclosures) and what facilities should be provided in them? The AD B Volume 2 (paragraph 3.4) guidance is that stair lobby refuges *'…offer relatively safe areas for people to wait…'* and at 3.4(c) '*The number of refuge spaces does not need to equal the number of wheelchair users who may be in the building'*. The workstream hoped to consider whether AD B guidance on refuges was appropriate and adequate for the needs of the present population. Another matter the project hoped to consider was whether evacuation lifts could play a role in evacuation in specialised housing and care homes? This last point is explored further in Example 11 (below) and considers provisions necessary to facilitate dignified escape for disabled people. If evacuation lifts could play a role, consideration would need to be given to whom would operate the lift controls. What degree of engagement has been expected by the building's management team for each of the different typologies in the specialised housing sector and what should be expected? Could/should residents operate suitably fire protected lifts?

- <u>Dignified escape</u>. Rather than having to use an evacuation chair for an assisted escape or having to 'bump' down flights of stairs, initial findings were that wheelchair users would much prefer to use an evacuation lift. Designing buildings with suitably protected evacuation lift(s) would, in most instances, would represent the best way to achieve dignified escape to a place of safety at ground level.

  Even if wheelchair users were happy to use an evacuation chair or 'bump' down flights of stairs (unassisted), there is always the question of what happens at the bottom of the stair? Is the individual's chair following on behind, or is it likely the chair will be left in a refuge on an upper floor? For an individual reliant on their wheelchair, to make autonomous (dignified) decisions about their own mobility, consideration extends beyond their descent in a building to their dignity once they are outside the building.

  Facilitating choice to leave rather than provision of facilities to stay, would be a sea change in approach to provisions for means of escape, for disabled people.

<u>Further consideration by BRE Global on how specialised housing is being used and the challenges for AD B</u>

The sheltered housing typology aims to attract pre-retired and retired (generally over 55) who are physically active. The model assumes residents will not need much help, but as they age, and their needs become more acute, they would move first to a care home and thereafter a nursing home. Sheltered housing schemes traditionally had a 24/7 on-site warden. From 2003, this arrangement changed and they subsequently became available during working hours only. Today, most wardens are based off-site (sometimes in remote monitoring centres), and a telecare radio alert system has become a fundamental alarm alerting system, see AD B Volume 1 (paragraph 1.12).

The extra care typology, as the name suggests, caters for persons who may need an even greater level of 'care' or 'assistance' than would be the case in sheltered accommodation. See Example 10 (below) which shows that extra care schemes can have very large complexes. Some schemes that identified whilst researching this typology are only available to persons over 65 years old. It is not unusual to see all the features one would expect to see in high end hotels integrated into some of these buildings.

Further consideration by BRE Global on the growth of the extra care sector and purpose groups:

A Royal Institute of British Architects' study suggests that by 2024 one quarter of the English population will be over 60 years-old [171]. A Housing Learning and Improvement Network (LIN) report [172] repeats a Government forecast that: "*…the number of people aged over 80 is set to rise from around 3.2 million today to [5.0] million in 2032. Meanwhile, the number of people aged 100 or over has increased by 85% over the last 15 years, with 14,430 centenarians living in the UK.*" Also, "*…the number of people aged 80 or over who will suffer from falls is expected to rise from 1.6 million today to around 2.5 million in 2032, a rise of 900,000. In line with this increase, by 2032 the total cost to the NHS of falls amongst the elderly will rise to £2 billion a year.*"

A Knight Frank report [173] points to a market shift taking place in the specialised housing sector to suit this shift in demographics. In 2006, approximately 24% of homes in the integrated (Extra) care sector were for private sale/rent and 76% were for social rental. The report predicts that by 2026 these percentages will have shifted to approximately 40% of homes in the integrated care sector being for private sale/rent and 60% being for social rental. The market is very active and not nearly at its peak.

The All-Party Parliamentary Group Inquiry (Housing and Care for Older People) *Rental Housing For An Ageing Population* (2019) [174][20] has also identified this growth in supply in the private sale/rental sector. The report believes some 1.1 million additional homes will be needed by the late 2040s – this equates to a rate of building of 38,000 new units per year. The report cites benefits of community living, including making less demands of the NHS and concludes that designing homes for the elderly "*…saves the NHS huge costs on hospital admissions, delayed discharges and readmissions*" and "*…community housing [permits] hospital patients to be discharged into appropriate housing sooner*". These findings resonate today – delayed discharges from hospitals and ambulance response times are frequently covered in the news media as being interdependent 'problems'.

The sector not only satisfies a genuine need for the elderly, but Government may agree that growth in this sector has benefits elsewhere i.e. it can reduce pressure on the NHS and Ambulance service and free-up the supply of larger family homes back into the housing market.

[20] This report is the work of an all-party parliamentary group that has produced five reports on housing for an ageing population. The first report was issued in 2009.

Given the predicted level of activity in the market (see evidence from [172] and [173] above) a critical first stage for designers and regulators is to understand the different subgroups under the general name of specialised housing. In 2017, the National Fire Chiefs Council (NFCC) *Fire Safety in Specialised Housing* guide tried to shed light on the many different typologies within the specialised housing 'genre' [175]. The typologies include:

Sheltered housing – This is sometimes referred to as *self-contained residential accommodation* and/or *retirement housing*.

Extra care housing – This is sometimes referred to as *very sheltered/assisted living and/or housing with care and/or assisted living and/or integrated care and housing and/or close care.*[21]

Supported housing – This is sometimes referred to as *housing in the community* and/or a *group home* whether staffed or not. Other terms used [176] include *wheelchair adaptable housing, wheelchair accessible housing, co-housing, lifetime homes, specialised dementia care and residential home*. There may be more names and more nuances developing all the time.

Further consideration by BRE Global for refuges in extra care premises:

The following can be considered, in addition to Example 7 (above), and feeds into discussions around purpose groups.

The following typologies (within the specialised housing sector) are set out in order of increasing patient need/dependency; sheltered housing, extra care (including very sheltered and close care), residential care home and nursing home.

The guidance in AD B Volume 1 (2019 edition with 2020 and 2022 amendments) (AD B Volume 1) relating to sheltered housing is very light touch and mostly 'cautionary', although there is specific guidance on fire alarm configuration. There is detailed guidance in AD B Volume 2 (2019 edition with 2020 and 2022 amendments) (AD B Volume 2) for horizontal escape, intended for Residential care premises. The guidance of AD B Volume 2 at paragraphs 2.35 to 2.40 inclusive, describes progressive horizontal evacuation whereby, during a fire event, the population in one ward (a 10 bed sub-compartment) is facilitated to be able to move horizontally to the next ward, through a compartment wall. Paragraph 2.40 states that the "*… adjoining protected area should have a floor area able to accommodate its own occupants plus those from the largest adjoining protected area.*" Each adjacent sub-compartment is, in effect, a temporary refuge.

It is not clear where one turns to for guidance on extra care compliance.

A refuge in a stair is considered a place of relative safety for a wheelchair user and assistant to await rescue. In their absence, or at the same time, the space may be shared with a person/people having a walking disability and in their absence any person and their assistant needing temporary respite whilst on a vertical descent. The guidance on size of refuges (see bullet point above under the heading *Challenges that relate to B1: Means of warning and escape*) in AD B Volume 2 at paragraph 3.4 (c) is noted, in the context of a wheelchair user. However, the end point of progressive horizontal evacuation in a residential

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[21] Whilst researching this BRE Global encountered a term *Flexicare housing.*

care home is vertical (mattress) evacuation or a managed evacuation using evacuation lifts. The intended wheelchair waiting space will, in all probability, be used to set down, reposition and turn a mattress within the stair.

In the context of extra care homes, where it is reasonably foreseeable that many residents will use mobility scooters or conventional wheelchairs, or other mobility aids it appears that AD B Volume 2 paragraph 3.4(c) would result in very small provision to assemble and wait. This would become particularly apparent in circumstances where the Fire and Rescue Service abandon stay put in favour of simultaneous evacuation. See Example 11 (below) on dignified escape and the ability to choose to leave, that would require reconsideration of refuge areas.

Example 10

Driver: The underlying driver in this example is the need to provide housing for the ageing population for all the reasons (above).

Evidence: The evidence arises from the different typologies in the specialised housing sector.

Implication for AD B: The material challenge to AD B is whether it is current for these typologies.

The sheltered scheme concept of the 1970s and 1980s has evolved into new typologies, the most prevalent being the extra care group (described above). The specific challenge to AD B therefore, is whether there should be bespoke guidance for extra care housing and whether guidance should fall under purpose group 2(a) or a new purpose group.

The predictions (above) on population change over the next century (the number of sexagenarians through to the number of centenarians) the implications for the NHS and Ambulance service, the growth of and financial investment going into the extra care sector, all suggest, that this housing typology needs consideration, review and definitive AD B guidance. The initial considerations following discussions with the Part B workstream project lead, for the project *Specialised housing and care homes*, suggested (at the time of the discussion) that the workstream was considering very broad themes. The themes included (to varying degrees) management's role in event of fire, the speed of movement of the residents, places of relative safety (refuges – how large?) travel distances in corridors and dignified escape.

This specific example of extra care housing is predicated on all the above considerations and included here to showcase the difficulty for designers, constructors and Authorities Having Jurisdiction (AHJs) in ensuring fire safety in these buildings and knowing what guidance applies to what typology, especially as the boundaries in practice seem indistinct. It is also included to reflect several interweaving considerations in Examples 4 and 6 (above) and Example 11 (below).

The guidance in AD B Volume 1 for sheltered housing is light touch and mostly 'cautionary', although there is specific guidance on fire alarm configuration. AD B Volume 2 provides detailed guidance on residential care homes and specific guidance on the arrangement of beds and corridors and the concept of progressive horizontal evacuation. There is a guidance vacuum between the provisions for sheltered housing in AD B Volume 1 and the provisions for residential care homes in AD B Volume 2. The NFCC *Fire Safety in Specialised Housing* guide reminds the reader of the nuances between the specialised housing typologies and the sheer number of them. Consideration could be given to reviewing each of these typologies and exploring whether new ones have since emerged. More clarity and guidance on each in AD B would be very welcome.

It is noted that there has been a slight re-ordering of some of the words in what was Table D1 *Classification of purpose groups,* in AD B (2000 edition) to Table 0.1 *Classification of purpose groups,* in both Volumes of AD B. The changes of substance, in the intervening 23 years, amount to just the removal of the words '*place of lawful detention'* (from Institutional use) and the addition of '*rental of storage space to the public'* (to shop and commercial use). Such minor revision over 23 years points to a need for a meaningful review of purpose group definitions and, more a detailed review of the guidance provisions that apply to each. Such limited change over 23 years suggests that review of AD B really must be iterative. This would be best achieved by constant horizon scanning.

The NFCC guide shows the breadth of typologies in the specialised housing sector and provides information and statistics on fire risks. BRE Global has seen marketing literature for extra care schemes where the minimum age is as high as 65 and, as with sheltered schemes, the expectation is that residents come into extra care as physically active persons for whom additional or 'extra' care can be provided (purchased) as their needs change. BRE Global has seen that some scheme providers seem to offer a range of typologies on the one site, suggesting the sector is becoming increasingly complex. It is a very real challenge for the AHJs to make the right call on what constitutes reasonable provision for this type of accommodation. BRE Global has seen extra care housing described as belonging purpose group 1(a) and therefore akin to 'general needs' housing. Were extra care to be described as belonging in purpose group 2(b) it is noted that the AD B Volume 2 guidance limits itself to sheltered housing and then only to focus on compliance with Requirement B4 and Regulation 7(2).

A Housing Learning and Improvement Network Technical Brief (No. 5) by Standish, Faithful and Gould in association with the Department of Health *Fire Safety in Extra Care Housing in the UK* [177][22] points to timber frame being a favoured construction method, accounting for 60% of the new builds of extra care accommodation. The considerations of Example 4 (above), which apply to mid-rise buildings up to nine storeys high, would appear very relevant for such tall extra care schemes, if comprised of combustible construction. The considerations of Example 6 (above) would also appear very relevant, as it is reasonably foreseeable that there will be more mobility scooters in extra care schemes than would be likely in general needs accommodation. Also, as Approved Document M *Access to and use of buildings* (AD M) paragraph 3.25 guidance is more widely adopted (in new schemes) with each flat having up to two scooters on charge close to the front door, the risk increases. The risk is higher yet, if the construction of an extra care facility is comprised of combustible material, and if the building has a stay put fire strategy. Almost all private extra care schemes offer leasehold flats for sale. This is also seen to be significant in the context of Example 6 (above) since building management would not necessarily have a right to inspect a private flat to see how the fire safety features are being maintained and how scooters are accommodated and charged.

[22] BRE Global has not been able to find revised data for preferred construction typology between 2010 and 2023.

Whilst BRE Global notes many extra care facilities have a top storey less than 18 m above ground, there are several schemes now operational which have nine or 10 (or more) storeys. Examples include [178] [179] [180] [181]. The look and feel of some of these extra care schemes are akin to a high-end hotel/private club. A couple of private sector schemes were noted to include communal facilities including a private garden, gymnasium, spa, restaurant, lounge (including a large library) games room, exercise studios, and even a cinema.

The social sector schemes can offer some of the same features in their developments. The concept of being able to exercise choice as to whether to leave a building during a fire event or to stay put is at the heart of the discussion in Example 11 (below). This is certainly now the case in London, with the advent of the London Development Plan accordingly, dignified escape and would equally apply to these mid-rise and high-rise extra care facilities.

Challenge to AD B arising from Example 10	
B1	The Specialised housing typology has produced many sub-typologies since the 1970s and 1980s. There is no guidance in either Volume of AD B for extra care (or its closely allied typologies of very sheltered or close care housing). See Town and Country Planning guidance on dignified escape and evacuation lifts in Example 11 (below). It is not known how these typologies accommodate residents – presumably all ages, abilities/mobilities and needs are mixed? On any floor there may be a mix of elderly active, with those who have assistance needs, and those with more profound assistance needs. The more profound the assistance need, the greater the chance that the individual will be slower in the pre movement and movement stages of an evacuation. Many residents may have mobility assistance devices.
B3	The considerations of wheelchair parking and lithium-ion batteries enclosures and refuges are also of concern.
B5	The risks of adopting a stay put strategy in an extra care home, where the fabric is comprised of combustible construction needs to be discussed more widely before conclusions can be drawn and guidance provided. There will need to be a reconsideration of reasonable provision for Fire and Rescue Services too.

See also section 3.3.5. (above) for discussion on some of the issues associated with supported housing and group homes. The guidance in AD B refers to HTM 88 but this was withdrawn from the NHS website guidance in November in 2008, see [120].

3.4.3 Means of escape for disabled people in buildings described as Other than dwellings

This Part B workstream aimed to take a fresh look at disability, considering physical and cognitive factors as well as wider definitions of ability. The project scope encompassed common buildings, not complex buildings e.g. airports or fire engineered buildings. Fire engineered strategies fully in accordance with BS 7974: 2019 [1] (and its seven published documents) lay outside the scope of the project.

The project considered the 'egress' provisions, as set out in AD B Volume 2. These provisions can be contextualised and contrasted with the emphasis placed on access to buildings, made successful by Schedule 1 requirement Part M *Access to and use of buildings* [92] and the Equality Act 2010 [182].

The project aimed to identify the latest anthropometric data, the range of impairments, demographics (both current and predicted) evacuation alerts/aids and technologies. The project hoped to consider the degree of engagement of building management with means of escape for disabled people. At the time that feedback was sought from the project leads, work had already begun, considering evidence from disabled people of their experiences of building evacuations and human behaviour during such evacuations. The intention was to critically appraise what disabled people felt about the concept of dignified escape.

Initial considerations following discussions with the project lead suggested:

<u>Challenges relate to the Introductory sections in AD B</u>

- Section 0.6 Management of premises and 0.8 Inclusive design. It was felt there is a need for guidance on building management's role, in the early stages of an evacuation, prior to the arrival of the Fire and Rescue Service.

<u>Challenges relate to B1: *Means of warning and escape*</u>

- How large should refuges be? What facilities should be provided in refuges? Can communication systems be three-way? i.e. connecting to; i) the refuge, ii) the alarm receiving centre and iii) the Fire and Rescue Service, either directly to the call handlers (for fire survival guidance) and/or the Fire and Rescue Service command and control vehicle once established outside, or the bridgehead once set up. Guidance on the size of lobby and evacuation lifts to facilitate dignified escape was to be considered.

- <u>Dignified escape</u>. The same considerations described in section 3.4.2 (above) applied to this project. Consideration would need to be given by management as to who would operate an evacuation lift. Rather than having to use an evacuation chair for an assisted escape or having to 'bump' down stairs, wheelchair users would much prefer to use an evacuation lift. If an evacuation chair is used or if the person 'bumps' down stairs there is the question of what to do at the bottom of the stairs. Where is their wheelchair? Staying in their own chair for dignified escape is likely to be the preferred option. Temporary refuges may need to accommodate more than one person and one helper. Current sizing of refuges and perception of the 'typical' person waiting (resting/taking a breather) in a refuge needs consideration.

<u>Further consideration by BRE Global on how AD B Volume 2 guidance is being challenged</u>

- When a fire alarm is sounding, the 'noise' in a protected stair enclosure (and therefore the 'noise' in each refuge) can be as loud as 85 dB. It is nearly impossible to have a conversation via three-way communications system with such background noise. People that may be on the neuro-diverse spectrum may struggle to cope with such a noisy environment. Even if not a specific consideration for this Part B workstream, it would appear reasonable to mark this as an issue of modern building design, for AD B could consider in guidance provisions going forward.

- Might assistive technologies like wayfinding be a consideration for AD B guidance in some scenarios? A smart phone app may be a solution (for some people) e.g. in a gallery or shop. Hearing dogs may be a solution for others and there may be other unique solutions for people with different disabilities in other settings.

- Consideration should be given to the matters discussed in Example 11. Whilst these matters will apply to purpose groups covered by AD B Volume 1, they also apply to some of the specialised housing typologies and clear purpose groups covered by AD B Volume 2.

- Since 2nd March 2021, the Mayor for London's strategic vision for 'good design' provision across all 32 London Boroughs and the Corporation of the City of London came into effect. Policy D5(B5) Inclusive design in the London Plan requires:

  "In all developments where lifts are installed, […] as a minimum at least one lift per core (or more subject to capacity assessments) should be a suitably sized fire evacuation lift suitable to be used to evacuate people who require level access from the building."

  BRE Global notes the requirement applies on a core by core basis, as a minimum. The guidance also makes the following point:

  "All building users should be able to evacuate from a building with dignity and by as independent means as possible. Emergency carry down or carry up mechanical devices or similar interventions that rely on manual handling are not considered to be appropriate, for reasons of user dignity and independence. The installation of lifts which can be used for evacuation purposes (accompanied by a management plan) provide a dignified and more independent solution."

  It is therefore reasonably foreseeable that other Core cities and Combined Authorities may adopt similar policies if the implementation in London is considered successful.

3.4.4 Trigger heights and thresholds

This project aimed to identify every trigger threshold referenced in AD B and provide an objective analysis to prioritise trigger thresholds for further review. The project also considered subgroupings based on purpose group in order to identify differences between the purpose groups. Ultimately, the project intended to consider if the triggers of AD B in Volumes 1 and 2 reflected relevant up to date evidence (available at the time of the review i.e. early- to mid-2020s) and whether or not anything needs to be done about the evidence base.

The review was to consider:

i) Why a particular piece of guidance triggers at its set threshold, and

ii) Having triggered, whether the guidance was effective and appropriate for modern buildings.

Initial considerations following discussions with the project lead suggested:

Challenges that relate to the Introduction in AD B

- Section 0.14: Purpose groups. Whether the purpose groups fitted, appropriately, with the triggers? See Example 10 (above) and the observation that there had been only slight re-ordering of some of the words from what was Table D1: *Classification of purpose groups* in AD B (2000 edition) to Table(s) 0.1: *Classification of purpose groups* in both Volumes of AD B. The changes of substance in the intervening 23 years included the removal of the words '*place of lawful detention*' (from Institutional use) and the addition of '*rental of storage space to the public*' (to shop and commercial use).

Challenges that relate to B3: *Internal fire spread (structure)*

- Are compartment size and basement triggers appropriate? This Project was not broad enough to consider an in depth review of whether buildings are getting bigger. It is not known, for certain, if fire load densities have changed over the last 20 or so years. However, it is suspected they have. What is more than suspected is the prevalence of lithium-ion batteries in day-to-day living, see the discussion and examples (above) on lithium-ion batteries.

- The uplift to Part L (2021 edition) was designed to achieve a 31% betterment in CO_2 emissions over Part L (2013 edition) for buildings. A revision to Part L is due in 2025 (the consultation for this revision was closing at the time of writing this report, see also Example 4 (above)). It is expected that at very least fabric airtightness standards will increase and there may be a requirement for post construction testing, to prove thermal performance. The more airtight a building, the greater the speed of initial heat build-up and reduction in time to flashover in a compartment. Observations could feed back into structural fire resistance considerations and under ventilated fire compartments.

Challenges that relate to B5: Access and facilities for the fire service

- The findings of various investigations conducted under the Investigation of real fires contract, see section 3.4.7 (below) following discussions with Fire and Rescue Service's (FRS) incident commanders, revealed 'reduced' water pressure, during firefighting operations, was a significant disbenefit. Reduced water pressure at a fire ground can hamper the FRS's ability to conduct firefighting operations on their terms, resulting in the FRS's having chasing fire spread. Accordingly, this consideration links back to B3 *Internal fire spread (structure)* and B4 *External fire spread*. Should there be more guidance on building height limitations and the availability of water (or other firefighting medium)? It may be that consideration needs to be given to water volumes and pressures dependant on building height and when to use wetting agent (if at all).

- An emerging theme is that there might be benefit in describing some triggers as 'hard triggers' i.e. where they are intended to be more 'prescriptive' and some triggers as 'soft triggers' where perhaps there could be some leeway to accept alternative provisions.

The project aims to determine if designs circumvented the triggers and, if so, what equivalent provision is made in lieu if the provision otherwise triggered.

3.4.5 Structural fire resistance and fire separating elements

This project aimed to assess the current provisions in AD B asking if the guidance was effective and appropriate. The scope of the first part of the project entailed reviewing the underpinning factors, evidence and assumptions that gave rise to the current AD B guidance for both structural fire resistance and fire separating elements and then to consider whether the guidance remained effective and appropriate for modern technologies, building design and building use.

The underpinning factors, evidence and assumptions under consideration were to include the legacy and ongoing validity of the Post-War Building Studies, existing test methods and classification criteria, current scientific thinking on test methodologies and modern construction methods, building design and building use.

The project sought to identify gaps and shortfalls in these test methods, and any limitations and misunderstandings about the fire resistance tests. The intention was to show if fire resistance provisions for elements of structure were sufficient. Modern building considerations include innovative construction technologies and methods, fire loads, thermal insulation and modern designs e.g. multi-level basement car parks and or car-stacking car parks. A question to consider would be whether modern vehicles pose more or less of a fire risk when involved in a fire than their steel bodied and petrol/diesel fuelled predecessors.

Gaps and shortfalls were also to be considered from the perspective of compartment sizes, subdivision of cavities, enclosure of fire hazard areas and fire penetration through roofs.

Initial considerations following discussions with the project lead suggested:

Challenges relate to B3: *Internal fire spread (structure)*

- The project was to consider whether large-scale testing would be a more appropriate indicator of fire resistance performance than standard wall and floor fire resistance tests. The periods of fire resistance, described in Post-War Building Studies, assumed that the external walls of structures were inherently non-combustible. The studies did not envisage external walls contributing to fire growth and spread. This direction was not specific to any one wall or floor system but to any that incorporate combustible materials.
- The project also intended looking at wall and floor systems and build-ups to see the effect of materials in combination. Once again, the intention was to experiment at large-scale.
- Lastly, the project intended looking at fixings since it was suspected that fixings may become the limiting factor. An example could be a lightweight thin-gauge timber to timber joist hanger.

This workstream appeared to have cross-over themes with B4: *External fire spread* and B5: *Access and facilities for firefighting*. An external wall which contributes to fire growth and therefore fire spread has implications for external fire spread. Also, an external wall which contributes to fire growth and fire spread will affect the Fire and Rescue Service’s ability to fight the fire.

3.4.6 Balconies, spandrels and glazing

This project aimed to assess the current provisions in AD B relating to balconies, spandrels and glazing and to consider if the guidance was effective and appropriate. The scope of the first part of the project entailed reviewing underpinning factors, evidence and principles regarding external fire spread.

The project considered the technical knowledge relating to modern technologies and design of balconies, spandrels and glazing.

The project considered whether current guidance remained effective and appropriate for modern buildings. The project was to consider other policy options and alternative approaches and determine via cost benefit analysis whether they were viable options.

The Building (Amendment) Regulations 2018 (SI 2018 No 1230) [183] came into force on 21st December 2018, requiring balconies, attached to an external wall of a 'relevant building' to be constructed from materials achieving a classification A2-s1,d0 or A1 when classified in accordance with BS EN 13501-1: 2007+A1: 2009 *Fire classification of construction products and building elements*. *Classification using test data from reaction to fire tests* [184].

Initial considerations following discussions with the project lead suggested:

Technology challenges that relate to B4: *External fire spread*

- The balcony design/manufacturing industry was changing, in order to use appropriate materials to comprise the structural frame and floor of balconies that could comply with the new regulations. Glazing was identified as a potential mechanism for fire spread because the polyvinyl butyral interlayer, in standard laminated glass, was combustible. One company was marketing impact and fire-safe laminated glass balustrades – other manufacturers were expected to follow suit. This was seen as an example of an industry led design solution, which Government favoured.

In the absence of ongoing controls by Building Control Bodies, there remained the residual risk of combustible material being placed on balconies.

In addition, BRE Global Fire Investigations observed a potential anomaly in AD B for larger balconies and deck-access structures, with more than one exit from flat front doors. Paragraph 3.27 in AD B Volume 1 deals with provisions when there is a single escape route from a flat front door onto a deck or balcony. If there were two routes of escape, the opportunity (cited in paragraph 3.27) to follow the 'alternative guidance' in paragraph 3.29 may also be missed.

Paragraph 3.29 states:

"*Paragraph 3.27 may be modified using the guidance in clause 7.3 of BS 9991"*

Paragraph 3.29 of AD B states that paragraph 3.27 *may* (not 'shall' or 'must be') be modified. Therefore, one has the option of not following the guidance.

A selection of the guidance from Section 7.3 of BS 9991 [185] includes:

a) "The deck should be 30 minute fire rated, and

b) The walkway surface should be imperforate, and

e) The suitability of the walkway (if < 1.8 m away) should be proven not to be susceptible to hazardous exposure levels or smoke logging – using BS 7346 [186] and BRE Report BR 368" [187].

At present, the use of the word 'may', means the guidance of Section 7.3 of BS 9991 (parts a) to g)) is likely to be overlooked should the deck/balcony access have two (or more) exit routes, where the designer/regulator are content to follow guidance paragraph 3.27 alone.

3.4.7 Investigation of real fires

The Investigation of Real Fires project was a contract which ran on a rolling three-year term, from 1988. Prior to the 1988 start date, a small group of BRE fire scientists conducted inspections of Fires of Special Interest and research, for Government bodies. After the Building Regulations changed from being prescriptive to broadly functional in 1985, it was felt by Government that there should be a formalised on-going watching brief of real fires, and developments in fire incidents occurring in the built environment. The project sought to determine from real fire incidents if;

1) The building and occupants responded in ways intended or expected under the new system of Building Regulations, and

2) The access and facilities for firefighting would be sufficient for purpose under the new system of Building Regulations.

The guidance in AD B was, and still remains concerned with life safety.

Reports were submitted to the Government department, with responsibility for building regulation policy, to stimulate debate and, where appropriate, they led to research. On occasions, the research resulted in new guidance. By way of example, see AD B (2000 edition) Appendix F: *Fire behaviour of insulating core panels used for internal structures*.

The following types of modern methods of construction and considerations for AD B have been identified from a small selection of the BRE Investigations and research projects under the Real Fires project for MHCLG/DLUHC from 2018 to 2021:

- Compartment wall/engineered roof section abutments
- Balconies and balcony screens/facades
- Atria
- Photovoltaic panels
- Living/green walls
- Numbers of persons self-evacuating high-rise residential buildings

<u>Compartment wall/engineered roof section abutments</u>

At the time of writing this report, BRE Global is considering indicative research into how easily a fire might pass from one compartment to another via a junction between a compartment wall and a roof. The programme of indicative experiments considers whether modern roof technologies would perform in fire as expected or unexpectedly. The indicative experiments observe whether fire can break through a standard gypsum plasterboard ceiling, attack a roof construction (different roof typologies considered) and pass across a construction representative of a compartment wall. The work is tending to reinforce the need for good fire stopping between the wall and the underside of the roof construction.

<u>Balcony screens/facades</u>

BRE Global recently completed a research project that considered the reaction to fire characteristics of timber when used as a decorative façade/screen. The study sought to understand how thermally modifying timber might change its reaction to fire characteristics. The International ThermoWood (Industry) Association was only formed in 2000, accordingly the thermally modified timber product is still comparatively new. Thermally modified timber undergoes heat and pressure treatment to improve dimensional stability and resistance to decay. The industry production statistics for 2021 [188] show the year after launch of the Association, approximately 19,000 m^3 of thermally modified timber was being produced, rising to 115,000 m^3 in 2011 and 250,000 m^3 in 2021. The market expects to continue to grow in coming years. This characterisation study considered timber (Scots pine) in four different states: virgin (no treatments at all), thermally modified, (having undergone a thermal modification process), thermally modified (but seven years aged) and thermally modified (and having also undergone a fire-retardant chemical treatment). The timber sections, 44 mm by 94 mm were mounted at 110 mm centres (as though a picket fence) onto 60 mm by 60 mm angle irons (rather than horizontal timber rails). This arrangement allowed four-sided ventilation to the test samples.

The work highlighted the need to classify the timber to BS EN 13501-1: 2018 *Fire classification of construction products and building elements. Classification using test data from reaction to fire tests* [189] based on the timber façade/screen's end-use condition. What this means is that the outer layer(s) should be tested in its end-use condition (to a maximum depth of 60 mm, where possible) to BS EN ISO 11925-2: 2020 *Reaction to fire tests – Ignitability of products subjected to direct impingement of flame* [190] **and** the outer layer(s) should also be tested in their end-use condition (to a maximum depth of 200 mm) to BS EN 13823: 2022 *Reaction to fire tests for building products – building products excluding floorings exposed to the thermal attack by single burning item* [191] (the SBI test). Because the SBI test allows up to 200 mm-thick wall construction(s) to be tested, it is important to include next adjacent materials i.e. voids, membranes, battens, sheathing, and insulation, if it is to be representative of the end-use condition. Could AD B revert to provision of educative text to emphasise the need for construction actors to request test evidence of end-use systems, incorporating all next adjacent material(s) including voids to a depth of 200 mm maximum?

The study revealed how thermally modifying timber did appear to change its reaction to fire characteristics. Virgin Scots pine was able to be subjected to both the small flame test and the SBI test but the thermally modified timber could not complete a full duration SBI test. The reason for this was that the SBI tests on the thermally modified timber were abandoned early because of excessive flow temperatures in the test apparatus' exhaust ductwork. The European classification 'E' (BS EN 13501-1) that the thermally modified timber achieved was based on the small flame test alone. The ability to quote a classification based on the reaction to the small flame test alone should be 'marked' in some way, so that industry can give due consideration to the lack of complete SBI data. Could AD B revert to provision of educative text to emphasise the need to complete both tests? Could AD B consider setting limiting thresholds, which can be derived from the SBI test? An 'E' classification may not tell the reader of a fire test report the implication of deploying a particular end-use construction on certain more sensitive purpose group buildings?

Considerations regarding conditioning samples prior to test.[23]

Atria

The Investigation of real fires project allowed the prevalence of atria spaces in different purpose group buildings to be observed. The investigation work revealed that atria spaces have become mainstream across multiple purpose groups. Once the province of city centre or business park office designs, atria can now be found in buildings such as hospitals and specialised housing. Keeping the designs of atria, for use in different purpose groups, under review, would seem an appropriate response and results could feed into AD B consideration/review.

Photovoltaic panels

The Investigation of real fires project allowed the prevalence of photovoltaic panels on different buildings and further observe whether the fire involved the photovoltaic panels or the inverter to be observed. A more recent addition to these systems involves the provision of electric energy storage systems. See Example 4 (above), which considers the issues surrounding electrical energy storage systems associated with the new Schedule 1 relevant requirement L2: *On-site generation of electricity*.

Living/green walls

The Investigation of real fires project allowed the prevalence of buildings with a living or green wall when involved in fire to be observed. One fire was observed in Knightsbridge, London in June 2018, but there have not been a number of buildings with green walls, involved in fires, to see patterns and issues emerge. A clear consideration for a living/green wall is how to condition it to constant mass to BS EN 13238: 2010 before testing to both BS EN ISO 11925-2: 2020 and BS EN 13823: 2020. At constant mass

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[23] Draft changes to the conditioning procedures of BS EN 13238: 2010 *Reaction to fire tests for building products. Conditioning procedures and general rules for selection of substrates*, were published in March 2024 by the CEN Reaction to Fire Technical Committee Working Group [192]. The changes proposed raise a wider point that may affect policy and direction for AD B across multiple fire safety considerations (as multiple Fire Safety committees develop/progress multiple standards). In BRE Global's opinion, changes that AD B makes may be diluted by CENs changes to ENs. An example of a change to clause 4.1 of the conditioning standard is shown below:

> *"Test specimen for external (wood species) use applications shall be conditioned at a temperature of 20 and a relative humidity of 65%."*

This is a lower temperature and higher relative humidity (RH) than is the case for any other material. In BRE Global's opinion, the current regime of conditioning should apply at 23 ± 2°C and a RH of 50 ± 5%. In BRE Global's opinion, tests conducted following previous conditioning rules were likely to have led to more onerous results than would be the case if conditioning were to be carried out, as suggested in the draft changes, since timber conditioned at a higher relative humidity will retain more moisture. To reflect long dry summers, timber intended to be applied to the outside of a building should be conditioned to the more onerous not least onerous conditioning requirements.

See also discussion under *Living/green walls*.

the green wall is likely to be dead or close to being dead. It is unclear from the research whether any thought is currently being given to a bespoke set of tests for such walls?

Government may wish to consider the proposed changes to BS EN 13238 (which at the time of writing were being considered by the CEN Reaction to Fire Technical Committee Working Group) in order to determine if they are appropriate. BRE Global believes some of the proposed changes relax, rather than tighten conditioning protocols.

Specifically, the suggestion is that if a green wall arrives for testing with a moisture content of > 40% then:

> *"[it] will be conditioned for less than 24 hours to keep them [the growing leaves] alive."*

If carried through as written, then perhaps it will be reflective of the green wall's 'condition' on the day of installation, or during/immediately after irrigation, or during periods of inclement weather. It is inappropriate to test the leaves and the growing medium (and wetted surfaces of the planters and irrigation pipes and membrane) when the greater risk will occur when the materials are dry i.e. in the summer months. It would be a reasonably foreseeable temptation to deliver young, healthy leaf growth which, just prior to delivery, had been 'gone through' to remove all trace of dead material.

The e-bulletin by the Met Office *UK and Global extreme events – Heatwaves* [193] is of relevance here when it states:

> *"The top 10 warmest years for the UK since 1884 have occurred since 2002",*
>
> *"The 2022 UK summer heatwave, marked a milestone in UK climate history, with 40°C being recorded for the first time in the UK and new national records set in Wales and Scotland and England",*
>
> *"We are experiencing higher maximum temperatures and longer warm spells in recent years. Warm spells have seen their average length more than double – increasing from 5.3 days in 1961-90 to over 13 days in the decade 2008-2017", and*
>
> *"South East England has seen […] warm spells increasing from around 6 days in length (during 1961-90) to over 18 days per year on average during 2008-2017."*

After several years of growth there would be some build-up of leaf fall, twigs (even nests) concealed under fresh leaf growth. Testing after two or three season's growth would be a worthwhile consideration, but this may be impractical in any context other than as part of a research project. Another concern for green/living walls is the effect of a long dry summer [194]. The heating in cities can lead to an urban heat island effect (super heating) and hosepipe bans are not an uncommon phenomena in South East England (in particular). Thus, testing when the system is relatively dry, but not dead, is another consideration. This is important if the system is to demonstrate its resilience/robustness.

There is no guidance in the SBI test standard about how the foliage should be 'dressed' for testing. Foliage is non-planar, it will not hang down, perfectly, in front of the planters. Plants will exhibit forward, cascading, and tumbling leaf growth resulting in inconsistent and 'variable' depth of living wall. This may also mean planters cannot be fully accommodated on the SBI rig. The depth of test samples on the SBI rig is limited to 200 mm, see (above) under balcony screens/facades.

For all the above reasons, green walls should be tested on an Intermediate scale test rig test apparatus i.e. a frame that is larger than the SBI test rig but smaller than the BS 8414 [195] [196] cladding test rig. Simple conditioning criteria and pass/fail criteria could be set. This may need to be the subject of a new standardised methodology and classification system.

A sample should be placed on the test apparatus and allowed to ‘condition’ (preferably outside) until an agreed moisture content is reached. How that would be measured would need to be considered.

Some research should be conducted into the effect of several growing seasons on the test results. Similarly, research could consider the added effect of testing when the plants are suffering from ‘drought-like’ conditions, representative of a long hot period of weather in a typical English summer. These considerations would ensure the living wall was reasonably representative of the real world.

Other materials may be present in close proximity e.g. the living wall may, in part, grow over a timber trellis (forming a privacy screen). The living wall may have achieved its classification on a breather membrane on a calcium silicate sheathing board, but if an architect intends part of the wall to pass over a trellis and the trellis has a chieved the same classification on the same substrate e.g. (say C-s3,d2), how likely is it that designers and regulators would understand the need to test both ‘systems’ in combination? BRE Global observes that it is only by testing materials and systems in combination that one can know whether the result of combining the systems would lead to the same, or a worse or considerably worse classification.

The AD B (2019 edition with 2020 amendments) at paragraph 10.6 in Volume 1 and 12.7 in Volume 2 references the DCLG publication *Fire Performance of Green Roofs and walls* [197] for guidance on living walls. Since this publication dates back to 2013 and given the changes to AD B since 2018, it would be appropriate that the guidance is revised to suit AD B and Regulation 7(2) changes.

Lastly, BRE’s research into this subject led to considerations from international architecture. Other designers, around the world, appear to be following the lead [198] [199]. It is reasonably foreseeable that a local planning authority in England would welcome the ethos behind the vertical forests (Milan) [200] [201]. Accordingly, there needs to be further consideration of living walls and vertical forests so they can be adequately tested (not using the SBI test) and that any agreed testing should be reflective of onerous not beneficial conditioning. Designs need to prove they are robust and resilient.

<u>Numbers of people self-evacuating high-rise residential buildings</u>

During BRE Global’s Investigation of Real Fires project for MHCLG /DLUHC, it was noted (in 2019/2020) that the number of people reported to have evacuated blocks of flats, during fire incidents, was high, when compared to pre-Grenfell Tower years. By 2020, Fire and Rescue Service (FRS) incident reports were capturing the number of rescues, evacuations and self-evacuations separately on the fire incident reports. Accordingly, in 2020/2021, BRE Global tried to capture data on the number of people self-evacuating, before the arrival of the FRS. These data are distinct from rescues and evacuations brought about by the FRS once at a fireground. Given that BRE Global had not broken down the data in this way before, it was not possible to compare year on year whether there was a paradigm shift taking place. What became very clear in 2020/2021, was that even if the FRS report described a fire involving a single flat or perhaps two flats (by the time it was fully extinguished) the numbers self-evacuating seemed to be in the tens, i.e. very high.

An Inside Housing article [202] in December 2022 considered whether trends were beginning to emerge regarding escape provisions for high-rise residential buildings (with a habitable floor at 18 m, or more, above ground level). A study (the Tomlinson study) considered data held on the London Fire Brigade incident recording system for mass evacuations from high-rise residential buildings. The data show that in a period 1st April 2019 to 31st March 2022 there were 154 cases where 10 or more people evacuated from such buildings. The study found that: *"…Nearly 8,500 residents chose to evacuate these*[Ibid] *buildings rather than stay put either before, during or after the fire and rescue service arrived".*

BRE Global notes that these data translate to an average of 55 people self-evacuating from each of these 154 incidents.

The Tomlinson findings reflected the BRE Global observations during 2020/2021. There would be a challenge to AD B if these residents were leaving buildings because they did not feel safe, based on their individual observations that fire was spreading beyond the flat immediately above / adjacent to the flat of fire origin. If some of these buildings had a waking watch, evacuation of large numbers of residents was to be expected. Accordingly, where fire reports and media coverage did not suggest the fire spread any further than the flat of fire origin or the flat immediately above / adjacent, and where no evidence existed of the building having a waking watch does point to a paradigm shift. The paradigm shift is that even though one may be told it is safe to stay put, if one's flat is not directly affected by the fire, residents' lived experience is to exercise free choice and get out, rather than follow 'instruction' to stay put.

Whilst carrying out the Investigation of Real Fires project between 2019 and 2021, BRE Global investigated two fires of significance where social media played a part in mobilising residents to evacuate, and influencing group think. Accordingly, it appears that, social media has the capacity to undermine any stay put strategy and encourage behaviour which runs counter to 'historic' written instruction. The written instruction that social media appears capable of 'trumping' may be the pamphlet given to each resident on their first day of occupation of their flat, or the 'action plan' notices posted in communal areas and which forms the underlying Fire Strategy for the building.

In any future study as to why occupants make the decisions they do, about self-evacuation or 'stay put', it would be worth studying these mass evacuations [203] [204] [205] and the part played by social media in alerting and orchestrating the evacuation. A short safety training video [206] reinforces the principle of group think. The video shows that unless someone else, in a group, makes the first move to leave or there is clear direction from a person in authority to leave, then the tendency is to do nothing – this is known as group think. In 2022, there were fires where occupants of a block of flats made decisions as to whether to stay or escape based on messaging on social media [207] [208].

BRE Global makes three observations of these fires:

i) there is a presumption, on the part of the residents that a communal alarm should sound when there is a fire and there is anger and incredulity they were '*not working*'

ii) residents will respond to a mobile phone notification/messaging (stressing perceived severity of a fire, and the need to get out) and they will in the moment forget/ignore previously stated stay put 'messaging'

iii) residents with all good intentions are taking it upon themselves to bang on neighbours doors to alert as many residents to a fire event and to encourage all to get out. These are matters for AD B to acknowledge.

The question for AD B is does it continue as before or sense there is a paradigm shift occurring here?

Whilst researching for the Objective A work, BRE Global noted the Home Office research and analysis *Evacuation from fire in high-rise residential buildings: A rapid evidence review* (24th November 2022) [209] which sought, as one of its objectives, to identify how occupants make decisions about fire evacuation from high-rise residential buildings. The evidence emerging, relating to the UK, was small scale and of limited value, suggesting wider more in-depth research in this area is required.

Example 11

Driver: The underlying driver in this example is Equalities legislation and the consideration of equal opportunity when considering means of escape.

Evidence: The evidence originates from a Mayoral Office (London). The Mayor's Office has issued London-wide development guidance on evacuation of disabled people. This guidance takes the form of London Plan Policy D5 (5B) which requires every new building, where lifts are provided, to have an evacuation lift. If a building has one lift core, then one of the lifts in that core must be an evacuation lift. If a building has multiple lift cores, an evacuation lift is required at each core (i.e. one lift per 'bank' of lifts). The intention of the policy is to allow those that need level access to enter and level egress to leave a building, the same opportunity to escape in a fire event, as non-disabled people.

Implication for AD B: The provision of evacuation lifts is being driven by local authority planning departments. The technical specification for such lifts should be a fire safety consideration and guidance should be addressed in AD B as it is essential that this is considered and controlled by the building control body, not the local planning authority. Future guidance in AD B may consider technical, management, and operational issues (including the 'management' role expected of a 24/7 concierge – where available). The provision of evacuation lifts is another consideration for the Fire and Rescue Service. Will there be any merging of current standards i.e. BS EN 81-72 (for firefighting) [210] and Draft BS EN 81-76 [211] (for evacuation)?

In London, it is the Mayor's Office that issues (and keeps under review) a spatial plan called the London Plan, and it is expected that the London Local Authorities will adopt London Plan policies into their own Local Development Plans (LDPs). This particular challenge to AD B will apply to all residential buildings in London that have one or more lift cores[24].

AD B Volume 1: paragraph 3.3 states that escape routes need a higher standard of protection to:

> "[…] *allow occupants to escape should they choose to do so or are instructed/aided by the fire service*."

The key words being '*should they choose*'.

[24] Note that if adopted by other Mayors it could become policy in some or all of North of Tyne, Tees Valley, Liverpool City Region, Greater Manchester, West Yorkshire, South Yorkshire, West Midlands, Cambridge and Peterborough and West of England.

The same principle that residents have a choice is also accepted in London Fire Brigade's Fire Survival – Policy Number 0790-Update: (March 2021) [212], which states at Paragraph 9.1:

> "[…] *Incident Commanders should be aware that occupants may choose to leave their flats if they do not feel safe and they are free to do so.*"

The principle was also included in the foreword of the former guidance on mandatory means of escape in case of fire (in use up until June 1992) British Standard Code of Practice CP3 Chapter IV Precautions Against Fire [213] where it stated:

> " […] N*evertheless, the possibility that individuals may seek to leave the building cannot be overlooked and provisions should therefore be made for the occupant of any dwelling to do so by his own unaided efforts…"*

When it comes to allowing all to have this choice, the new policy D5(5B) paragraph 8 sets out the underlying principles behind the policy:

> *"[…] All building users should be able to evacuate from a building with dignity and by as independent means as possible. Emergency carry down or carry up mechanical devices or similar interventions that rely on manual handling are not considered to be appropriate, for reasons of user dignity and independence. The installation of lifts which can be used for evacuation purposes (accompanied by a management plan) provide a dignified and more independent solution."*

In London therefore, it will not be acceptable for those using a wheelchair or other walking aid to be expected to:

i) Decant into an evacuation chair or

ii) Be carried down the stair or

iii) Bump down flights of stairs on their backside or

iv) Be left at street level without their wheelchair or walking device, during a fire event.

The AD B guidance Volume 1 Paragraph 3.3 '*allows*' a resident who:

> "[…] m*ay require assistance to escape* […] *to remain"*.

This is no longer seen as a tenable option.

There will still be some residents who require assistance to dress, access their wheelchair and leave the building. There will be a large number who do not require assistance to go about their daily lives. For the latter group, provided the lifts are in good working order, they can go about their daily business.

Where residents cannot leave their flat without an outside carer (or other) first accessing their flat, the stay put proposition may need to apply. Should the resident not require assistance to leave their flat or, if a designated carer, neighbour, or other person is available and can assist the resident across the lift lobby then, the principle of choice that the London Plan policy D5(5B) affords them will now clearly apply.

At the time of writing, there are legal challenges in progress in the High Court and this may change the concept of evacuation plans in the future for buildings in England. Until the legal challenges are all complete, there will be a lack of guidance on how lifts such as these are expected to be installed protected and used. AD B will be the document that construction actors turn to first, in order to find guidance.

Additionally, clarification of management's role during the early stages of a fire event (in connection with 'operating' the evacuation lift(s) until the arrival of the Fire and Rescue Service) would be welcome in AD B.

Challenge to AD B arising from Example 11	
B1	New buildings (including residential buildings) erected in London, now require evacuation lift(s). An evacuation lift is needed at each lift core (each bank of lifts). There is a possibility this London Plan policy D5 (5B) will be adopted by a Mayor in a combined authority elsewhere. Nationally applied guidance (i.e. AD B may go some way to preventing 'variants' of the policy evolving. Such technical matters should be dealt with by the building control body not the local authority planning service. Future guidance in AD B may consider technical and management issues and operational issues (including possible 24/7 concierge).
B3	Consideration needed for how lift cores are to be protected.
B5	This impacts the Fire and Rescue Service. Will there be any merging of current standards BS EN 81-72 (for firefighting) and Draft BS EN 81-76 (for evacuation)?

3.4.8 MHCLG Call for Evidence responses

Approximately 140 individuals/organisations responded to the MHCLG Call for Evidence, submitting a total of 1,342 separate responses on all subjects from a variety of different organisations with an interest in fire safety. There were 94 separate responses (from 82 individuals/organisations) classified as 'Construction Technologies and Design'.

The published analysis of responses to the Call for Evidence [2], published on 5th September 2019, contained the following observations:

> "*A noticeable feature […] was the large degree of commonality of viewpoint from respondents on many of the issues.*"

> "*The consultation focused on technical matters but responses included considerable non-technical observation. Much of this was in the nature of preamble expounding the need for review of ADB […].*"

> "*There was a significant number of respondents who stated that ADB does not give a sufficient focus to the varied nature of MMC and the risks presented. Gaps between units, jointing, combustible frameworks, premature collapse of panel systems, the encapsulation of flammable materials amongst others were quoted as being of concern. Respondents generally seem to support innovation, but concerns were expressed that testing regimes and verification applied to MMC may be leaving uncertainty as to whether ADB objectives are sufficiently safeguarded*".

The commonality between the MHCLG Call for Evidence responses and the survey responses was evident. The observation quoted, citing the varied nature of modern methods of construction and the risks presented, e.g. gaps, jointing, combustible framework, premature collapse of panel systems, encapsulation of flammable materials, and concerns over testing regimes and verification, were all carried forward to the interactive Technical Steering Group session (see section 3.6).

3.5 The survey

A survey was designed for this project to gather input from industry stakeholders on whether Approved Document B remained relevant and continued to provide appropriate guidance for modern construction technologies, building design and building use. The survey was launched on 24th February 2021 with an initial close date of 31st March 2021 an extended deadline of 14th April 2021. A total of 151 detailed responses were received, a significant return rate for a survey of this nature.

BRE Global estimated that the total potential reach of the survey was therefore in the region of 20,000 stakeholders, broadly in five categories: design, supply chain, contracting/build, Building Control, Fire and Rescue Services. Respondents varied from: a) individuals giving their own personally held views; b) individuals providing views on behalf of a wider industry group or employer (such as professionals, trade bodies, institutions, associations); and c) what BRE Global understood to be small working parties representing industry bodies, actors and groups.

For more details about how the survey was constructed, distributed and analysed, see section 4.

The respondents' answers were further explored in the interactive Technical Steering Group session (see section 3.6) and were considered in detail in Objective B (see section 4) and Phase C (see section 5).

3.6 Summary and interactive Technical Steering Group session

3.6.1 Introduction

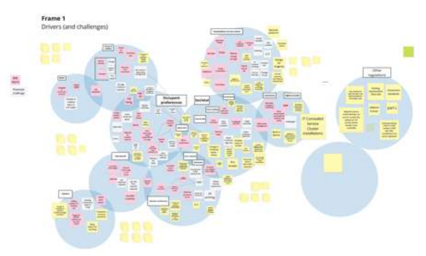
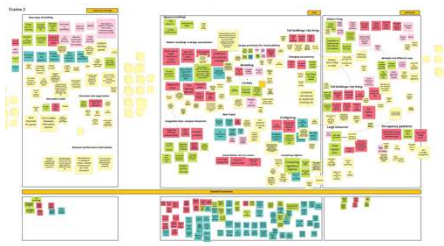
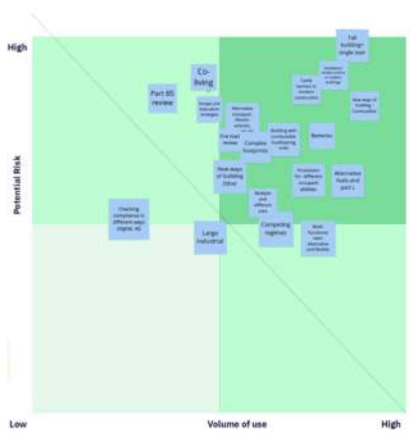
The key issues identified from the research in Objective A, together with comments received on initial draft outputs and discussions with stakeholders, identified the following key drivers for the Technical Steering Group interactive whiteboard session:

- Brexit
- COVID-19
- Clean growth
- Advances in manufacturing
- Skills
- Labour availability
- Societal
- Occupant preferences
- Future of mobility
- Aging society
- Home shortage
- Overcrowding
- Fuel poverty
- Digital innovation
- Urbanisation
- Sustainability/net zero greenhouse gas emissions
- Competing regulatory interventions
- Learning from history

This started the session (step 1) and was followed by further detailed work, expanding and grouping key challenges emerging from these drivers and other evidence collected (section 3 of this report). The issues identified were then grouped into modern construction techniques, modern building uses and modern design issues (Step 2) and finally ranked by risk (step 3).

An overview of the interactive session activities is presented in Table 2.

Table 2 – Overview of interactive session activities

Step	Activities	Interactive white board thumbnail*
1	Technical Steering Group members considered and reviewed headline drivers and challenges to AD B previously identified and described in the Objective A report (incorporating written feedback from DLUHC and Technical Steering Group members). The members reviewed and added further missing drivers and challenges to complete considerations.	
2	Technical Steering Group members considered evidence and survey responses and Technical Steering Group feedback received to date which BRE Global had placed under the headings, 'Modern construction technologies', 'Modern design' and 'Modern building use(s)'. The members considered responses and completed additional issues for consideration under those headings.	
3	During a break, BRE Global reviewed all comments and grouped them into themes ready for the last step. In the final exercise, members considered each theme and placed it on the risk matrix for prioritisation. The matrix axes were frequency of occurrence and potential of risk (if AD B guidance was considered unclear or unavailable).	

*See Figures 17, 18 and 20

Post-meeting, the risk matrix prioritisation for final review and close out was circulated. The Technical Steering Group members finalised the Objective A risk ranking and confirmed categorisation using a risk grid (based on probable extent of use of technology and potential impact of inadequate AD B provisions).

3.6.2 Drivers

The first frame of an interactive white board had been populated with future drivers and challenges to AD B prior to the session. These were listed as identified and described in section 3.3, incorporating written feedback from DLUHC and Technical Steering Group members. The following contributions were collated:

- Technical Steering Group members' observations during Technical Steering Group sessions
- Project partners' input on modern construction technologies, design and building use
- BRE Global's experience, such as the wider Fire Safety team's experience and understanding of fire safety, fire investigation, reaction to fire and fire resistance testing
- Information from meetings with project leads of the other 'parallel' Part B workstreams
- Targeted internet research
- Targeted research using BRE archive reports
- Targeted research from other guidance documents, e.g. NHBC Foundation publications
- Various Government publications, e.g. The Construction Playbook, Modern Methods of Construction: introducing the MMC definition framework

Figure 17 shows the first frame of the populated board at the end of the session.

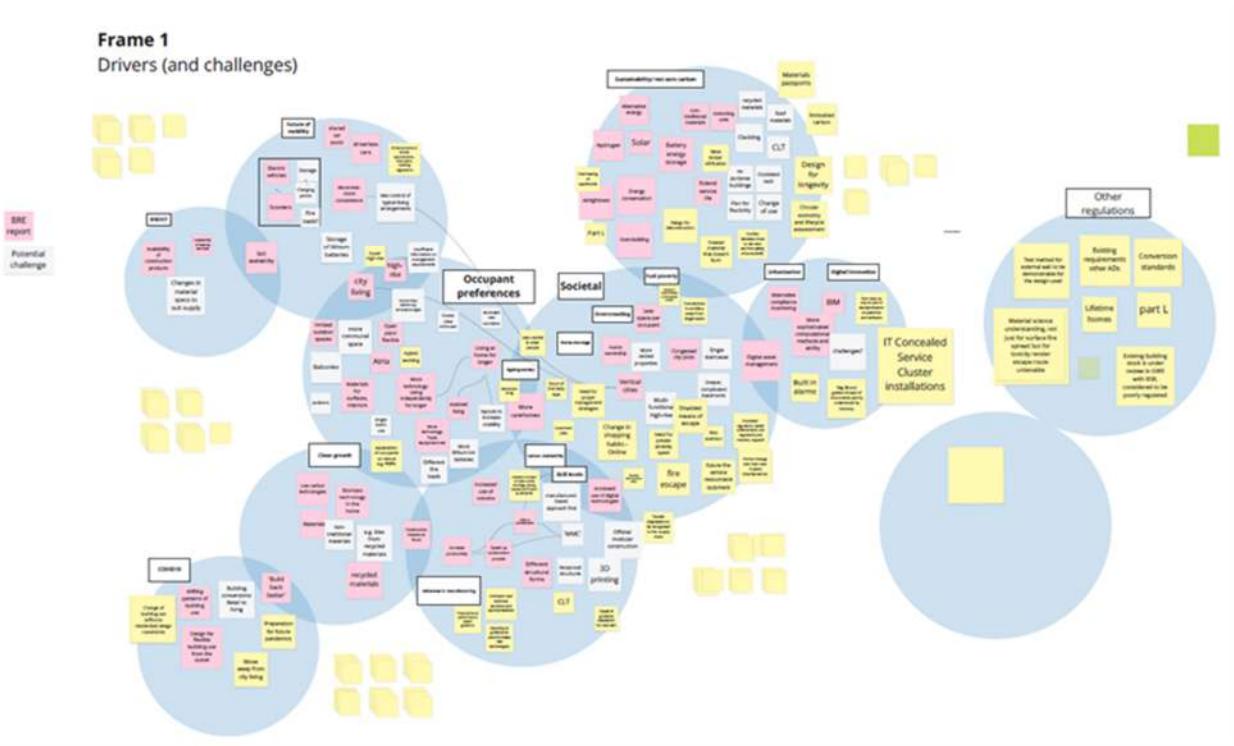


Figure 17– Drivers and potential challenges

3.6.3 Potential challenges to AD B (for construction technologies, design and building use)

The second frame of the board was pre-populated with the research outputs of Objective A (see sections 3.2 to 3.5). This also included analysis of survey responses, all of which were categorised and assigned to modern construction technology, building design or building use.

The overview also included:

- Technical Steering Group members' observations during Technical Steering Group sessions
- Structured interview outcomes with Partners about modern construction technologies, design and building uses.
- BRE Global's experience, such as the wider Fire Safety team's experience and understanding of fire safety, fire investigation, reaction to fire and fire resistance testing
- Information from meetings with project leads of the other 'parallel' Part B workstreams
- Targeted research using BRE archive reports
- Targeted research from other guidance documents, e.g. NHBC Foundation publications.
- Various Government publications, e.g. The Construction Playbook, Modern Methods of Construction: introducing the MMC definition framework.

These comments/challenges were placed under the three main headings:

1) Design
2) Construction technology and
3) Building uses and subheadings under each category.

Technical Steering Group members considered these comments/challenges and added comments/challenges (in an interactive process).

BRE Global reviewed all the comments/challenges and grouped them into overarching themes ready for the third step, the risk ranking exercise.

The 20 themes were:

- Tall buildings and single stairs
- Ventilation/smoke control in modern buildings
- Cavity barriers in modern construction
- New ways of building: Combustible construction
- Co-living
- Alternative transport: Electric vehicles
- Escape and evacuation strategies
- Part B5 review

- Batteries
- Building with combustible loadbearing units
- Complex footprints
- Fire load review
- New ways of building: Other
- Alternative fuels and Part L
- Provisions for different occupant abilities
- Multiple and different uses
- Multi-functional uses: Alternative and flexible
- Competing regimes
- Large industrial
- Checking compliance in different ways (digital and Artificial Intelligence)

Two themes were not carried forward to positioning on the risk matrix. ‘Patterns of use’ was considered by BRE Global to be covered by ‘multiple and different uses’ and ‘multifunctional uses: alternative and flexible’. ‘Rainwater (harvesting/attenuation)’ was felt by BRE Global to be too specific and, if needed, reconsideration of roofs in general would be covered under several of the 20 themes identified.

Figure 18 shows the second frame of the populated board at the end of the session.

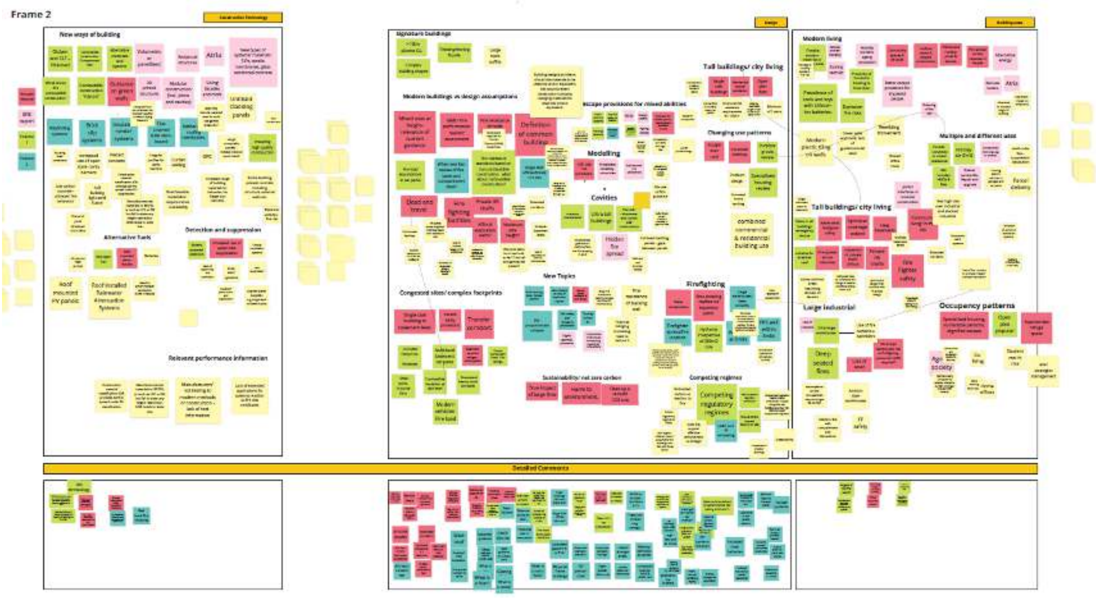


Figure 18 – Comments/challenges (construction technology, design, building uses)

3.6.4 Risk matrix prioritisation/Risk ranking exercise

The Technical Steering Group members were asked to rank each of the themes identified by their likely volume of use/frequency of occurrence (x axis) and the potential of risk/harm if AD B guidance is unclear or unavailable (y axis).

The risk matrix used to rank the resulting themes is shown in Figure 19. This has the anticipated/potential volume of use of a construction technology, design approach or building use, from low to high, on the x axis and the potential risk of sub optimal provision in AD B for construction technology, design approach or building use, from low to high, on the y axis.

As an example, if a popular construction technology, design approach or building use was anticipated likely to lead to sub-optimal (and in turn increasing the risk) AD B provisions, the overall risk would be evaluated to be in 'red' zone (in the top right-hand corner of the matrix).

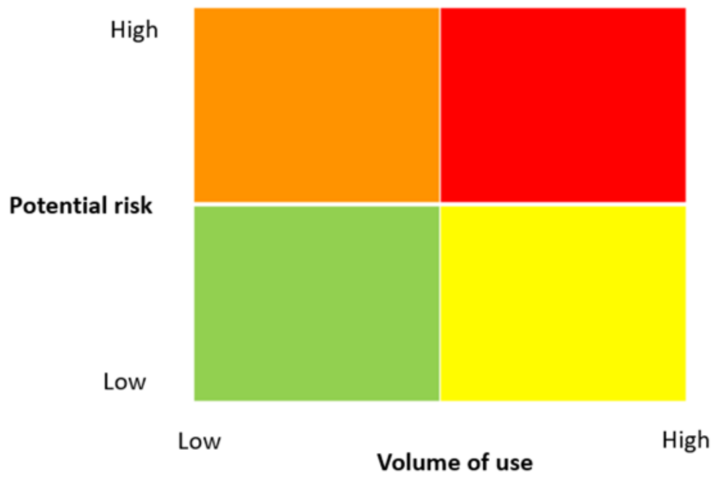


Figure 19 – Risk matrix for grouping the challenges

Each Technical Steering Group member positioned their individual voting dot on the risk matrix to represent where, in their opinion, the key item sticky note should be placed, see Figure 17 (without the voting dots). This resulted in a spread of voting dots on the matrix. The BRE Global moderator placed the key item virtual sticky note centrally to the cluster of voting dots and agreed on the final overall position with the Technical Steering Group members.

Using this methodology, the identified construction methods, design approaches, building uses and future drivers, 20 overall emerging themes, were ranked by the Technical Steering Group participants.

The risk ranking at the end of the interactive session is shown in Figure 20.

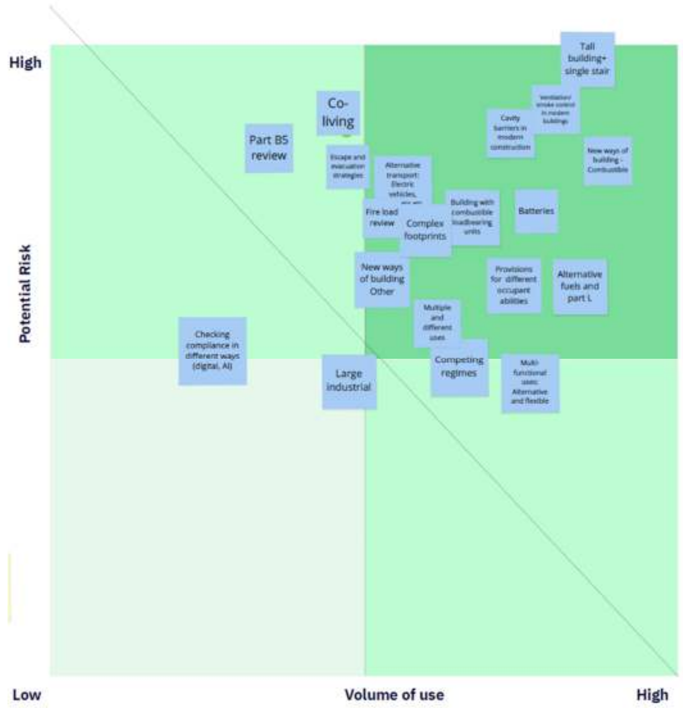


Figure 20 – Risk matrix prioritisation

Table 3 shows the priority ranked themes, derived from the risk matrix. For the priority ranking, where items were placed in equal ranking, severity of impact was prioritised over frequency of occurrence (i.e. scale of use of product, issue, technology, etc).

Table 3 – Priority ranking of themes

Priority	Theme
1	Tall buildings and single stairs
2	Ventilation/smoke control in modern buildings
3	Cavity barriers in modern construction
4	New ways of building: Combustible construction
5	Co-living
6	Alternative transport: Electric vehicles
7	Escape and evacuation strategies
8	Part B5 review
9	Batteries
10	Building with combustible loadbearing units
11	Complex footprints
12	Fire load review
13	New ways of building: Other
14	Alternative fuels and Part L
15	Provisions for different occupant abilities
16	Multiple and different uses[1]
17	Multi-functional uses: Alternative and flexible[2]
18	Competing regimes
19	Large industrial
20	Checking compliance in different ways (digital and Artificial Intelligence)

Note 1 Multiple and different uses: Change of use over life of building. When considering residential uses please change to any/all the following HMOs, Airbnb, holiday lets, apart-hotels and conventional flats. For other uses consider based on your own experience and if you have experienced new trends such as 'meanwhile' or 'pop-up' uses.

Note 2 Multi-functional uses: Alternative and flexible. When ranking we need you to consider designing for change from the outset. We want you to consider how commonly designers are saying to other designers, contractors and regulators that they want the building to be compliant for two or more uses. Is multi-functional use in this sense a modern trend or not widespread?

Input from the Technical Steering Group members was sought after the meeting, using email exchange, to confirm the risk matrix ranking of the 20 themes.

The risk ranking table was circulated to Technical Steering Group members for proposed priority adjustments, see Table 4. Column 1 of the table captured the priorities from the interactive session, Column 2 captured the themes and Column 3 asked members to advise on ranking for any re-ordering they felt appropriate.

Table 4 – Priority ranking of themes (proposed priority adjustments)

Priority	Theme	Any proposed priority adjustments
1	Tall buildings and single stairs	
2	Ventilation/smoke control in modern buildings	
3	Cavity barriers in modern construction	
4	New ways of building: Combustible construction	
5	Co-living	
6	Alternative transport: Electric vehicles	
7	Escape and evacuation strategies	
8	Part B5 review	
9	Batteries	
10	Building with combustible loadbearing units	
11	Complex footprints	
12	Fire load review	
13	New ways of building: Other	
14	Alternative fuels and Part L	
15	Provisions for different occupant abilities	
16	Multiple and different uses[1]	
17	Multi-functional uses: Alternative and flexible[2]	
18	Competing regimes	
19	Large industrial	
20	Checking compliance in different ways (digital and Artificial Intelligence)	

Note 1 Multiple and different uses: Change of use over life of building. When considering residential uses please change to any/all the following HMOs, Airbnb, holiday lets, apart-hotels and conventional flats. For other uses consider based on your own experience and if you have experienced new trends such as ‘meanwhile’ or ‘pop-up’ uses.

Note 2 Multi-functional uses: Alternative and flexible. When ranking we need you to consider designing for change from the outset. We want you to consider how commonly designers are saying to other designers, contractors and regulators that they want the building to be compliant for two or more uses. Is multi-functional use in this sense a modern trend or not widespread?

A few members had provided observations and comments, with only a small minority disagreeing on some of the ranking, on specific subjects. This was noted and formed the basis for discussion to finalise the issues to be taken forward to Objective B and Phase C of the project.

3.6.5 Final risk ranking

To enable progression of issues into Objective B and Phase C of this project, the Technical Steering Group was consulted to advise:

- Themes where a difference to the original ranking was proposed
- Aligned themes which had matching or linked considerations
- Review to ensure all themes carried forward were linked to outdated (or soon to be outdated) AD B provisions due to change in the way buildings are constructed, designed or used (rather than comments generally expected under a general consultation)
- Themes covered by other current DLUHC Part B research projects

Specifically, the following themes were reviewed with the members to check their incorporation for further work in Objective B and Phase C:

- Tall buildings and single stairs
- Ventilation/smoke control in modern buildings
- Large industrial (buildings)

Whilst the two former issues were confirmed to be within the scope of this work, the latter (large industrial buildings) was considered outside the scope for this particular work (albeit considered and recommended by the Technical Steering Group as a priority for further work and this was noted by DLUHC representatives).

The Technical Steering Group was also asked to confirm that the following selected themes were within the scope of currently ongoing research work as part of the wider research (some members have also been involved directly in these research projects):

- Cavity barriers in modern construction
- Combustible construction: New ways of building
- Escape and evacuation strategies
- Building with combustible loadbearing units and
- Provisions for different occupant abilities

DLUHC representatives confirmed this approach.

All risk items and their ranking remained unchanged after reaching consensus at the meeting and as established, their prioritisation to progress to detailed review (Objective B and Phase C) was confirmed.

3.7 Summary

Following the meeting, a detailed overview was prepared to capture all the evidence supporting the themes. The wording for each challenge derives either directly from the note on the interactive board or BRE Global's knowledge of the underlying point(s) made by survey respondents and Technical Steering Group participants (that for brevity could not be represented in their full meaning). Each theme is presented, summarising key drivers, leading to the challenges to AD B and specific, detailed associated issues considered.

Table 5 shows an example overview of the table for one of the themes (*Tall buildings and single stairs*).

Table 5 – Summary of considerations by theme (Tall buildings and single stairs)

	Key: Grey shading = derived from 'construction technology' tower (4 grouped comments) + ungrouped 'detailed comments' in the box beneath Unshaded = derived from 'design' tower (12 grouped comments) Blue shading = derived from the ungrouped 'detailed comments' in the box beneath the 'design' tower Beige = derived from 'building uses' tower (5 grouped comments) + ungrouped 'detailed comments' in the box beneath												
Tall building+ single stair													
Drivers	Preference for city living (urbanisation), shortage of homes, congested city plots, less space per occupant/overcrowding, vertical cities, need for multi-functional purpose, limited outdoor spaces, ageing society (living at home for longer), shared car pools												
Leading to	High and super high-rise construction, vertical cities with multi-functional uses incorporated in one building, need for common communal spaces, use of balconies, space saving single stair and complex underground construction for car parks, storage etc, assisted living, layouts for increased mobility, layouts to optimise space (i.e. cooking close to fire exit), enclosed residential corridors, driverless cars, shared car pools, over cladding, overheating of apartments												
Glulam, Cross Laminated Timber (CLT) and fire load	Combustible construction compartment size	Alternative materials and systems	Volumetric or panelised	New systems/material: Structural Insulated Panels (SIPs), tensile membranes, glass reinforced material and others	Wind-driven fire combustible construction	Combustible construction and stay put Table 10.1 states 'No provisions'	Guidance on living walls/green walls	Modular construction including joints and cavities	Living roofs green, brown and blue	Unitised cladding panels	Pod construction	Brick slip systems Plastic tiling on walls
Insulated render systems	Increased use of open state cavity barriers Could closed state barriers be detailed with correct DPC (damp-proof course) membrane and weep hole detailing?	Curtain walling	Large composite panels: metal/mineral wool/metal	Low carbon concrete unknown fire behaviour	Full building constructed using light steel frame	Irregular profiles for cavity barriers	Should there be height limitations, even where and external walling 'system' meets the performance requirements of BR135?	Need to accommodate ventilation ducts in façade	Battery powered detectors	Increased use of water mist	Smoke exhaust, smoke control Leakage and actuation of fire dampers and AOVs	Smoke ventilation systems Deep multi-level basement car parks Dead spots and need for impulse fan guidance Downstand beams and presence of services may affect smoke movement?
Car park fire loads including deep multi-level car parks Insulated soffits of ground floor slab ... adding to basement car park fire loads	Evacuation alert systems Ancillary spaces threatening escape routes Stairs continuing	Shared water supplies... suppression on wet mains Can BS 9251 Automatic Fire Suppression Systems (AFSS) be	Oil filled transformer rooms... still relevant as places of special fire hazard? Should there be new	Evacuation alert systems	Buildings with a habitable floor at >18m Complex shape facades Influence of facade shape on fire	Tall buildings/ city living Single stairs Open plan flats What is the maximum length of	Should tall residential buildings have more than one stair? Is a building with 20 (or 40 or 60 or more) flights a	Bariatric occupants and evacuation	What period of structural fire resistance in high, ultra-high blocks? Also, purpose group review	Podium design	Increased home working leading to residential and commercial 'combined' uses Also, consider mixed use in	MMC realistic test regime Fire resistance where construction is combustible

The full evidence is presented for each theme in Appendix A.

Technical Steering Group members were asked if, in their opinion, all the evidence supporting the themes had been captured and if not, to provide any further evidence that had been missed. No further evidence was received.

As part of this phase of the work over 1,500 challenges were identified, reviewed and categorised. These were organised into drivers and associated trends ('leading to'), construction technologies, design and building uses, see Figure 21.

Overall specific issues/challenges related to 'design' were most numerous, with over 650 potential specifics/applications identified. Modern construction technologies and applications were the second most identified challenge (over 300) followed by changed patterns of and building uses (240).

It is inevitable that specific issues overlap or are aligned. Some repetition is unavoidable, and upon analysis, brings confidence that issues identified are relevant due to their interwovenness with other issues, confirming the breadth of considerations. The broad approach and resulting volume of issues raised as part of the work is hoped to stand the test of time and present robust evidence and underpinning for the future of AD B revision.

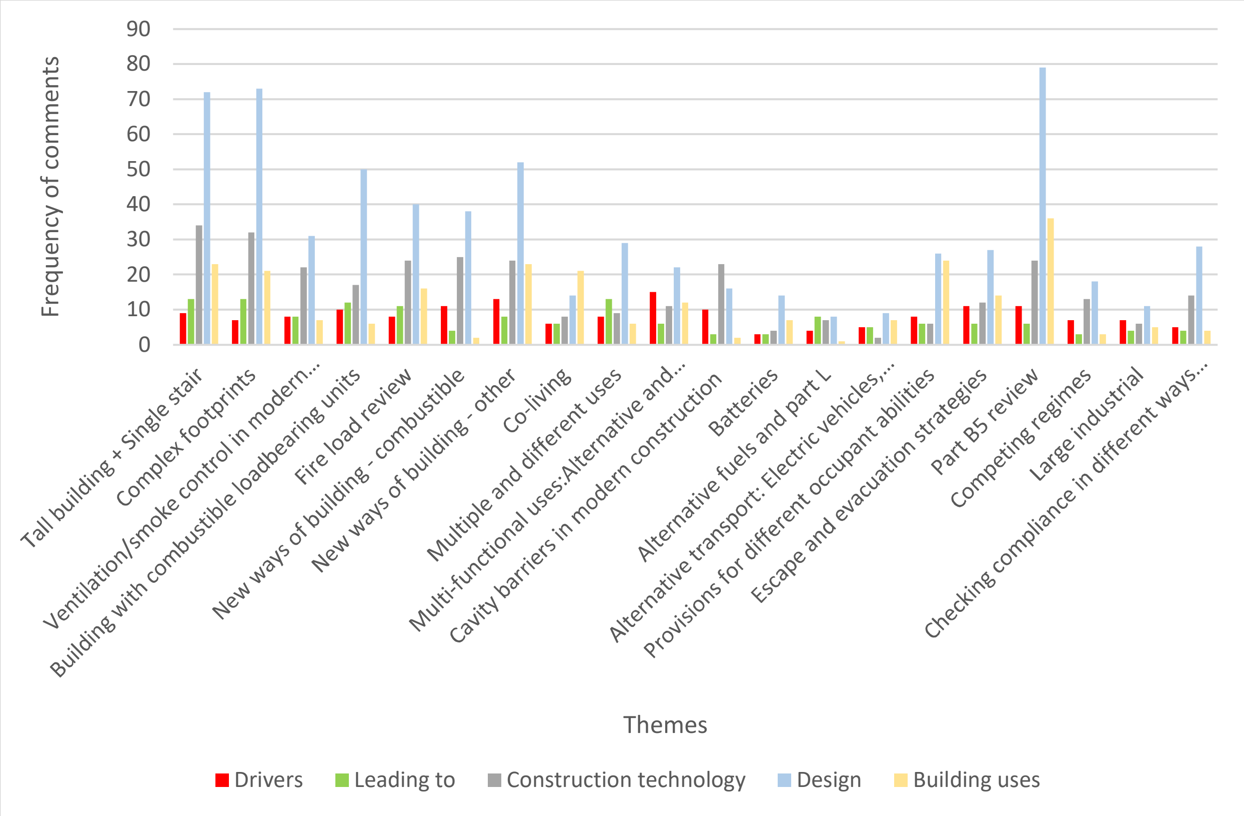


Figure 21 – Number of comments by theme

4 Objective B − Review of current provisions in Approved Document B considering the application of modern construction technologies and trends in design and building use

4.1 Introduction

This section focuses on the Objective B review of the current provisions in Approved Document B (Volumes 1 and 2, 2019 edition, current version), considering the application of modern construction technologies and trends in design and building use.

The methodology for Objective B, the review of AD B Volumes 1 and 2 on how current provisions cater for these modern approaches to constructing, designing and using buildings, was as follows:

- A survey was designed for this project to gather input from industry stakeholders. The survey was launched on 24th February 2021 with an initial close date of 31st March 2021 and an extended close date of 14th April 2021. The potential reach of survey was estimated to be 20,000.
- Survey respondents were asked to identify the paragraph(s) that they found particularly problematic and given 'free text' opportunity to respond with what they wanted to have recorded about a particular paragraph(s). Respondents were requested to respond in terms of their innovative/modern construction technology and or modern design methodology and or modern building use.
- In order to maximise the number of completed survey responses, two weeks before the close of the survey, people who had part completed the survey and left contact details, were contacted and encouraged to complete the survey.
- 151 completed survey responses were received and the raw data from the completed surveys was held in a spreadsheet. The raw data word count for the survey was approximately 100,000 words. BRE Global read each respondent's comment(s), checking which paragraph(s) the respondent was claiming to be responding to. Where respondents did not reference a specific paragraph(s), BRE Global identified (as best it could) the relevant paragraph(s). In addition, so that there was uniformity of approach, BRE Global wrote up the comments in the same style. The style tried to capture whether the respondent: a) sought *clarity* on a point b) sought *inclusion* in AD B of a point of guidance c) generally *sought more definitive guidance* in AD B or d) sought to *fill a gap in technical guidance*.
- From the survey comments, a 'map' had emerged of paragraphs in AD B that respondents were commenting on more frequently than others. Two heat maps (for AD B Volumes 1 and 2) were generated. Due to resource reasons, BRE Global decided (with the knowledge of the Technical Steering Group and agreed with DLUHC) to focus only on the hot spots. Having identified which paragraphs or clusters of paragraphs were attracting most comments (approximately 10 comments) the essence of what the respondents were saying in each hot spot was captured. Where comments varied and where there was no single 'thrust', BRE Global identified either powerfully argued points or the new considerations perhaps not being captured by AD B in order to bring them to the Technical Steering Group participant's attention. BRE Global's sifting of comments was necessarily subjective.

- Nine detailed review workshop sessions were held with participants from the Technical Steering Group.
    - The first two detailed workshop sessions for Technical Steering Group member participants were held to consider the survey hot spots and the distillation of comments arising from Volumes 1 and 2. BRE Global presented the essence of each hot spot. There were 16 hot spots from Volume 1 and 15 hot spots from Volume 2. For each hot spot, there may have been three or four 'matters' which were either disparate or loosely or closely linked. BRE Global shared these matters with the participants, and these were discussed. There was agreement on most points between the participants at the workshops and the distilled comments from the survey hot spots. The participants were able to add even more context to some points. These original or further contextualised points became tables of comments.
    - The subsequent seven workshop sessions covered the 14 themes emerging from the interactive white board session (Phase C, see section 5).

Sources of information for Objective B

The sources of information for Objective B were:

- Mainly the tailored survey responses, Technical Steering Group members input via Technical Steering Group meetings including interactive virtual whiteboard session, detailed workshop sessions, BRE Global experience (such as Fire safety and Fire investigation), articles and technical journal papers and reports, detailed responses from survey respondents who provided their own research work, documents, information, drawings and detailing, and a very detailed spreadsheet of information.
- Underpinning Objective A, Objective B and Phase C was information gleaned from project leads on other parallel Part B workstreams/projects (Specialised housing and care homes, Balconies, spandrel panels and glazing, Structural fire resistance and separating elements, Means of escape for disabled people, etc.)

4.2 Introduction to survey

A survey was designed for this project to gather input from industry stakeholders on whether Approved Document B remained relevant and continued to provide appropriate guidance for modern construction technologies, building design and building use. The survey was developed with input from the Technical Steering Group. Introductory text and questions were agreed by DLUHC prior to the Technical Steering Group consideration.

The survey was launched on 24th February 2021 with an initial close date of 31st March 2021. The deadline for the survey was extended to 14th April 2021.

The survey was distributed to BRE Global's 'subscribers' in addition to many professional institutions, trade bodies, associations, specialist industry suppliers, contractors and sub-contractors ('industry actors'). Members of the Technical Steering Group agreed to distribute the survey to their respective memberships. Industry actors were pleased to receive the survey on behalf of their memberships and undertook to forward it to all their members. BRE Global estimated that the total potential reach of the survey was therefore in the region of 20,000 stakeholders, broadly in five categories: design, supply chain, contracting/build, building control, Fire and Rescue Services. Respondents varied from: a) individuals giving their own personally held views; b) individuals providing views on behalf of a wider industry group or employer (such as professionals, trade bodies, institutions, associations); and c) what BRE Global understood to be small working parties representing industry bodies, actors and groups.

As the period in which to complete the survey drew to a close, BRE Global noted that 450 people had opened the survey and either begun to complete the survey or had fully completed it. Where respondents had left the survey unfinished and had left an email contact, BRE Global followed up to see if the respondent could be encouraged to complete the survey before formal close. Several promised to do so and there was a flurry of last-minute submissions.

A total of 151 detailed responses were received, a significant return rate for a survey of this nature.

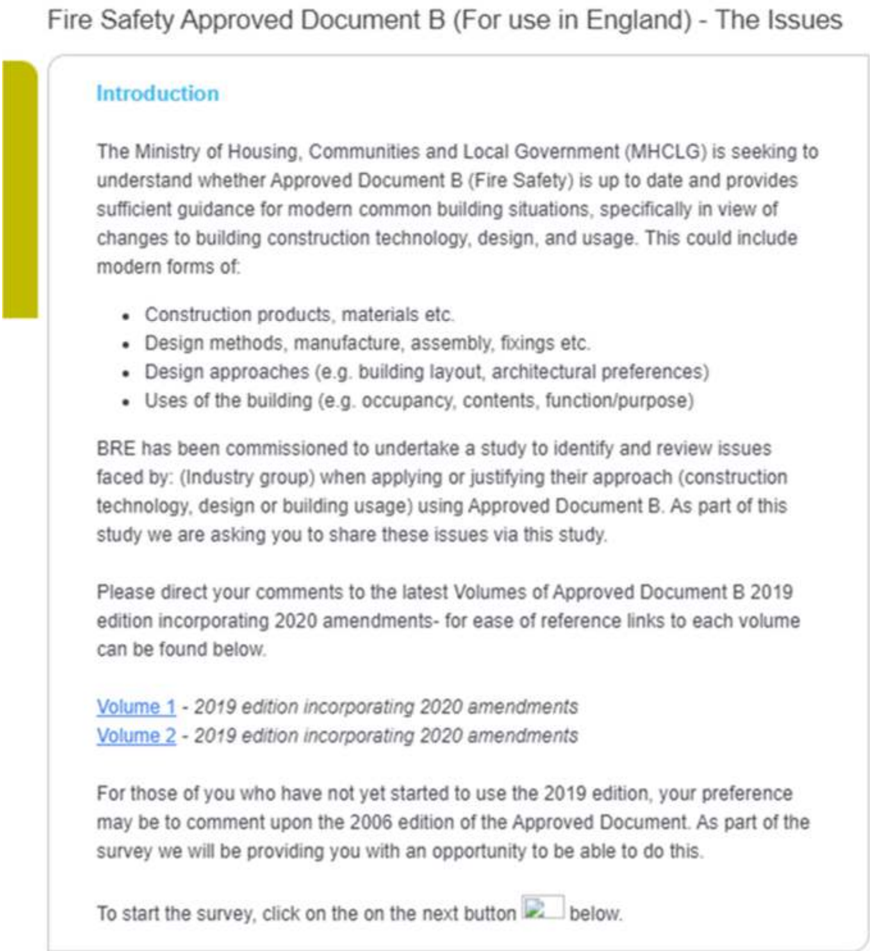
4.2.1 Survey questions

The survey asked the following core questions:

- In your opinion, which part of AD B is lacking in guidance?
- Please quote the clause(s) or appendices or definition(s) in AD B that give(s) cause for concern
- Can you give examples of the issue(s)?
- Is there industry guidance that you believe is better than the current AD B? Can you cite the document(s) and section(s) that work better?
- Free text (optional)
- What in your opinion is as the heart of the problem(s) that is not identified in the text of AD B?
- Are you happy to be contacted for follow-up?

The full survey screenshots are presented in Appendix B.

Figure 22 shows the introduction to the survey.



Fire Safety Approved Document B (For use in England) - The Issues

Introduction

The Ministry of Housing, Communities and Local Government (MHCLG) is seeking to understand whether Approved Document B (Fire Safety) is up to date and provides sufficient guidance for modern common building situations, specifically in view of changes to building construction technology, design, and usage. This could include modern forms of:

- Construction products, materials etc.
- Design methods, manufacture, assembly, fixings etc.
- Design approaches (e.g. building layout, architectural preferences)
- Uses of the building (e.g. occupancy, contents, function/purpose)

BRE has been commissioned to undertake a study to identify and review issues faced by: (Industry group) when applying or justifying their approach (construction technology, design or building usage) using Approved Document B. As part of this study we are asking you to share these issues via this study.

Please direct your comments to the latest Volumes of Approved Document B 2019 edition incorporating 2020 amendments- for ease of reference links to each volume can be found below.

Volume 1 - *2019 edition incorporating 2020 amendments*
Volume 2 - *2019 edition incorporating 2020 amendments*

For those of you who have not yet started to use the 2019 edition, your preference may be to comment upon the 2006 edition of the Approved Document. As part of the survey we will be providing you with an opportunity to be able to do this.

To start the survey, click on the on the next button below.

Figure 22 – Introduction to the survey

Changes were made to the survey following suggestions from Technical Steering Group members. An additional step/page was added to the survey to accommodate some of the Technical Steering Group members' comments.

The survey did not allow people to input diagrams, text boxes, tables and/or drawings so text was added so that respondents could send in additional information by email. Further instructions were also added informing respondents wishing to make multiple comments on any particular section to create their own headings within the free text. Text was also added on the additional step/page explaining that the survey applied to AD B England.

4.2.2 Reach of the survey

Figure 23 shows the total number of responses for each stakeholder group at close of the survey. Most respondents identified as 'Other'. The 'Other' category held survey responses from a variety of respondents, including fire safety consultants and fire engineers. There have also been some collated responses on behalf of larger organisations/professional bodies. Seven respondents did not indicate to which stakeholder group they belonged.

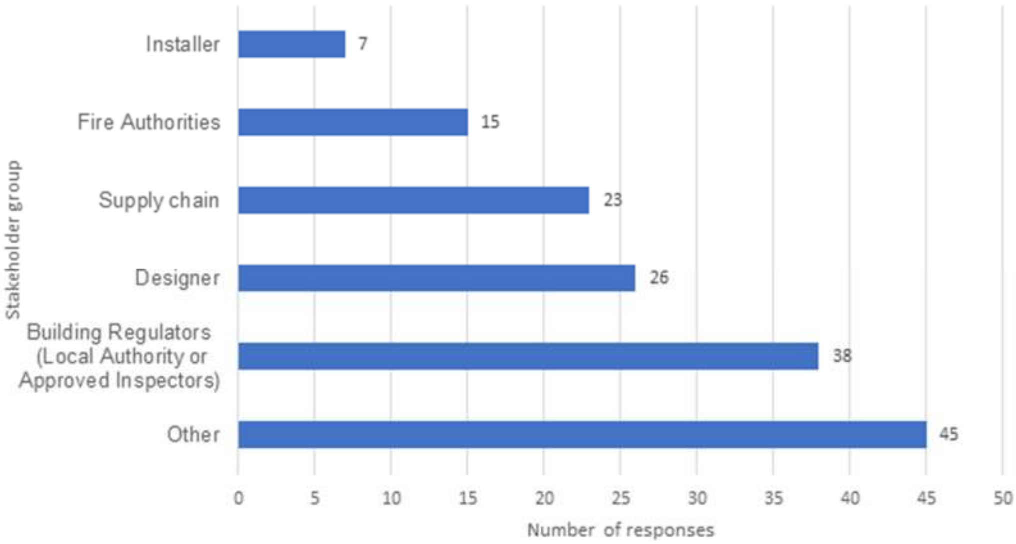


Figure 23 – Number of responses for each stakeholder group

The ratio of survey respondents of Approved Inspectors to Local Authority Building Control was about 50:50.

Some of the survey respondents stated they represented the following professional bodies:

- Association for Specialist Fire Protection
- Centre for Window and Cladding Technology/Society of Facade Engineering
- Local Authority Building Control
- National Fire Chiefs Council
- National House-Building Council
- RISC Authority
- Royal Institute of British Architects
- Smoke Control Association

Some of the survey respondents stated that they were employed by the following Fire and Rescue Services, but it is not known whether their observations were privately held views or those of their employer:

- Bedfordshire Fire and Rescue Service
- Cheshire Fire and Rescue Service
- Cumbria Fire and Rescue Service
- Derbyshire Fire and Rescue Service
- Durham and Darlington Fire Rescue Service
- Humberside Fire and Rescue Service

- Kent Fire and Rescue Service
- Lancashire Fire and Rescue
- London Fire Brigade
- Nottinghamshire Fire and Rescue Service
- Oxfordshire Fire and Rescue Service
- Royal Berkshire Fire and Rescue Service
- Shropshire Fire and Rescue Service
- West Sussex Fire and Rescue Service

Some of the survey respondents stated that they were employed by Local Authority Building Control and some from Approved Inspectors, but it is not known whether their observations were privately held views or those of their employer.

Some of the survey respondents stated that they were employed by design, installation, and other supply chain companies, but it is not known whether their observations were privately held views or those of their employer.

Some of the survey respondents fell into the 'Other' category (BRE Global noted that these were fire engineers/consultants), including individuals providing their own opinions.

The respondents commented on AD B volumes as shown in Figure 24.

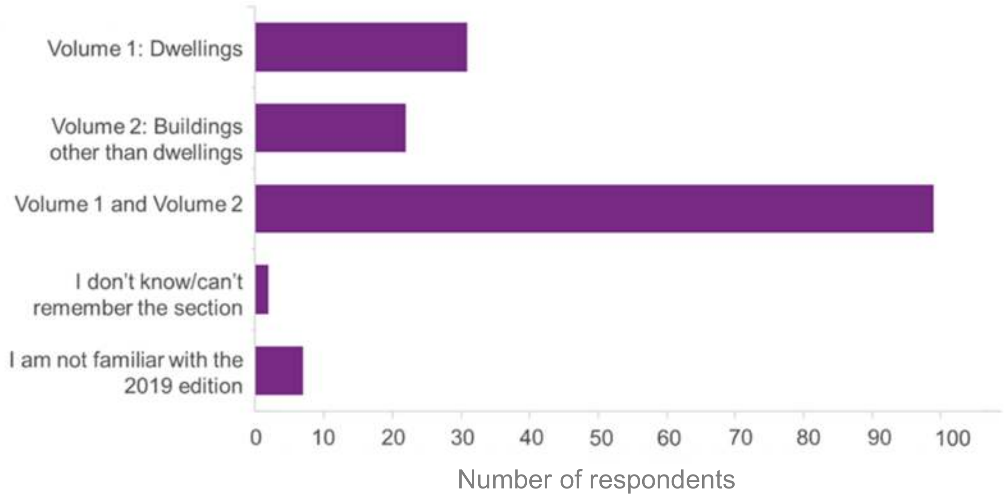


Figure 24 – Number of respondents and AD B volume(s)/edition commented on

The range of comments on different sections in AD B Volumes 1 and 2 is shown in Figure 25 and Table 6.

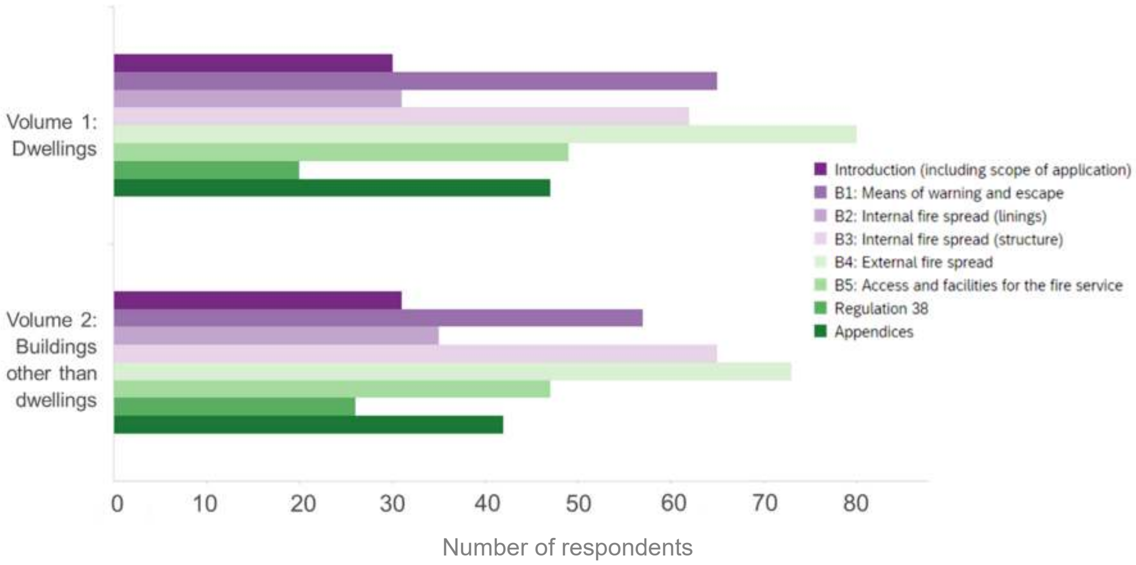
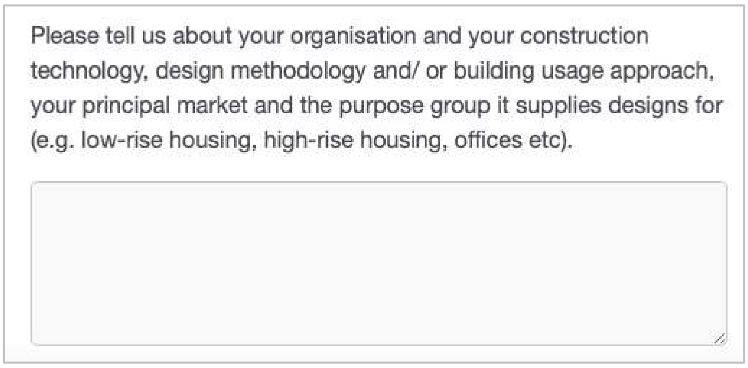


Figure 25 – Spread of comments on different sections in AD B Volumes 1 and 2

Table 6 – Percentage and number of comments on different sections of AD B Volumes 1 and 2

Section of AD B	Volume 1: Dwellings		Volume 2: Buildings other than dwellings		Total
Introduction (Including scope of application)	49%	30	51%	31	61
B1: Means of warning and escape	53%	65	47%	57	122
B2: Internal fire spread (linings)	47%	31	53%	35	66
B3: Internal fire spread (structure)	49%	62	51%	65	127
B4: External fire spread	52%	80	48%	73	153
B5: Access and facilities for the fire services	51%	49	49%	47	96
Regulation 38	43%	20	57%	26	46
Appendices	53%	47	47%	42	89

As part of the survey, respondents were asked to state relevant scope of works they were currently undertaking that, in their view, challenges AD B, see Figure 26.



Please tell us about your organisation and your construction technology, design methodology and/ or building usage approach, your principal market and the purpose group it supplies designs for (e.g. low-rise housing, high-rise housing, offices etc).

Figure 26 – Extract from survey

The survey respondents stated the aspects of construction, materials, designs and building uses as the basis of their responses to be as follows, see Figure 27.

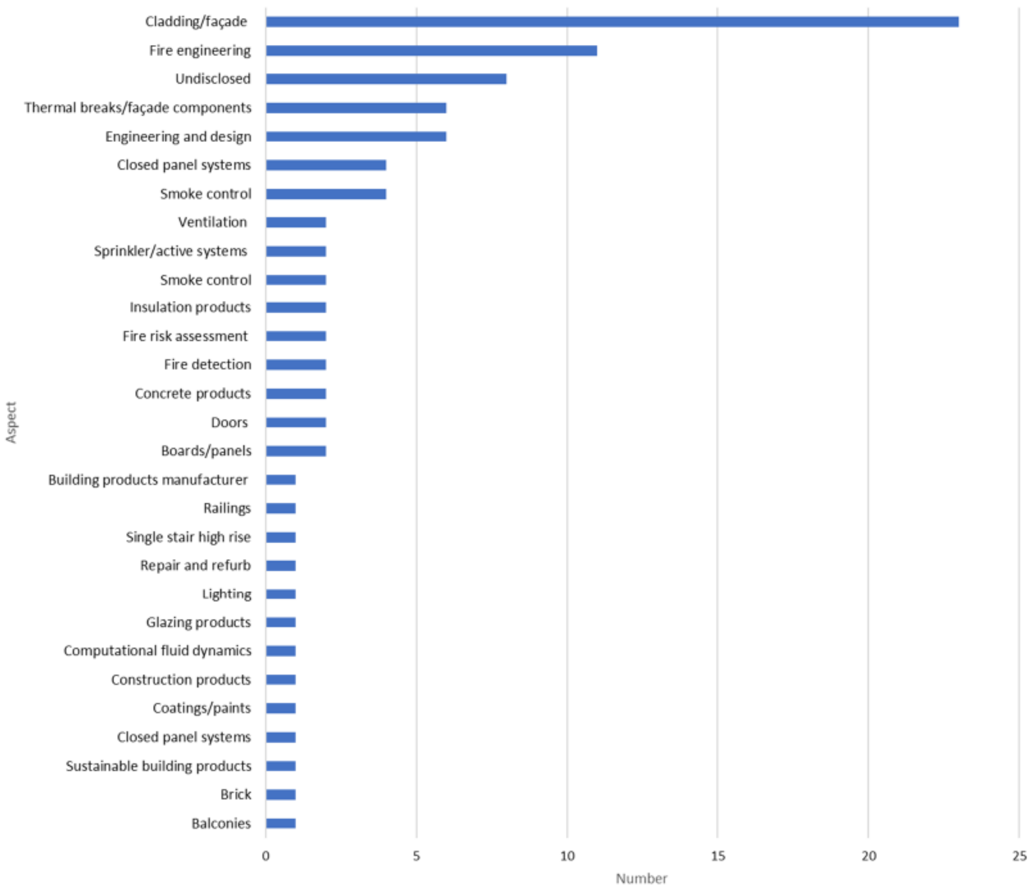


Figure 27 – Survey responses on construction technologies

The majority of respondents stated that their main challenge when working with AD B related to cladding/façade applications and aligned with this, thermal breaks and other key façade components as requiring clarification or additional guidance. The main level of challenge for these respondents seemed to relate to new construction methods rather than implementation of known methods. Many respondents did not see their construction technology use as new, *per se*, but had views of how AD B could support them in meeting client expectations, such as open plan layouts, irrespective of the height to the top storey in a dwelling.

4.3 Extraction of raw data from survey

The survey software automatically populated a spreadsheet with all of the survey question responses. E.g. if the respondent had commented on Section 1 (Fire detection and alarm systems), their verbatim comments were held under the AD B section B1. BRE Global worked through all of the comments held on the spreadsheet.

Figure 28 shows an example of comments on Volume 1 – Introduction.

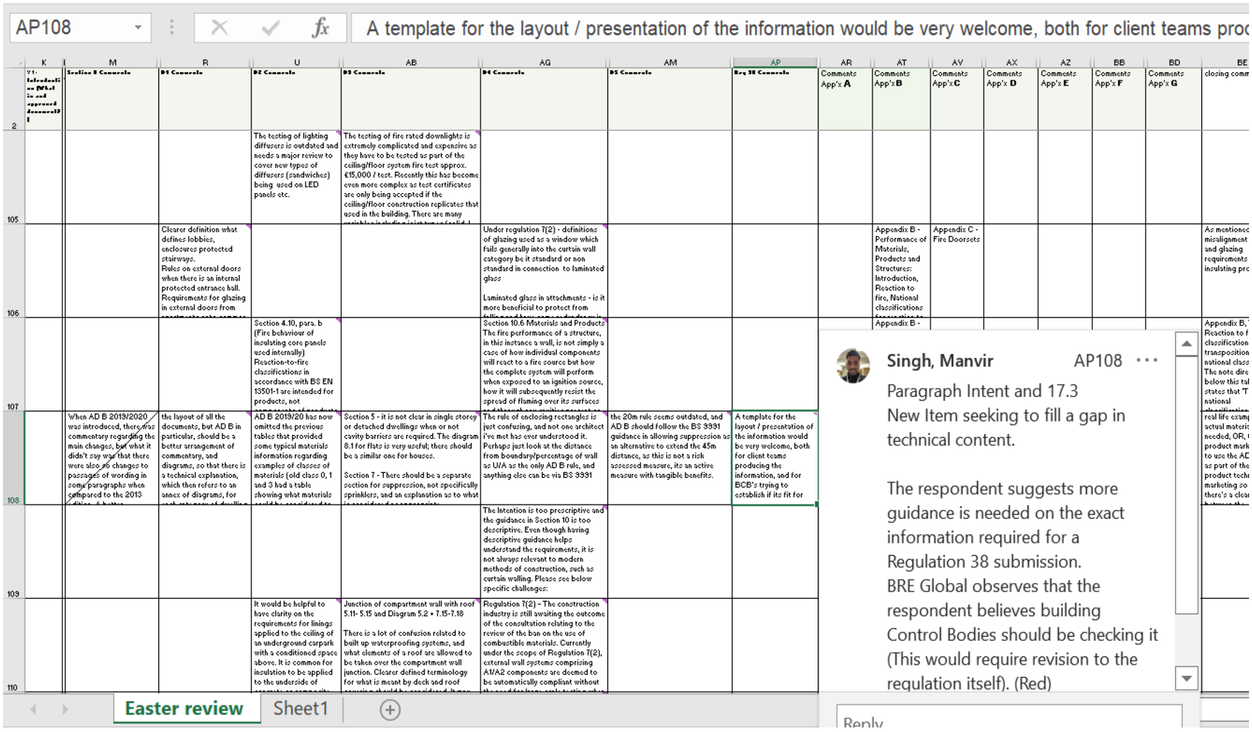


Figure 28 – Example extract of raw data from survey responses for Volume 1

Figure 28 shows that there were two comments from respondent 105 on B2 and B3. There were five comments from respondent 106 on B1, B4, Appendix B and Appendix C and a closing comment.

This figure also shows a purple 'flag' in the top right corner of various cells with comments. The flag indicates where BRE Global has interpreted and made its own comment on the respondent's comment. At the time this snapshot was taken, BRE Global had considered all of the respondents' comments up to and including Regulation 38, as denoted by the flags.

This figure shows that respondent 108 made comments on many parts of Volume 1. Specifically, Figure 29 (below) shows their comments on Regulation 38 with the pop up in Figure 28 showing BRE Global's consideration of those Regulation 38 comments.

Following this, the comments were distilled and allocated to the relevant AD B sections. The survey data was collated and sorted.

4.4 Findings of survey

4.4.1 Nature of responses – what the respondent is seeking?

Respondents were encouraged to type 'free text' responses in the survey. The 'range' of responses varied from a few words to several pages of text. Some respondents represented a professional body / organisation and these comments tended to be very detailed. The majority of respondents did not identify exactly which AD B paragraph(s) they wished to comment on. Frequently, comments related to multiple paragraphs, across different sections and appendices.

Comments were ordered to create a universal 'style' and required BRE Global to determine whether the thrust of the respondent's comment was about:

1) AD B guidance needing to be clearer, or
2) AD B guidance needing to include something, or
3) AD B guidance needing to be more definitive, or
4) Whether the comment was more challenging, and the respondent was perceived to be trying to fill a gap in the technical guidance.

The comments which fell under 1), 2) and 3) were highlighted in amber and comments which fell under 4) were highlighted in red. In simple terms, amber highlighted comments were thought likely by BRE Global to be suggesting a slightly easier change to implement (such as an additional note in a diagram), whilst red highlighted comments suggested matters harder to implement (such as "*it is time to make Part B consider property protection*"). At no stage were comments judged to be valid or invalid unless they did not articulate a meaningful comment. This process was about capturing the comments fairly and ordering them.

4.4.2 Analysis of responses

The analysis of responses was BRE Global's interpretation of what the respondent was saying. E.g. if the respondent claimed they were responding to a B1 issue relating to the location of smoke detectors and BRE Global agreed that their comment related to the placement of smoke detectors, their comment would be attributed to the correct paragraph in section 1.

Where a respondent claimed to be responding to a B1 issue relating to the location of smoke detectors, but their comment was clearly related to another section of AD B (e.g. placing information about the detectors and their maintenance in the Regulation 38 submission), BRE Global placed their comment in the appropriate section and paragraph. In the latter example, although the respondent felt it was a B1 comment, BRE Global would have attributed this comment as a Regulation 38 comment.

4.4.3 Creation of heat maps

From the survey comments, a ‘heat map’ began to emerge of the paragraphs in AD B that respondents were commenting on more frequently than others.

Regulation 38: Fire safety information				
Intro Reg 38	**Intention**		24(38); 46(38); 58(38); 62(38); 86(38); 108(38); 119(38); 121(38); 132(38); 142(38); 149(38)	
	Fire safety information			
Section 17	**Fire safety information**	17.1		
Section 17	Fire safety information	17.2		
Section 17	**Essential information**	17.3	100(38)	16; 86(3); 108(38); 112(38); 132(38); 142(38); 149(38); 150(38)

Figure 29 – Example snapshot from the Volume 1 Heat map (Regulation 38)

Figure 29 shows an example snapshot from the Volume 1 heat map for Regulation 38. The unbracketed respondent number is linked to the bracketed number where the respondent made their comment and where BRE Global distilled their comment to be referring to. By way of example, respondent 100 made their comment under Regulation 38 and therefore has a (38) next to the respondent number. In some cases, a comment could come from a different section in AD B but BRE Global had distilled the comment and concluded that it could also refer to a different section. E.g. in the snapshot above, respondent 86 has made a comment but made it under section B3 (that is why there is a (3)) but BRE Global has distilled their comment to also be making a point under Regulation 38.

The colour scheme used in each ‘heat map’ was intended to give a 'visual picture of areas of disquiet'. The colour was made progressively deeper to reflect an increase in the number of comments against a particular paragraph. Cells shown dark yellow/brown in colour represented many type 1) and/or type 2) and/or type 3) comments, whilst cells shown dark red in colour represented many type 4) comments.

The heat maps were split into three separate versions to allow BRE Global to recognise where certain hot spots were being formed, see Appendix C.

The first heat map was a helicopter/overhead view which was derived from all of the respondent’s comments, with their respective respondent numbers placed into the section of AD B that their comment related to.

The second heat map removed all the sections of AD B that only had 1 or 2 comments referring to them which allowed for certain hot spots to be formed. Also, the respective individual respondent numbers were also removed and instead replaced by the cumulative responses made under a particular section.

The third heat map was the final BRE Global distillation, where only the hot spots remained with the number of comments made under each hot spot also presented.

4.4.4 Volume 1 and Volume 2 heat maps

The heat map for AD B Volume 1 is presented in Appendix D and the heat map for AD B Volume 2 is presented in Appendix E.

4.4.5 BRE Global views of survey hot spot responses

For reasons of resource allocation, it was decided by BRE Global (in conjunction with the Technical Steering Group and DLUHC) to focus only on the hot spots. Having identified which paragraphs or clusters of paragraphs were attracting most comments (approximately 10 comments), BRE Global's views of each survey hot spot were captured in Appendix F.

4.5 Options/recommendations for potential future work for Objective B

Emerging draft options/recommendations for potential future work (short, medium and longer term) for each of the hot spots in Volume 1 and Volume 2 of Approved Document B were derived from BRE Global's further analysis and synthesis of the BRE Global distillation of survey hot spot responses (see Appendix F) and the Technical Steering Group's feedback on this from the first two detailed workshop sessions.

The emerging draft options/recommendations for potential future work for each of the hot spots are included in Appendix G. An example is included in section 4.5.1.

Note that the various hot spots were interconnected.

Note that further draft options/recommendations for potential future work are included in section 5, following a similar exercise, for the Phase C Technical Steering Group workshops.

5 Options / recommendations for potential future work for Phase C

This section focuses on Phase C the provision of options / recommendations for potential future work to address the issues identified and challenges to AD B.

20 identified themes that emerged at an interactive Technical Steering Group meeting were ranked at the end of Objective A, see section 3.6.

Tables in Appendix H present the emerging draft options / recommendations for potential future work (short, medium and longer term) for each of the 14 themes pursued during the detailed workshop sessions for Technical Steering Group member participants, together with drivers and implications for AD B.

Six themes: ‘Large industrial’, ‘Cavity barriers in modern construction’, ‘Combustible construction: New ways of building’, 'Escape and evacuation strategies', ‘Building with combustible load bearing units’, and ‘Provisions for different occupant abilities’ were not pursued during subsequent detailed workshop sessions, as they were part of other current DLUHC Part B research projects.

The information contained in the Appendix H tables was derived from the work carried out to date, primarily based on the workshop discussions with Technical Steering Group participants, contributions received and BRE Global’s experience.

Note that there was interconnection between the various themes.

Note also that further draft options/recommendations emerged from further consideration and analysis of the Objective B survey hot spots, see Objective B, section 4.5.

6 Implications for AD B and future work/direction

This section provides implications for AD B Volumes 1 and 2 and future work / direction to inform future editions of AD B for each of issues arising from a) the survey hot spots and b) the 14 themes identified during the workshop sessions. This approach mirrors that used when considering each of the 11 Examples (in section 3 above).

6.1 Arising from the survey hot spots AD B Volume 1 (2019 edition including 2020 amendments)

6.1.1 Survey Issue 1a: The Scope of AD B

Background – Survey Issues 1a to 1d arise from both the Introductory text, and all of section 0, in AD B Volume 1.

Survey Issue 1a considers a pre-issue, relating to the scope of AD B.

Driver – There is no single driver. The survey highlighted a range of issues, some of which are identified here.

The introduction of the Manual to the Building Regulations in July 2020 [20] went further than the earlier published AD B (2019 edition including 2020 amendments) which, in turn, went further than AD B (2006 edition) in narrowing the scope of application of approved documents. When AD B (2006 edition) came into effect, the standard clause applied which stated:

> *"The approved Documents are intended to provide guidance on some of the more common building situations."*

The AD B (2019 edition) introduced 'restrictions' and 'with caution' guidance clauses:

> *"Although approved documents cover common building situations, compliance with the guidance set out in the approved documents does not provide a guarantee of compliance with the requirements of the regulations because the approved documents cannot cater for all circumstances, variations and innovations. Those with responsibility for meeting the requirements of the regulations will need to consider for themselves whether following the guidance in the approved documents is likely to meet those requirements in the particular circumstances of their case.*
>
> *Where the guidance in the approved document has been followed, a court or inspector will tend to find that there is no breach of the regulations. However, where the guidance in the approved document has not been followed, this may be relied upon as tending to establish breach of the regulations […]."*

The guidance above with the 'restriction' clauses makes it much harder for the user of AD B to rely on its content, in the way they may have relied upon it in 2006. With the exception of highly complex uncommon schemes such as the construction of an airport, users of AD B (1985 edition through to the 2006 edition) were unlikely to have conducted a final review as to whether the '*circumstances, variations and innovations'* of their particular project, meant AD B was still suitable for their project, or not.

There appear to be three industry views around this point:

1) The current clauses (and the guidance in the manual) are reasonable and correct, and the clarity they bring is overdue. Moreover, users of AD B should be suitably qualified and experienced in applying it.

2) AD B should be doing more of the 'heavy lifting' in terms of guidance that it offers. In BRE Global's experience, designers and constructors crave certainty (even if it is more costly) over uncertainty, delay and compliance surprises, further down-the-line.

3) Both positions (described in (1) and (2) above) are broadly correct and both could and should co-exist.

One respondent believed Authorities having jurisdiction (AHJs) should not be 'bounced' to accept matters that AD B is silent on, nor should they be obliged to accept something that is stated in AD B if the context is different.

It is important to acknowledge the Coroner's observations following the Lakanal House fire, in the Rule 43 letter of 28th March 2013, to the Secretary of State for the Department of Communities and Local Government. The letter made the following observations about AD B and the need for it to be accessible to a wide range of professionals:

> *"…AD B is a most difficult document to use. Further, it is necessary to refer to additional documents in order to find an answer to relatively straightforward questions…"*
>
> and
>
> *"[AD B should be] intelligible to the wide range of people and bodies engaged in construction… and not just to professionals who may already have a depth of knowledge of building regulations and building control matters."*

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'. BRE Global recognises that this Survey Issue is reflective of an industry viewpoint.

Some respondents were observing that there is no definitive guidance on what a common building situation is and, with the introduction of the Manual to the Building Regulations July 2020 [20] (the Manual), AD B's scope and reach has become more uncertain.

One survey respondent's (respondent) view was that there was increasing uncertainty in industry as to whether AD B applies and whether or not a 'modern' design is accepted or rejected by the Authority Having Jurisdiction (AHJ). In the absence of guidance, the concern is that it could fall to personal interpretation and local viewpoint. This could represent a potential single point of failure in an AHJ's decision-making process. If, however, an AHJ's decision-making process is based on nationally applied guidance, then industry should benefit from more consistent interpretation. Indeed, society should benefit from buildings being designed and built to a more consistent compliance picture, across England's core cities.

The respondent felt Government's intention to support Modern Methods of Construction was being thwarted because of a lack of ambition on the part of AD B:

> *"The […] Construction Leadership Council['s][…] second key policy* [71] *is to:*
>
> *'Drive innovation and Modern Methods of Construction, through standardisation and aggregation of demand, increased client capability and setting clear requirements of suppliers.'*
>
> *AD B really needs to support this ambition in order to help give greater confidence and assurance to the industry."*

The Manual points to approved documents as not being appropriate for very large or very tall buildings, large timber buildings, and some buildings that incorporate modern methods of construction. These descriptors could relate to a number of quite 'common' buildings in a city centre context.

One respondent raised section 7 of the Building Act 1984 (the Act) [214], which considers the status of approved documents, and the expression:

> "*comply[ing] with an Approved Document."*

It appeared to the respondent, that whether the guidance was very comprehensive or very limited, designers may be able to argue that they can only follow what is in front of them. Section 7(1) (b) of the Act states:

> *"[…] Proof of compliance with such a document may be relied on as tending to negative liability."*

BRE Global observes that if nothing is expressly disapplied from the document, users will work their way through the guidance, applying it as best they can to all manner of building typologies except in the case of the airport example.

Section 6 of the Act states that where a guidance document is referenced, it needs to be suitable for its purpose of:

> *"Providing practical guidance […] if in the opinion of the appropriate national authority or, as the case may be, the body concerned the document is suitable for that purpose."*

Section 6(2) makes it clear that the guidance does not have to be all encompassing and an approved document can include:

> *"[…] references to a part of a document; and accordingly, in relation to a document of which part only is approved, a reference […] to the approved document is a reference only to the part of it that is approved."*

There is therefore now a tension between what The Building Act 1984 seemed to be intending (under sections 6(1) and 7(1)(b)) and the precepts of AD B (2019 edition with 2020 amendments). The precepts of AD B include intangible expressions that the document is unsuitable for very large, very tall, large timber and some buildings that incorporate modern methods of construction. It also maintains a tension with the Coroner's observation (above) that a wide range of actors need to rely on it.

In the mid-2020s, AD B is seen as more 'restricted' than was the case when the AD B (2006 edition) was being considered, see Table 7 which shows the changes since 1985. Section 6(2) of the Act clearly envisaged the practical guidance would evolve as it was revised.

AD B could do more to clearly spell out its scope of application, within the introductory section(s), so that it can be considered suitable for purpose.

Table 7 – The narrowing of 'scope of the application' of the Approved Document between 1985 and mid-2020s

The Edition	What is an approved document?	Limiting words
AD B (1985)	*"This document has been approved […] as practical guidance to meeting the requirements of […] [the Schedule 1 [requirements]"*	
AD B (1992)	*"The detailed provisions contained in the Approved Documents are intended to provide guidance for some of the more common building situations"*	"**some**" and "**more common**"
AD B (2006) including April 2019 amendments	Ditto to above	
AD B (2019) To the present	*"The approved Documents provide guidance for common building situations"*	"**Common**"

Some Fire and Rescue Authorities are particularly concerned that the often-used argument, by those wishing to push the boundaries, is "*The Approved Document does not say I can't do it"* and therefore would be broadly welcoming of the 'restrictive' or 'with caution' clauses.

One Regulator was particularly concerned that buildings are increasingly a hybrid of systems, and that testing of interacting 'systems' is not explicitly addressed in AD B, and that fire engineers should play a greater role in preparing evidence of compliance.

Implication for AD B –The responses to the survey in this area suggest that without additional guidance, industry will continue to muddle through and apply AD B as best it can, under the circumstances.

Unchanged, the document will preside over a breadth of interpretation. Single points of failure are likely to be one authoritative person in an AHJ or a fire engineering practice that imposes their 'compliance view' on how one should consider aspects of modern designed buildings:

> "AD B doesn't provide guidance, so I ask for X or Y or Z…"
>
> or
>
> "I won't accept it unless they do V or W…"

Single points of failure will continue to emerge where there is a lack of guidance in AD B and where the document uses intangible expressions: *'very large'*, *'very tall'*, *'large timber'* and *'some buildings [incorporating]'*. It is reasonably foreseeable that the outcome will be a more varied picture of what compliance looks like, between fire engineering practices, between AHJs and between cities. Emerging construction typologies (e.g. combustible construction and volumetric modular and others) would benefit from greater detailed guidance rather than less guidance.

Greater certainty would result if guidance also addressed the different types of building work e.g. material alteration and material change of use.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Adding clarity for the users of AD B as to the clear triggers (when AD B no longer applies).
2) Whether AD B should provide clear detailed guidance covering increasingly common construction typologies and different types of building works.

6.1.2 Survey Issue 1b: The approved documents (What is an approved document), Property protection and combustible construction

Background – Survey Issue 1b considers together, AD B Volume 1 Introductory section: *The approved documents* and paragraph 0.7: *Property protection*. It also considers combustible construction, as an overarching theme.

The survey had repeating themes considering combustible construction. Concerns were raised around combustible structures, potentially exacerbating fire spread, adding to the fire load and negatively impacting on 'stay put' (in residential use buildings) and firefighting conditions.

This Survey Issue has themes which overlap with those described in Examples 5, 9 and 10 (above). See also Survey Issue 1f (below) on means of warning and escape. See also Theme 1: Issue 1 (below) and Theme 6 (below) which considers alternative fuels and Part L, sustainability and whole life cycle carbon costing.

Driver – There is no single driver. Drivers include:

i. growing desire for sustainable forms of construction,
ii. interpretation of the current restrictions regarding external walls of certain buildings,
iii. uncertainty over demonstrating fire safety provisions for tall (very tall) and large (very large) combustible structures,
iv. environmental damage and overuse of firefighting medium,
v. changing perspective on insurance,
vi. emerging vulnerable details (with cavities) and
vii. whole life cycle carbon cost.

Growing desire for sustainable forms of construction

In BRE Global's opinion, combustible forms of construction and certain forms of modular construction (e.g. volumetric modular) are more common today than when AD B (2006 edition) was being drafted, and they are attracting support from various Government departments [215] [216].

Government supports and presumes to favour modern methods of construction for its own capital works projects [217]:

> *"At Autumn Budget 2017 the government announced its commitment to Modern Methods of Construction through the adoption of a presumption in favour of offsite construction for relevant departments from 2019."*

Survey Issue 1a (above) explores how the latest AD B 'restricts' use of AD B for some buildings that incorporate modern methods of construction. See also the frequently asked questions page (updated March 2024) on the Part B website, in response to Questions 21 and 22 [218]:

> *"[…] following the guidance in AD B […] may not be sufficient to meet the requirements of the building regulations […]"*

The Industry sector which manufactures off-site modules would welcome certainty, consistency of interpretation and acceptance of its 'product(s)'. Certainty comes easily for the traditional heavy massy typologies (i.e. masonry, concrete and steel) that are able to follow linear routes to compliance described in AD B, see Example 5 (above). Considerations around combustible construction are also explored in Example 2 (above). The observation made in Survey Issue 1a (above) applies equally here:

> *"[…] AD B really needs to support [MMC's] ambition in order to help give greater confidence and assurance to the industry […]"*

One of BRE Global's network of contacts pointed to a shift in Local Authority planning departments' preference for brownfield site redevelopment. The preference is against demolition followed by rebuilding in heavy massy construction, see also the London Assembly Planning and Regeneration Committee report *Retrofit or Rebuild (Reducing Carbon in the built environment)* February 2024 [219]. The trend being observed is that where a developer intends to demolish and rebuild but undertakes to rebuild in sustainable forms of construction, e.g. using mass timber or offsite-manufactured units, planning permission appears to be easier to obtain, than would be the case with heavy massy construction (i.e. masonry, concrete or steel). There is a commensurate preference for the repurposing and adaptive re-use of buildings (see Example 2 (above) regarding change of use). Thus, it is clear that, unlike the time when AD B (2006 edition) was being drafted, the picture in the mid-2020s is very different, with local authority planning departments favouring more sustainable forms of construction. This is explored in more detail in *Whole life cycle carbon cost* (below).

Interpretation of current restrictions regarding external walls of certain buildings

There is no firm 'trigger' in AD B, restricting the height of buildings comprised of combustible construction. The trigger under Regulation 7(4)(a) relates to the construction of external walls of relevant buildings under Regulation 7(2). Regulation 7(2) requires that all elements of external walls need to be formed using materials that achieve a Classification of A1 or A2-s1,d0, in accordance with BS EN 13501-1. BRE Global notes the December 2022 to March 2023 consultation by DLUHC [220] which asked users of AD B whether paragraphs 10.6 in AD B Volume 1 and 12.6 in AD B Volume 2, were unclear and in need of clarification. In March 2024, Government clarified its intention to call for further evidence on these paragraphs. Government wants to learn about the materials which should be captured in these two paragraphs and seek views on the wording of both paragraphs to ensure the approved document is as clear as possible.

Also, in March 2024, useful commentary was provided at FAQ 13, in relation to the need to consider the exposure condition applicable to internal floors and walls, and external load-bearing walls (above openings) for some buildings [221]. The answer to FAQ 13 appears particularly relevant to all other purpose groups and building types falling outside of Regulation 7(2).

Whilst the principle of the commentary is useful, there is no detail. Instead, it requires that:

> *"Designers should apply the most credible fire exposure conditions for their building situation and verify that the associated evidence of performance (e.g., standard test, assessment, calculation) is appropriate for the field of application."*

This commentary applies equally to internal walls and floors. Without detailed guidance, there is the potential for the answer to FAQ 13 to preside over a breadth of interpretation on which test standard one should rely on when considering fire exposure from inside, outside and via interstitial spaces simultaneously.

<u>Uncertainty over demonstrating fire safety provisions for tall (very tall) large (very large) combustible structures</u>

The themes considered in Survey Issue 1a (above) show that the guidance 'picture' is very much more uncertain than was the case when AD B (2006 edition) was being drafted. However, the contra position may be that the authors of AD B (2006 edition) always intended professional and experienced users of the document to know that the 'restrictions' and 'with caution' clauses that are signposted in AD B (2019 edition as amended) also applied back then.

The wording of paragraph 0.30 in AD B (2006 edition) was:

> *"[Fire safety engineering] … may be the only practical way to achieve a satisfactory standard of fire safety in some large and complex buildings and in buildings containing different uses e.g. airport terminals."*

However, designers and fire engineers used AD B as the framework to prove the provisions had been complied with, for all manner of very large or very tall buildings or large timber buildings or some buildings that incorporated modern construction methods, with a few notable exceptions (e.g. a new airport terminus). It was exceptionally rare to undertake an appraisal before using AD B to consider whether one should put AD B down and pick up BS 7974 *Fire safety engineering in buildings*.

In trying to add clarity to AD B from 2019 onwards, but without tangible triggers, industry is increasingly unsure if AD B can apply. Perhaps the actors undertaking building work would sooner have *the certainty of misery over the misery of uncertainty*[25].

The following shows the extent of consideration needed in the mid-2020s, and where one needs to look to obtain guidance.

By way of example, a seven-storey Extra care facility formed from 3D volumetric (combustible construction) modules, with the sixth floor located circa 18 m above ground is not definitively described by AD B as very tall or a large timber building. It is of note that the National Fire Chiefs Council *Provision of multiple routes for evacuation of residential buildings – Opinion Paper* (February 2024) [222] believes:

> *"tall buildings are those between 18 m and 45 m in height. Anything above this height is outside the scope of this [Opinion Paper]."*

The Manual to the Building Regulations suggests that **some** buildings incorporating modern methods of construction are non-standard typologies (BRE Global's emphasis **in bold**). The 'restrictions' and 'with caution' clauses in AD B (2019 edition including 2024 amendments) suggest AD B may not be applicable for this Extra care facility, but even this is not definitive.

Question 21 on the AD B FAQ webpage considers general principles, but there are no firm triggers:

> *"where the structure is able to contribute as a source of fuel during a fire, [they] are not common building situations and present additional considerations which designers should have regard to*
>
> and
>
> *"The designer should consider the type of construction, alongside factors influencing the consequences of fire spread and fire induced structural failure such as height, size, and use of the building, when considering whether it is appropriate to apply the provisions in Approved Document B."*

The AD B (2019 edition including 2024 amendments) requires that buildings this tall need a second escape stair, however at the time of writing, this provision was not due to come into effect until 30th September 2026 (or 31st March 2028, if a development is able to take advantage of the transitional provisions).

It is not clear what 'very large' means. In 2019, BRE Global attended a residential block of flats, which suffered a balcony fire which spread into and damaged eight flats. The floor plate of the entire building was approximately 2,500 m^2 and comprised approximately 20 flats per storey. If the Extra care facility (previously described and formed from combustible construction) was of the same order of size, circa 2,500 m^2, but was two storeys less in height, i.e. with the fourth floor (top habitable storey) located circa 11 m above ground level, would this trigger as 'very' large'? This modified example of a smaller (in

[25] Adapted from a quote attributed to author and psychotherapist Virginia Satir (1916 -1988) 'People prefer the certainty of misery to the misery of uncertainty'.

height) building would avoid the provisions of Regulation 7(2). Other provisions intended to apply at or above 11.0 m may also not apply. In BRE Global's opinion, the single trigger (the 11.0 m dimension) makes it susceptible to being a 'gamed' threshold. Typical storey heights for residential developments are 2.85 m. This exceeds the 11.0 m threshold by only 0.4 m. If ground levels were raised locally (e.g. raised beds) and designs were honed to utilise thinner floors, then the design could be 'engineered' so that the building fell just below the 11 m threshold, to avoid the provisions triggering at 11.0 m.

The Part B FAQs 13 to 16 inclusive, appear to be relevant to buildings of any height, and would be welcome in the above scenario. BRE Global welcomes the guidance in the answer to FAQ 13 as it introduces new thinking about complex mechanism(s) of fire attack in combustible construction, saying:

> *"Designers should consider the […] potential for load-bearing elements (including walls and floors) to become exposed on multiple faces if internal and / or external fire spread occurs. Designers should apply the most credible fire exposure conditions for their building situation and verify that the associated evidence of performance (e.g., standard test, assessment, calculation) is appropriate for the field of application."*

> *"[…] consideration should be given to the potential for load-bearing elements (including walls and floors) to become exposed on multiple faces if internal and / or external fire spread occurs."*

Since the above guidance does not cite a test standard with pass / fail criteria, actors wishing to follow the guidance are unlikely to do so with any consistency.

If one elevation of the above example of a five-storey Extra care facility (previously described and formed from combustible construction) was < 1.0 m to a relevant boundary, it would be even more critical that the designer should understand the performance of the wall when exposed to fire on multiple faces i.e. if internal, external and interstitial fire spread could occur. In the absence of detail, the designer may only be able to refer to Table B3: *Specific provisions of the test for fire resistance of elements of structure* (Condition 5.a.) to determine that the wall achieve 60 minutes (stability; integrity and insulation (R;E;I) from each side **separately (**BRE Global's emphasis **in bold**).

The next steps for AD B would appear to be that it considers a test standard and pass / fail criteria. Was the intention of the answer to FAQ 13 to point to a single test arrangement similar to the BS 8414 test?

Overall, with the guidance not being tangible or residing in a single location, one is reminded of the Coroner's observations following the Lakanal House fire, in the Rule 43 letter of 28th March 2013, that:

> *"'…[regarding] AD B[…], it is necessary to refer to additional documents in order to find an answer to relatively straightforward questions…"*

The themes touched on in Example 5 (above) suggest some forms of construction, in practice, prove to be robust and dependable even in extended duration fires (see the Windsor tower fire in Madrid). Some specifications e.g. masonry enclosures (say around a firefighting shaft) may be capable of achieving much higher levels of performance than they are required to achieve in practice. An example of this can be demonstrated by looking at a typical enclosure forming a firefighting shaft, formed of 190 mm thick 7 N aerated concrete blockwork. Such construction, when subjected to standard fire resistance testing, is likely to achieve 240 minutes (REI) [223], far exceeding the 120 minute requirement given in the current AD B Table B3 (condition 12), (for stability; integrity and insulation (R;E;I) from each side **separately**) (BRE Global's emphasis **in bold**).

This highlights that some traditional, heavy and massy construction materials, have considerable fire robustness ‘in reserve’, and whether subliminally or not, may be preferable over combustible construction. The heavy and massy construction has proven itself in real fires, often where those fires are of extended duration.

The lack of testing at scale, of combustible and modular forms of construction (e.g. volumetric modular) leads to uncertainty over its use in very large, very tall, large timber buildings and some buildings incorporating modern methods of construction. Hence, having no tangible thresholds just leads to uncertainty and inconsistency and will likely lead to a mixed picture of compliance across English cities.

Environmental damage and over use of firefighting medium

The construction media, news media and society generally, all appear to be more vocal in criticising modern construction where repeatedly, a seemingly unsurprising fire event (occurring in a building) results in disproportionate damage and loss. Such fires strain the emergency services and place an unquantified strain on the environment via air pollution and water course contamination (with run-off).

A localised fire (confined to the compartment of fire origin or to two compartments) will require far less firefighting medium than would be the case when an entire building becomes involved in an extended duration fire event. How likely therefore is it that AD B can remain immune from consideration of matters relating to sustainability and use / over use of water (for firefighting operations)? See the Met Office *UK Climate Projections Headline Findings August 2022* [224] that the UK faces hotter and drier summers. In BRE Global’s opinion, when there are restrictions on use / over use of water (including hosepipe bans in summer months), the amount of resource used for firefighting needs to be considered.

Changing perspective on insurance

A review by Glockling of the RISCAuthority’s white paper on the insurance challenges posed by new methods of timber construction [225] provides the insurance industry’s perspective on modern design trends, for larger and mixed-use buildings and the risk to the insurance industry associated with ‘massive timber buildings’:

> *“[there is] a scale of build where occupants become so distant from a place of safety, and remote from attending help, that assurance of life-safety may be problematic where the main structure contains combustible materials.”*
>
> And
>
> *“there is a substantial role for government to play in developing Building Regulations that better appreciate the challenges, if more complex construction types are to be embraced.”*

The report shows the insurer’s thinking, that an Estimated Maximum Loss (EML) for a ‘typical’ fire in a conventionally built building would amount to: i) a total loss on the fire floor, ii) smoke damage to a number of floors above and iii) water damage to a number of floors below. Historic insurance industry data show that such EML claims tended to amount to a small percentage of the overall build cost. However, with modern building (specifically combustible construction typologies), insurers are now faced with the prospect of EML being 100% of the build cost.

In conclusion, the report states:

> *"For some (predominantly combustible) construction methods, compliance with building regulations alone might have little relevance [to a building's insurability]."*

The report also goes on to point out the insurer's view of 'traditional methods' of construction and the image this conjures up of 'contiguous' fire compartments, without interconnecting voids, in contrast to what it sees as 'modern construction'. The report states:

> *"In many MMC structures the occupied compartments can be essentially suspended within a lattice of combustible voids whose only defence against fire ingress are layers of plasterboard and the provision of cavity barriers."*

Paragraph 1.10.1 of the NFCC formal submission, to Dame Judith Hackitt's *Independent Review of Building Regulations and Fire Safety*, made the following point about the Approved Document Guidance:

> *"The building regulations for fire are out of step with other approved documents which take into consideration environmental and sustainability factors in both the construction and life of a building. [AD B] has no such focus, and as a result there is no consideration for property protection and/or environmental damage caused by fire"* [226]

When the new 'broadly functional' regime of Building Regulations came into effect on 11th November 1985, it was thought that property protection standards would be driven by the insurance industry. Such 'ownership' by the insurance industry never materialised. The NFCC raised several points and concluded that AD B should consider property protection, if not for all purpose groups than at least for some.

<u>Emerging vulnerable details (with cavities)</u>

This observation relates to detailing at the head of buildings, above the thermal line, particularly those that are "relevant buildings" as described in Regulation 7(4). Parapet walls or decorative capping features (at the top of a building) which are not thermal elements, may not be being provided with fire stopping to the same standard as compartment walls. A parapet wall or decorative capping feature which does not separate a thermally conditioned part of a building from the external environment will not have insulation above the intersection with the flat roof insulation.

In buildings which do not qualify as "relevant buildings" e.g. those with six or less storeys or with a highest storey < 18 m above ground level, it is possible the framing members of a parapet wall or a decorative capping feature may comprise combustible material and the layers may also comprise combustible boarding, and depending on the height of the parapet or capping feature, the void may be extensive.
Fire spread via parapet voids is showing itself to be of concern. The Phase 1 Report of the Public Inquiry into the Fire at Grenfell Tower on 14th June 2017 – Volume 4 (October 2019) Part 111 Conclusions, made the following point (at paragraph 33.6):

> *"In view of the part played by the architectural crown in the spread of the fire at Grenfell Tower, particular attention must be paid to decorative features composed of combustible materials."*

A fire occurred at Petworth Court, Elm Road, Wembley, on 29th January 2024. Petworth Court is a five-storey block of flats. The flats were located above an under-croft car park. The fire either began on a fourth floor inset balcony or it began in the fourth floor flat and spread to the balcony. The fire involved the ceiling and walls of the inset balcony, as well as the contents of the balcony. The fire plume exiting the inset balcony spread over the parapet wall directly above. Photographic and video evidence of the fire (including photographs of the building after the fire) showed that the parapet was framed using timber – the building was timber framed with a board finish on the rear and brickwork outer skin at the front and side. The parapet wall was effectively a large, enclosed void, which allowed the flames that entered it to travel laterally, quickly. The fire spread in the parapet void and resulted in burning brands falling in wall voids below; this dropping mechanism allowed another unseen means for fire spread to occur.

If a flame plume from a flashover fire enters a hollow void of a parapet or decorative crown, the plume will likely spread laterally in the void with considerable energy, particularly if the void was designed to 'breathe' via overhanging copings and or if the void was open to the roof construction (itself also formed from timber construction).

In combustible construction such as that found at Petworth Court, fire has the potential to spread to new locations, unseen. This is concerning for the Fire and Rescue Service.

The schedule 1 relevant requirement B3(4) requires that:

> *"the building shall be designed and constructed so that the unseen spread of fire and smoke within concealed spaces in its structure and fabric is inhibited."*

This functional requirement alone should be enough to require cavities in construction outside of the building envelope to still be considered as 'material' and consideration could therefore be given to providing guidance in AD B, on these details and the construction of robust fire breaks.

See also Survey Issue 1h: *Provision of cavity barriers, construction and fixing of cavity barriers and openings in cavity barriers and Cavities in flats, Provision of cavity barriers, and Pathways around fire-separating elements* (below) on dropping fires in cavities.

<u>Whole life cycle carbon cost</u>

The whole life carbon cost (W-lcc) associated with building using different materials is currently a driver, influencing construction choices that clients, building designers and constructors are now making. It is clear that Government wants there to be a greater use of timber and off-site methods of construction in order to reduce constructions' carbon footprint. See also the London Assembly's Planning and Regeneration Committee report *Retrofit or Rebuild (Reducing Carbon in the built environment)* [219].

There are counter views regarding the true carbon cost of using timber extensively in construction. By way of example, Searchinger, Peng Waite and Zionts argue in an e-journal [227] that *'Wood is not the climate-friendly building material some claim it to be'* and point out that;

> *"…most wood (<u>and its stored carbon)</u> is lost during [timber processing] production,*
>
> *and*
>
> *harvesting wood is not carbon-neutral*

and

Using wood in construction will most likely increase climate warming for decades."

Searchinger spoke on a BBC Radio 4s programme Rare Earth (aired 2nd February 2024) *Can we build a better world with wood*, to argue these and other points. During that programme, Searchinger went on to state that when a tree is harvested only 20% of the stored carbon in the tree is processed into useful construction timber with the remaining 80% being lost (given up).

The assertion that only 20% of a tree's stored carbon remains in the processed timber it yields, may be revised to a higher percentage in due course, however, whatever final figure all agree upon, it is clear that stored carbon in the useful processed timber only remains stored if the timber does not burn in a fire.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

BRE Global notes several fires in combustible construction, where disproportionate damage occurred. The fires at Samuel Garside House, Barking, June 2019 [228] Premier Inn, Bristol, July 2019 [229], Beechmere, Crewe, August 2019 [230], Richmond House, Sutton, September 2019 [231], Pankhurst Avenue, Brighton, September 2019 [232], and The Cube, Bolton, November 2019 [233], all involved significant elements of combustible construction and brought into focus the question of property protection. Following four of these fires (Premier Inn, Beechmere, Richmond House and Pankhurst Avenue) the remains of each building had to be demolished.

By following the guidance in AD B (B3 and B4) it is expected that if a fire starts in a flat, it will be confined to that compartment and, if it does spread to another compartment, the Fire and Rescue Service should still be able to extinguish the fire in each compartment.

This Survey Issue arises in the light of the fires identified (above) and others, which challenge precepts of fire safety, that the structure of a building should not contribute to the fire load and cavities should not be spaces in which fire and smoke spreads unseen and 'uninhibited'. In five of the six fires (above), the fire spread past lines of compartmentation both horizontally in roof and wall cavities and vertically (including downward fire spread) in wall cavities.

Five of the fires started as a result of an external ignition source, one started with an internal ignition source. In each case, fire spread to involve either external balconies, wall build ups, or wall and/or roof cavities. These fires point to disproportionate outcomes rather than outcomes where the damage is confined to one or possibly two compartment(s).

Combustible construction does not apply exclusively to timber, but where timber is the principal material, the form of construction can be:

> *"…light-timber frame construction, premanufactured volume elements or mass timber construction using engineered timber products such as glued laminated timber (glulam), laminated veneer lumber (LVL), nail-laminated timber (NLT) and cross-laminated timber (CLT)."* [234]

The timeline for use of Cross Laminated Timber (CLT) in buildings in the UK shows exponential growth and increasing popularity since 2005 [235]. One CLT supplier in an e-article (a news article for business opportunities for the environmental sector) suggested an anticipated rise in the use of timber in construction of 15% between 2017 and 2025 [236].

In January 2020, DLUHC called a four week consultation to seek evidence and views on factors contributing to fire risks in buildings, and approaches to prioritising such risks and appropriate action to take [237]. Whilst the purpose of the consultation was to identify a ranking of fire risks (for fire risk assessments) in existing buildings, the ranking that emerged, could quite easily serve as a checklist for considering the form of construction for a new building, since today's proposed building is tomorrow's existing building.

In the context of a 'stay put' fire strategy, the non-combustible nature of some construction typologies does not (in and of itself) impact adversely on considerations like occupant mobility and capacity to self-evacuate. For combustible construction typologies not to have an adverse impact on these considerations the construction must be protected so as to prevent fire and smoke spread/growth between compartments via the structure of the building.

If it is recognised that fire and/or smoke could spread/grow via the building's structure in this manner, this is likely to result in the selection of a different fire strategy.

One consideration might be to re-work the guidance into separate sections dealing with combustible construction in Volumes 1 and 2.

The final three ranked risks emerging from the consultation included 'risk to the community' (infrastructure) and a 'risk to the environment' and arson [Ibid][26]. Risk to the community and environment are considered in more detail in Theme 6: *Alternative fuels and Part L* (below).

The Home Office statistics show that on average, there were 3,200 fires started deliberately, each year, in dwellings in England, between 2012 and 2022 [238]. However, prior to this (most notably between 1995 and 2005) the prevalence of arson was much higher, averaging 10,700 fires per year. The statistics from 2019 to 2022 (the COVID-19 lockdown and recovery years) show the instances of arson were at their lowest since record keeping began; over forty years ago. BRE Global notes the NFCC *Arson reduction strategy report 2019 to 2022*, records all incidents (not just building fires) involving arson since 2014/15, and that they are on an upward trajectory [239]. Accordingly, it would appear prudent to continue to monitor dwelling fires (and other building fires) attributable to arson, to see if there is an uptick in the numbers reported from 2022 onwards. Although difficult, it would prove useful if data could be collated to capture those instances where a fire resulted in disproportionate fire spread, resulting in either partial, or

[26] This consultation produced a risk prioritisation for existing buildings in the following order: building height; various provisions for firefighting; the choice of construction (the palette of materials, the suppression installation, compartmentation, the selected wall build-up, the chosen alarm system, the complexity of the building, the proximity to other buildings and various other specific considerations); the occupancy profile in the building; building type (purpose group); the means of escape (fire strategy) the management involvement; the risk of arson the impact on community and environmental impact.

full building collapse. From this analysis, patterns may emerge of building type, construction type and vulnerability to arson.

Consideration could be given to what might be reasonable guidance if incidence of arson continues to rise and whether the guidance should apply with unequal measure to combustible and non-combustible construction.

Implication for AD B – The survey highlighted, as very concerning, that combustible construction is not treated differently from non-combustible construction, particularly when considering residential uses and specialised housing typologies. Moreover, concern was raised over the viability of stay put and the potential for disproportionate damage and sometimes the total loss of buildings suffering a fire event. The trends suggest that low frequency, high profile / high impact fires are most likely to occur in combustible construction.

The six fires identified in this Survey Issue, were more significant events than single compartment burnouts illustrating how combustible structures contributed to each fire outcome.

Without revised guidance on testing and or classifying elements of construction and system assemblies, there is a likelihood of further disproportionate fire events occurring in combustible construction which may result in total building loss for which, there is an increasing societal expectation that loss, on such a scale, is unacceptable.

Lastly, AD B does not consider the carbon cost associated with the construction of a building and, if taken into consideration, the cost should fairly account for reasonably foreseeable fire events and the loss of some or most of the asset over its lifetime. The disproportionate result of a seemingly reasonably foreseeable fire event, in combustible construction, is out of step with societal expectation.

The challenge arising from this Survey Issue suggests AD B could look at:

- Adding clarity for the users of AD B in the form of separate guidance for combustible and non-combustible construction. One consideration might be to re-work the guidance into separate sections in Volume 1 and Volume 2 of AD B, for combustible and non-combustible construction or to produce a third Volume.
- Consideration and a methodology for gaining insight as to whether construction has the potential to be 'robust' in fire, by monitoring / recording and classifying the construction after the standard fire resistance testing i.e. during the cooling phase, see also Example 5 (above) and section 3.3.8 (above). This challenges to walls, floors and roofs. The outcome of cooling phase monitoring / recording and classifying would be an indicator of an element's potential robustness in real fires and whether the construction could advance to large-scale testing or not.
- Monitoring closely if some forms of construction and / or building designs have become (or are showing signs of becoming) more vulnerable than others to disproportionate outcomes following arson and vary guidance to suit.
- Adding clarity for the users of AD B as to the risks of fire spread via parapet voids – see the Phase 1 report into the Grenfell Tower fire, which specifically raised the need for attention to be paid to architectural crown details and a recent fire at Petworth Court, Elm Road, Wembley in January 2024.

Linked consideration and discussion can be found in Theme 1: Issue 7: (below) *Tall buildings and single stairs and combustible construction high-rise and ultra-high-rise* and Theme 6: Issue 1: (below) *Alternative fuels and Part L* (below).

6.1.3 Survey Issue 1c: Management of premises, Inclusive design and management's role in ongoing inspections and evacuation

Background – Survey Issue 1c considers together, AD B Volume 1 paragraph 0.6: *Management of premises* and paragraph 0.8: *Inclusive design.* It also considers management's role in terms of ongoing inspections of buildings (including 'parts of buildings') and management's role in the initial stages of a fire, prior to the arrival of the Fire and Rescue Service.

An example cited in the survey looked at whether management is frequently stymied in its attempts to undertake routine inspections of fire safety features within private demises (i.e. inside flats) and whether this becomes more critical in combustible construction? If this is the case, then perhaps designers should be thinking of compensatory or 'trade-off' measures and, the suggestion was, that AD B has a part to play in providing such guidance.

The second consideration links directly to inclusive design and Equalities legislation and asks whether AD B should more clearly state what the expectations are for management in beginning an evacuation of people (with physical disability or sensory impairment), where those residents may wish to exercise their choice to leave.

One respondent said the Regulatory Reform (Fire Safety) Order 2005 should be looked at to see how it can:

> *"More closely shake hands with AD B (and vice versa) with regards to management obligations."*

Driver – There is no single driver. The first observation is that management's role in inspecting and maintaining fire-separating elements, within private demises, is still unclear, even in the mid-2020s.

In buildings comprised of heavy massy materials, the combined effect of small building movement(s) (associated primarily with wind or vibration or thermal effects) and the effect of occasional water leaks (even flooding events – e.g. following a Fire and Rescue Service intervention, as a consequence of a small fire event) on seals in compartment floors and walls, could be described as 'routine' and 'common' building maintenance. In contrast, not enough is known or understood of the effect of building movement(s) and wetting events on buildings comprised of some modern methods of construction, including seals in compartment floors and walls. If this has not been researched, and not enough is known of this, then building management may not appreciate the scale of any problem particularly if, investigation requires access to private demises and especially if the inspection needs to be invasive.

The driver is the increased uptake of some forms of off-site manufactured 2-D panels, structural insulated panels and 3-D volume modular elements. The evidence for increased uptake of combustible forms of construction can also be found in Survey Issue 1b (above) *Growing desire for sustainable forms of construction* and *Whole life carbon costing* and Theme 6 (below) *Whole life carbon costing*.

The driver for the second observation, considers the need to give equal 'voice' to disabled residents (who may choose to escape). This is driven by Equalities legislation and the concept of dignified escape. This has in large part been discussed in Example 11 (above), and in particular, the London Plan policy D5(5B) which calls for at least one evacuation lift to be provided in each 'bank' of lifts.

Evidence – There is no direct evidence available, as this point is respondent-driven, i.e. it is derived from *'practitioner viewpoint(s)*'.

The Fire Safety (England) Regulations 2022 [240] made it a legal requirement to make quarterly checks on fire doors and to conduct an annual fire door audit. The Regulations require the responsible person to:

> *"undertake – on a best endeavour basis – annual checks of all flat entrance doors (including self-closing devices) that lead onto a building's common parts."*

The term 'best endeavours' does not give weight to objective and the wording specifically targets front doors only. The requirement does not extend to checking all fire safety features within a flat e.g. fire-separating elements.

On the subject of best endeavours, the Home Office has published *Fact sheet: Firedoors (Regulation 10*) [241] – made under Article 24 of the Regulatory Reform (Fire Safety) Order 2005 [242], to address the intention of this, saying:

> *"It will be for responsible persons to determine the best approach to engage with residents in order to get access to undertake the annual checks of flat entrance doors. This could include the responsible person agreeing with residents a date, so access can be granted."*

It is one thing to gain access to check a front door, but quite another to be able to enter a private flat to conduct a condition survey / audit of the active and passive fire protection measures. This point was raised by one survey respondent as being particularly troubling where the structure of a building is comprised of combustible construction. Moreover, it should be a requirement to audit the ongoing efficacy of compartment walls and compartment floors between some forms of modern construction e.g. volumetric 3D modules.

It is reasonably foreseeable that a building will suffer water damage during its life e.g. a leaking waste water pipe, water supply pipe or other, and implications of this for the fire seals (and their potential to become sodden and slump or dislodge) is discussed in Survey Issue 1h (below).

A compartment floor should be diaphragm-like, spanning from external wall to external wall as a continuous element. A compartment floor should not span across a floor plate in a start / stop manner. When a building is comprised of 3D modular volumetric construction, compartment floors cannot be anything other than discontinuous since they start and stop (repeatedly). This suggests guidance is needed as this form of construction challenges the fundamental precepts of what a compartment floor should look like.

Industry would welcome guidance on the designation of the space between modules and clear guidance that the gaps must not be closed with cavity barriers, particularly since paragraph 9.14 of AD B Volume 1 (2019 edition with 2022 amendments) allows a reduction in performance below that defined in paragraph 9.13 at 30 minutes integrity (E 30) and 15 minute insulation (I 15). Even if correctly rated, fire stops are used, they may be hydrophilic and susceptible to slumping when saturated. Management need to be able to inspect these gaps and ensure seals remain robust and in place.

More needs to be known of the long term performance of seals particularly at floor level (and potentially, also in compartment walls) accordingly, in the meantime, industry would welcome guidance on what to do about sealing these gaps and this may need to be based on experimental work.

See Survey Issue 1b (above) the *Changing perspective on insurance*, a review by J D Glockling, in which he describes the problem the insurance sector has with voids:

> *"In many MMC structures the occupied compartments can be essentially suspended within a lattice of combustible voids whose only defence against fire ingress are layers of plasterboard and the provision of cavity barriers."*

This notion of a lattice of voids is a concern. Cavity barriers should have no place in maintaining continuity of a compartment floor or a compartment wall. Module boundaries seem a vital detail, in need of inspection / audit.

Example 11 (above) considers as evidence the guidance from the London Mayor's office – the London Plan Policy D5 (5B) which requires every new building, where lifts are provided (irrespective of height), to have an evacuation lift. It also considers the concept of 'choice'. This is the choice to leave a building rather than being facilitated to stay (see AD B Volume 1 paragraph 3.3). This becomes an issue for building's management in the early stages of a fire, prior to the arrival of the Fire and Rescue Service.

Example 11 (above) considers how in London it will not be acceptable for wheelchair users or people using another walking aid to be expected to:

i) decant into an evacuation chair or

ii) be carried down the stair or

iii) bump down flights of stairs on their backside or

iv) be left at street level without their wheelchair or walking device, during a fire event.

It is reasonably foreseeable that there will be a varied picture of what compliance looks like across England since other core cities and Combined Authorities may have a different view to London on escape provisions for disabled people. This is why nationally applied building regulations and not locally administered planning policy is the correct forum for resolving this type of issue.

A National Fire Chiefs Council (NFCC) *Provision of multiple routes for evacuation of residential buildings – Opinion Paper* (February 2024) [222] believes that:

> *"design teams appear to be attempting to apply [AD B] in its current form without acknowledging there is a live discussion around:*
>
> - *the design of means of escape and the principle of* ***equity*** *of escape [BRE Global's emphasis]*
> - *how the building design supports the accountable person in demonstrating that their duties are being met to regulatory bodies once occupied, and*
> - *incorporating local requirements, such as the London Plan, into a design."*

Example 11 considers how disabled residents are capable of independent living, provided the lifts are working. In order to achieve equitable provision for disabled people, it would suggest that evacuation lifts, with suitable redundancy are required.

The NFCC *Provision of multiple routes for evacuation of residential buildings – Opinion Paper* at paragraph 5.2 suggests in terms of the number of evacuation lifts that:

> *"There is a sufficient number of evacuation lifts for the potential building users, and to account for those times when a lift is unavailable (Note: in practice, this means that there will generally be more than one evacuation lift required per stair core or evacuation lobby."*

This does not appear to be an unreasonable proposition. When buildings are designed to the provisions of AD B (2019 with 2024 amendments) non-disabled people will be assured access to more than one stair. Accordingly, it would seem equitable to allow those who need to use a lift, to go about their daily lives, to have access to more than one evacuation lift during a fire event. A building's management needs to be involved in the decision-making process surrounding the 'management and use' of evacuation lifts.

Following the introduction of the Regulatory Reform (Fire Safety) Order 2005, the Department for Communities and Local Government issued guidance to those conducting fire safety risk assessments, including a supplemental guide *Fire safety risk assessment (supplementary guide): Means of Escape for Disabled Persons* [243]. The dedicated guide for escape for disabled people (which applied to all purpose groups except for residential uses) included the following:

> *"[…] responsible persons and building managers should take the right approach, recognising disabled people's dignity and right to independent access and evacuation, and they should provide as much information as possible to everyone about the plans for disabled people.*
>
> *And*
>
> *[…] disabled people are no different from anyone else in that they prefer to be in control of their own escape."*

The AD B (2019 including 2024 amendments) at paragraphs 3.29 and 3.53 requires that where evacuation lifts are provided, provisions will be necessary to protect the lift and the lobby from the effects of smoke ingress. Neither the London Plan nor the current AD B stipulate at what height lifts need to be introduced to residential buildings.

Note that in other core cities and combined Authorities, there may not be a mayoral plan covering this provision, accordingly, this is likely to lead to a varied picture of compliance between cities especially as the transitional provisions for AD B (2019 edition including 2024 amendments) might extend to 31st March 2028 (with many schemes completing later than this). BRE Global notes that, if elected at the 2024 General Election, the Labour Party's Manifesto pledge is to give more power to Combined Mayoral Authorities to plan for housing growth and:

> *"…[to] give Combined Authorities new planning powers along with new freedoms and flexibilities to make better use of grant funding."*

Also, changes introduced by the Mayor's office (in London) on 10th February 2023 require all residential blocks with a floor at 30 m or more to have a second escape stair. Following the consultation on the need for more than one stair in high-rise buildings(19), AD B was amended in March 2024. AD B (2019 edition including 2024 amendments) requires more than one stair where either dead-end travel distances exceed 7.5 m, or where a building has a habitable storey at 18 m or more above ground level.

In all probability, it may take until early, to mid-2030s before every scheme in design, or on site, is using the AD B (2019 edition including 2024 amendments). Until this time, there may be a varied picture of compliance across England's core cities and Combined Authorities. In the intervening years, perhaps more guidance could be provided on management's role during evacuation and inclusive design.

Clarity is therefore required on management's involvement (and the resource needed) in order to facilitate escape for the most vulnerable people, who might wish to exercise choice and be in control of their own escape (particularly from a high-rise residential building) both during the initial minutes before the arrival of the Fire and Rescue Service and at any time during a fire event.

Internet research as part of this project identified that many councils (as at 2023) were introducing concierge services at their larger estates and taller buildings. This observation is included here, as this represents a change from past practice. If an impediment to the introduction of management obligations in the past was cost, then perhaps, the 'landscape' is beginning to change.

Implication for AD B – Some implications are explored in Example 11 (above).

Whilst fire doors need to be inspected, there are other active and passive fire safety features that also require inspection as part of the fire safety provisions of a building. The legal mechanism to force inspection appears to still require further considerations, and that consideration becomes especially critical in buildings containing combustible construction.

There is an increasingly argument that disabled people are no longer prepared to be 'allowed' to 'await' rescue because of a blanket belief that the stay put strategy facilitates and:

> *"[…] allows occupants, some of whom may require assistance to escape in the event of a fire, in other flats that are not affected to remain."*

While for people not requiring assistance…

> *"Sufficient protection to common means of escape is necessary to allow occupants to escape should they choose to do so […]"*

It is clear that in ordinary circumstances, a great many disabled people just require that the lifts should work so they can get about their daily lives (privately, without assistance). For those who do require assistance, some recognition is required of the obligations of management during a fire event.

The principles of dignified escape under the London Plan and construction press comment, appear to point to the need to 'facilitate' escape as an option, by way of evacuation lifts. Failure to do so unintentionally dictates to one group and facilitates another group.

The position for AD B is that its provisions / commentary and guidance could be tightened to be more in-step with the obligations of the responsible person and intention of Equalities legislation. Manual handling devices such as evacuation chairs or an expectation that a disabled person should be prepared to 'bump-down' the stair (multiple floors) are no longer acceptable (certainly in London).

The issue for AD B prior to the March 2024 amendments was that it was being left behind by requirements made under Town and Country Planning.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Adding clarity for the users of AD B on how joints in fire-separating elements (e.g. volumetric 3D systems) might be made available for routine inspection. This could also include management's obligations in this regard.

2) Adding clarity for the users of AD B regarding the evacuation of residents who may elect to leave the building during a fire event but be unable to use the stairs.

3) Adding clarity for the users of AD B on reasonable roles and responsibilities for management during the early stages of a fire event (until the Fire and Rescue Service arrive and take control).

4) Adding clarity for the users of AD B by providing diagram(s) showing indicative lift lobby arrangements and commentary on how smoke management should be configured so as to ensure smoke is not drawn towards the lift lobbies.

5) The potential impact and reach of the London Plan (policy D5(5B)) i.e. whether, in time, it will gain traction in other core cities and Combined Authorities, and what to do in the meantime.

6) Whether the guidance on the operation of evacuation lifts should fall to Local Authority Planning departments or Registered Building Control Approvers.

6.1.4 Survey Issue 1d: Alternative approaches

Background – Survey Issue 1d considers AD B Volume 1 paragraph 0.9: *Alternative approaches.*

Some survey respondents called for AD B to accept industry guidance for facades, smoke control, specialised housing guide and BS 9999: 2017 [244] and BS 9991: 2015 [245]. These guides were either not in use when AD B (2006 edition) was being considered or they had only just been introduced.

One industry guide, not in use when AD B (2006 edition) was being considered, is the Centre for Window and Cladding Technology (CWCT) and the Society of Façade Engineering (SFE) guide – *Technical Guidance for interpretation in relation to the external walls and specified attachments of relevant buildings in England - Reg 7(2) and Reg 7(3)* (September 2020) [246]. Some survey respondents felt that the guide gave better and practical interpretation of the new rules around Building Regulations 7(2) and 7(3).

Another set of industry guides, not in use when AD B (2006 edition) was being considered, are the Smoke Control Association (SCA) guides which are widely used by designers, installers and approvers (AHJs) but SCA guides are not mentioned / adopted in AD B. This is linked to Theme 1: *Tall buildings and single stairs* Issue 2: *Physiological limitations of firefighters* (below) for guidance on smoke control in corridors and basements (and other areas where there may be under ventilated fires).

Neither the NFCC Specialised housing guide (which tried to shed light on the many different typologies within the specialised housing 'genre') [175], nor the Local Authority Coordinators of Regulators Services (LACoRS) *Housing - Fire Safety - guidance on fire safety provisions for certain types of existing housing* [247] were in use when AD B (2006 edition) was being considered. Both provide information on several specialised housing typologies and houses in multiple occupation (HMOs). Neither document is referenced in AD B, however, both documents are more likely to be used as guidance when undertaking fire safety risk assessments than they would when considering building design. Alternative design guides such as HTM 88 [119] should be kept under review to ensure they remain relevant, see Example 8 (above).

BS 9999: 2017 appears to be used sparingly and selectively by fire engineers, particularly when they need to add evidence, in support of a 'position' in a fire strategy, for a proposed building. The first edition of BS 9999 was issued approximately 18 months after AD B (2006 edition came into effect).

The Draft BS 9991 *Fire safety in the design, management and use of residential buildings – Code of practice* [DPC 21/30428100DC issued for comment 6th August 2021] [248] was, at the time of writing, still under consideration. If the proposals (out for consultation since 2021) are to be adopted, the new BS 9991 will look significantly different to the pre-existing BS 9991 and be out of step with AD B. The first edition of BS 9991 was not in use when AD B (2006 edition) was being considered.

The foregoing documents showcase how modern design has developed from the period when AD B (2006 edition) was being considered.

Driver – There is no single driver. It is practitioner experience that suggests facades may not be following (to the letter) the guidance of AD B and Regulations 7(2) and 7(3). Where designers feel the guidance is too inflexible, they believe the (CWCT) / (SFE) guide offers practical alternative modern design guidance.

AD B identifies pressure differential systems to BS EN 12101-6 [249] as being appropriate for smoke control of common escape routes by mechanical ventilation. In BRE Global's experience, the most common system covered by the Smoke Control Association guide is the mechanical (powered) smoke ventilation system, with powered shaft extract and natural inlet (from the head of the stair). The mechanical (powered) smoke shaft systems (with natural inlet from the head of the stair) are more widespread than pressure differential systems and combine environmental ventilation in normal use and smoke extraction during a fire event. The drivers may be cost, ease of commissioning and ongoing maintenance.

Neither the NFCC Specialised housing guide nor the LACoRS Housing fire safety guide are referenced in AD B. This will result in a varied picture of compliance across England as some Designers, Builders and Regulators referred to the documents whilst others do not.

The drivers for using BS 9999: 2017 and BS 9991: 2015 are that they provide alternative approaches which can be used to support designers and engineers working in this area.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*' and requests by some that the CWCT/SFE guide to be adopted as alternative / additional practical guidance.

The 'evidence' for the use of the SCA guides comes from limited direct reference to it in the survey, and through the experience of several members of the Technical Steering Group that the *Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes – Revision 3.1) July 2020* [250] that this guide is the principal modern design guide for smoke control in buildings with single direction of travel up to 30 m. The guidance in AD B assumes the maximum single direction of travel is 7.5 m.

Some survey respondents asked for clarity on the detail of systems associated with smoke control e.g. the sizing and testing of AOVs, how to calculate free air area(s), the merits/demerits of actuators and timber door blank AOVs as opposed to tested dampers, shaft termination at roof level and whether there are limits that apply to natural shafts in very tall buildings.

Survey respondent(s) were concerned that the standard for tested smoke control dampers (to BS EN 12101-8: 2011 *Smoke and heat control systems Part 8: Smoke control dampers* [251]), in use in the mid-2020s results in reliable, better designed and tested components and these respondent(s) questioned the continued reference to use of a door blank and actuator, envisaged in AD B (2006 edition). These respondents were asking for complete review of the systems and components encountered in the mid-2020s and for AD B guidance to be updated.

One respondent observed that they had seen a proposal for a natural smoke shaft in a 40-storey building without any test evidence demonstrating that such a tall shaft would work in practice.

It was also noted that the Smoke Control Association provides guides on smoke ventilation system design for loading bays and car parks and how to go about conducting CFD modelling when designing corridors with single direction of travel up to 30 m and for underground car parks. Respondents and Industry would welcome clarity on whether the guides are, or are not endorsed by AD B.

Both the NFCC Specialised housing guide and LACoRS Housing safety guide appear to be more suited to risk assessments for housing in-use rather than housing at the design stage (particularly the LACoRS guide).

Implication for AD B – Until independently reviewed, and referenced in AD B, there will still be a sense of nervousness in relying on these (and other guides) as equivalent ‘approved’ alternative approaches. A consideration is whether guides that might be referred to should be free of charge to download. The need to pay a fee or register with a provider will deter some. Without additional freely available guidance the compliance picture could be very varied from city to city and between registered building control approvers and local authorities.

Whilst there is no requirement for AD B to update and adopt the guidance in BS 9991 (draft version of BS 9991) and vice versa, it is worth noting how far apart these two guidance documents could become if the draft is implemented in full.

The following selection of proposed changes showing as an example the direction of travel of the draft version of BS 9991:

Open plan including kitchen layouts

The draft version of BS 9991 provides guidance (including mitigation) should a cooker in an open plan flat be close to the flat entrance door. AD B (effective since June 1992) maintains the ‘position’ that a kitchen must be remote from the flat entrance door.

Stay put linked to Survey Issue 1c (above)

See also Example 11 (above). The draft version of BS 9991 states:

> “[…] *all residents are always free to leave their flats if they wish…*
>
> and
>
> […] *in all developments, where passenger lifts are installed, at least one lift should be an evacuation lift*
>
> and
>
> […] *Buildings in excess of 18 m in height should be provided with more than one evacuation lift’*.

The provisions in AD B discussed in Example 11 (above) and Survey Issue 1c (above) are markedly different from the BS 9991 draft version.

See also the changes brought about by AD B (2019 edition including 2024 amendments) – discussed in Survey Issue 1b and 1c (above) and the concept of dignified escape and freedom to choose to evacuate.

Evacuation lift lobbies, pressure differential systems, products and controls

When considering possible alternative approaches, the draft version of BS 9991 provides guidance on lift lobby layouts and pressurisation systems to protect these lobbies, the lift shaft(s) and the stair. The draft also provides detailed guidance on pressurisation system products (e.g. smoke dampers not timber doorsets) system controls (and automation and overrides). It also gives guidance on fan operating speeds, supply cable routing, back-up power sources, location of uninterruptible power supplies and routing testing and management and maintenance of these systems. AD B (2019 edition including 2024 amendments) provides some guidance, but it is not as detailed, and it may take until the mid-2030s before all buildings being designed and built follow the AD B (2019 edition including 2024 amendments).

The AD B (2019 edition including 2024 amendments) will require more than one stair where travel distance exceeds 7.5 m. AD B advises on pressure differential systems, and states that guidance is available in BS EN 12101-6. The guidance from the SCA is that single direction travel up to 30 m is possible. BS 9991 suggests distances greater than 15 m are possible but only if the building is sprinklered and the corridors are ventilated in addition to a pressure differential system serving the stair, lobby and lifts.

BRE Global's research suggests that balancing the corridor extract system and lift lobby, lift shaft and stair shaft pressure differential system may prove complex to commission and more complex to maintain. Research may be needed (at scale) to understand how these pressurisation and extract systems interact, over time.

Guidance was issued by the Ministry of Housing Communities and Local Government: *Advice for Building Owners of Multi-storey, Multi-occupied Residential Buildings (January 2020)* [252] in support of the Building Safety Programme and the work of the Independent Expert Advisory Panel (EAP), following the Grenfell Tower fire. This guidance document consolidated 22 individual pieces of advice issued following the fire into one summary document. The advice represented the EAP's position on the action that building owners should be taking immediately, to address the risk of fire spread from unsafe external wall systems.

The document was far ranging and at section 9, it addressed Smoke Control Systems, with paragraph 9.10 stating:

> *"The Smoke Control Association provides advice on issues related to smoke control systems and have published a guide "Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes)" [the SCA guide]. This is available on their website, along with other specific advice […]"*

The issue for AD B is that this building owners' guidance document raised the notion that the SCA guide provided reasonable provision for smoke control in corridors. The SCA document considers measures for smoke control in corridors from which there is only single direction of travel up to 30 m.

The guidance in AD B (2019 edition including 2024 amendments) at paragraph 3.30 makes clear that if travel distance in single direction only, exceeds 7.5 m then more than one stair will be needed.

The SCA position and the latest AD B (with 2024 amendments) are incompatible.

Since its issue, the MHCLG *Advice for Building Owners of Multi-storey, Multi-occupied Residential Buildings* has been withdrawn. The reason cited on the Government website was that:

> *"The Consolidated Advice Note has in some circumstances been wrongly interpreted and has been used to justify instances of an excessively risk-averse approach to building safety. The Consolidated Advice Note has therefore been withdrawn to ensure that it is not used to justify disproportionate assessments."*

Whilst there is no suggestion that the guidance on smoke control was incorrect, the withdrawal of the guidance is still problematic. AD B (2019 edition including 2024 amendments) is now suggesting corridors should not be longer than 7.5 m without the introduction of a second stair and is silent on its support for the SCA guidance to have single direction of travel up to 30 m.

Natural shaft extract limitations

The draft version of BS 9991 limits the use of natural shaft ventilation system(s) both in terms of building height (≤ 18 m) if the building has a single stair or and (≤ 30 m) if the building has two stairs and in corridors < 15 m in length. The AD B does not restrict a shaft's use in this way and guidance in table 3.1 suggests the maximum travel distance in a dead end is 7.5 m.

Sprinklers in residential occupancies

The draft version of BS 9991 provides new guidance on sprinkler installations to BS 9251: 2021 [253] and the extent of coverage in 'other' areas e.g. retail, gymnasia, cafés, restaurants, bars, car parks, and bin stores, all of which can be found in modern designed residential buildings. Previously, an additional installation to BS EN 12845: 2015 [254] may have been required in these non-residential areas. This mix of uses, in a residential building, is now common particularly for co-living schemes in city centres. AD B does not give guidance on how to address modern designs like this.

Single stair buildings with a storey at 18 m or more, above ground level

The draft version of BS 9991 states that load-bearing elements may need to be constructed using material achieving a European classification A1 to BS EN 13501-1: 2018, under some circumstances. Timber construction would not be possible above 18 m. If corridors are > 15 m long, a smoke extract system would be required for the corridor in addition to the pressure differential system in the stair lobby the stair and the lift shaft(s). The stair would need to be 1.2 m wide. AD B does not discount the use of timber frames above 18 m but makes stipulations on the construction of the external wall. AD B guidance is that a 1.1 m wide stair is sufficient.

In conclusion, it appears that AD B and the draft version of BS 9991 are not aligned on in several key areas presenting a confusing position to those seeking guidance in this area. The relationship between AD B and should be considered and a clarification provided.

The BS 5588 *Fire precautions in the design, construction and use of buildings* series of British Standards offered users targeted and aligned guidance which one was directed to by the previous editions of AD B. It would be useful if BS 9991, in particular, could have this 'relationship' with AD B. The current AD B guidance at paragraph 0.9 (in both volumes) states:

> *"…If other standards or guidance documents are adopted, the relevant fire safety recommendations in those publications should be followed in their entirety. However, in some circumstances it may be necessary to use one publication to supplement another."*

These two sentences provide mixed messages – the first suggests following a guidance document in toto, the second suggests one document can supplement another document.

By way of another example, AD B (Volume 1) paragraph 3.29 suggests alternative approaches can be considered in relation to balconies or decks. The guidance is problematic in that rather than being instructional, using "*should be"* it is optional, using "*may be".* This point links back to Survey Issue 1a (above) on the scope of AD B and the observation by one respondent that the wording in Section 7 of the Building Act 1984 might suggest that if the guidance says 'may be…' then not paying heed to what follows after it, would still be proof of compliance with the document. Moreover, this is an example of not using a guidance document in its entirety.

In previous documents, under the first section *Use of guidance*, there was a sub-heading *Technical specifications* which, if it had been retained, may have been the place to expand on how one was to know when to follow 'allied guidance'.

The challenge arising from this Survey Issue suggests AD B could look at:

1) A wide-ranging review of all such potential guidance documents used by industry, rather than this selective and limited few.

2) Adding clarity for the users of AD B regarding suitable alternative provisions for HTM 88, which is no longer referenced as being a 'supported' document by NHS – and revised guidance for all the different specialised housing typologies.

3) Adding clarity for the users of AD B by incorporating some alternative technical guides, in the text of AD B. In doing so, it would address one of the criticisms described in the Coroner's rule 43 letter of 28th March 2013, following the Lakanal House fire 3rd July 2009, in which the Coroner said:

   "AD B is a most difficult document to use. Further, it is necessary to refer to additional documents in order to find an answer to relatively straightforward questions concerning fire protection."

   The point being made by the Coroner applies more widely to AD B, to provide more rather than less detail in one place, or splitting the guidance further to other volumes, see Survey Issue 1b (above) on the approved documents, combustible construction and property protection.

4) Adding clarity for the users of AD B by using shading or highlighting of sentences in AD B where it is explicitly intended that the reader should follow a referenced document. By way of example "… For deck access, reference should be made to BS 9991 paragraphs 999 to 1001".

5) Referenced design guides should be free at the point of reference and use.

6) How best use could be made of BS 9991 and BS 9999 i.e. how these could complement and not be seen to compete with AD B.

6.1.5 Survey Issue 1d.1: Alternative approaches (HMOs and exempt supported housing)

Background – Survey Issue 1d.1 also considers AD B Volume 1 paragraph 0.9: *Alternative approaches,* with particular focus on houses in multiple occupation and supported housing.

AD B does not provide guidance for houses in multiple occupation; however, this form of tenure in the mid-2020s is common, particularly in cities. With increasing rental prices in cities, building work is frequently undertaken to convert dwellinghouses to buildings containing a combination of flats and rooms to rent – thus creating a complex mixed of tenures. This type of accommodation was not so common when AD B (2006 edition) was being considered and was not therefore included in detail in the guidance.

Previously, AD B gave limited guidance on HMOs regarding means of warning and escape, but this guidance was removed with the AD B (2019 edition). It was felt by some survey respondents that guidance on HMOs needed reinstatement and considerable expansion.

The Government website confirms that the private rented sector underwent significant growth between 2009 and 2019 and makes these comments about some of the current occupants and the risks they face [255]:

> *"...Some HMOs are occupied by the most vulnerable people in our society. [In HMOs] the risk of overcrowding and fire can be greater than with other types of accommodation".*

Regulations introduced in 2006 required mandatory licencing for HMOs and this brought approximately 60,000 homes 'under control' (these dwellings occurred in three-storey, or taller, buildings). The intention behind new regulations, introduced in October 2018, was to extend the mandatory licencing to include HMOs in former two-storey dwellinghouses, and flats and HMOs above shops.

A linked problem is with the 'exempt' sector, which here refers to an exemption from any locally set cap(s) on housing benefit.

> *"Providers of exempt accommodation that are registered with the Regulator of Social Housing are exempt from HMO licensing requirements* [256]*".*

Neither Town Planning nor Housing legislation impacts this form of accommodation.

The question that appears relevant from the perspective of AHJs is why are these forms of accommodation not coming to their attention more routinely? It would seem Regulation 5(h) is worded so as it could 'catch' such change of use to HMOs, however, the guidance was removed from AD B in 2019 and, prior to this, the guidance was rather limited. Accordingly, many AHJs believe Local Authority Housing teams are controlling fire safety in HMOs.

Some survey respondents commenting on the lack of HMO provisions believe HMOs must be clearly defined in any reconsideration of purpose group definitions, which is the subject of Survey Issue 1e (below) and meaningful guidance in AD B should be provided as to fire safety provisions for schedule 1 requirements B1 to B5.

Driver – There is no single driver. Whilst compulsory registration of HMOs, following regulatory intervention in 2006 and 2018 appears to have been successful, the sector still seems to be slipping below the building regulation radar and, in particular, Regulation 5(h).

A fatal fire occurred in Shadwell, Tower Hamlets on 5th March 2023. One media report stated that the flat was licenced as an HMO for five persons, however at the time of the fire, it was reported that 18 persons were living in the flat. The circumstances surrounding this fatal fire were, at the time of writing, still being investigated but the London Fire Brigade reported that the cause and origin of the fire was a lithium-ion battery, see also Example 6 (above). A video posted on social media, purporting to show the flat prior to the fire, revealed overcrowding of bedrooms, a curtain in lieu of a fire door to one bedroom and the absence of a kitchen door. It was noted from the video that several doors within the flat were not latching.

Whether self-closing devices are required on fire doors in an HMO seems to fall to a judgement about the size of the HMO. AD B (2006 edition) stated that fire doors within flats no longer need to be provided with self-closing devices – this guidance remains current in AD B (2019 edition including 2024 amendments) and does not depend on flat size. This is in contrast to the Government's Approved Document B: Fire safety – frequently asked questions (FAQs) webpage [17], which suggests self-closing devices may be needed in HMOs. The FAQ reader is referred to the LACoRS Housing safety guide for more information. The LACoRS guide states that self-closing devices are needed in 'large' HMOs. Given the potential speed of fire spread, and quantity of smoke produced when a fire starts in a lithium-ion battery fire, the qualification of the 'size' and guidance around HMOs should be reviewed.

If guidance in this area is clarified, requirements for conversions and associated enforcement from AHJs may be more effectively applied to ensure where Regulation 5(h) triggers, the owner complies, in full, with Regulation 6: *'Requirements relating to material change of use'*. It should be noted that Regulation 6(1)(c), in so far as it imposes requirement B4(1) External fire spread – walls, only triggers if the building exceeds 11 m in height. This risk would appear to need to be re-evaluated.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

There was some guidance for HMOs in AD B (1992 edition) which was expanded upon in AD B (2000 edition).

Paragraph 0.22 of AD B (1992 edition) stated:

> *"[…] compliance with [AD B (1992 edition)] will enable a newly constructed or converted House in Multiple Occupation to achieve an acceptable standard of fire safety."*

The guidance in the 1992 edition on means of warning and escape was, however, confusing, since it suggested at paragraph 1.3, that the reader could follow guidance for dwellinghouses whilst also suggesting at paragraph 2.5 that the reader could also follow the guidance for flats. There was no further guidance on securing compliance with relevant requirements B2 to B5.

An expanded definition of HMOs given in AD B (2000 edition) was useful since it made clear that one could treat an HMO for six or less occupants as a single family dwelling – the inference being that if the building contained more than six persons one could use AD B guidance on flats. The new licencing regime overseen by local authority housing services applies where there five or more persons living in a building.

The Building (Amendment) (No 2) Regulations 2002 introduced a new definition, '*room for residential purposes'*, under Regulation 2(1). This definition was initially introduced to ensure pre-completion sound testing would apply to such accommodation. These regulations introduced new Material change of use Regulation 5(h) for buildings containing a room for residential purposes, where previously it did not. This in turn required that the Schedule 1 provisions as described in Regulation 6 would apply.

For some reason, all guidance on HMOs was removed from the AD B 2019 (edition) and this is proving problematic.

The Exempt sector was the focus of a DLUHC Parliamentary select committee deep dive which concluded that the typical residents in this typology could be:

> *"[…] refugees, care leavers, people with disabilities and those who have formerly been homeless, had alcohol and drug addictions, been recently released from prison, or been a victim of crime such as domestic abuse or modern slavery […]"* [257].

The DLUHC select committee report '*Exempt Accommodation*' – Third Report of Session 2022-2023 (19th October 2022) described how local Government agencies have been powerless to 'control' the sector, and the report confirmed that:

> *"[…] Where exempt accommodation works well, residents are provided with suitable accommodation and support […] however, there have been growing concerns from regulators, providers and councils [about] bad quality accommodation […] the governance of providers; and the exploitation of the system by unscrupulous landlords to profit from their operations at the expense of their residents and the taxpayer[…]*[Ibid]

It would seem appropriate to ensure that a house extended and or converted to an HMO, should be required to comply with building regulations under the watch of an AHJ. It should not be ambiguous or left to chance that it will be controlled by the Housing Service and registered under the licencing scheme.

See also Example 8 (above), where it is suggested that alternative design guides, such as the NHS HTM 88 guidance document for design, management and the maintenance of group homes, must be kept under review, and not allowed to become out of date and unsupported.

Whilst the NFCC Specialised housing guide and the Local Authorities Coordinators of Regulators Services (LACoRS) Housing safety guide provide information on HMOs, the guidance is more suited to risk assessments for existing HMOs and less suited to consideration of proposed building work and building regulation compliance.

Implication for AD B – Some survey respondents and BRE Global cannot understand why the HMO guidance in AD B was removed.

Conclusion 1 of the Select committee report *Exempt Accommodation Third Report of Session 2022-23* is relevant and striking and should be included here:

> *"[a] significant number of residents' experiences of exempt accommodation are beyond disgraceful. Taxpayers' money is being spent on uncapped housing benefit on the understanding that residents, who are usually vulnerable, receive some care, support, or supervision—yet it is clear that some people's situations actually deteriorate as a result of the shocking conditions in which they live. We heard of squalid environments, vermin, drug-taking, crime and abuse. We heard of people with a history of substance misuse being housed with drug dealers, and of survivors of domestic abuse being housed with perpetrators of such abuse. The support on offer is sometimes little more than a loaf of bread left on a table or a support worker shouting at the bottom of the stairs to check on residents."*

If some providers are capable of overseeing conditions that caused the committee to arrive at such a damning conclusion as this, how bad might these buildings be when considering compliance with all applicable building regulations and, in particular, Fire Safety provision?

The challenge arising from this Survey Issue suggests AD B could look at:

1) A wide-ranging review of purpose group definitions including HMOs.
2) Provisions for HMOs to demonstrate compliance with requirements B1 through to B5. The risks associated with lithium-ion batteries may suggest provisions should apply in all instances, to small as well as larger HMOs.
3) Regulation 6(1)(c) to determine if beginning 'control' of external fire spread – walls at and above 11 m, is appropriate for a typology, which can be beset with the problems identified by the DLUHC Select Committee.
4) The themes discussed in Survey Issue 1b (above) on approved documents, combustible construction (etc). The Select Committee identified that buildings like this, housing some of the most vulnerable residents, may well attract a criminal element, accordingly this residential typology may be more susceptible to arson attack.

6.1.6 Survey Issue 1e: Purpose groups

Background – Survey Issue 1e considers AD B Volume 1 paragraph 0.14: *Purpose groups*.

In addition to the lack of definitive guidance relating to houses in multiple occupation (described in 1d.1 (above)), BRE Global notes the lack of guidance relating to the many different and complex forms of specialised housing and temporary holiday accommodation.

The following are the typologies which are common in the specialised housing sector in the mid-2020s and the complexity associated with these typologies did not exist at the time of the AD B (2006 edition).

- Move-on accommodation
- Shared ownership, including for people with long-term disabilities
- Very sheltered / assisted living
- Extra Care (including very sheltered and assisted living) offering more support than sheltered housing (can be staffed or not staffed)
- Close care (linked to a care home but living independently)
- Very close care
- Retirement villages incorporating sheltered, very sheltered, extra care, close care and nursing care

In addition to the above, are targeted 'support' homes [258]. Further research would be needed to determine how prevalent each specialised 'support' home was at the time AD B (2006 edition) was being considered.

- Support for people with drug or alcohol problems
- Support for people with mental health problems
- Support for people with learning disabilities
- Support for people with disabilities
- Support for offenders and people at risk of offending
- Support for young people leaving care
- Support for teenage parents
- Support for refugees
- Move-on accommodation

The following are the typologies which are common in the holiday sector in the mid-2020s.

- Apart hotel
- Airbnb style rental (both short and medium term)

The 'residential' purpose group is now extraordinarily complex and different to that at the time of the AD B (2006 edition).

Driver – There is no single driver. HMOs, in particular, are frequently formed in large traditionally single occupancy dealings built in Georgian, Victorian and Edwardian era semi-detached and detached properties in city settings. It is common for such a property to undergo material alterations and extensions (ground and first floor and a loft conversion) which can be complex work to control. It is also common for the AHJ to discover unauthorised conversions to HMOs whilst conducting inspections for extensions and other alterations to dwellinghouses. The resulting buildings (having been extended) often accommodate bed-sit flats and an HMO, in combination.

The survey also brought out confusion by practitioners as to what regulations to apply where a flat in a block of flats (not having building work carried out) which starts to be marketed as a holiday let and not a residential property.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

The lack of guidance on HMOs is recognised as a problem area but the sheer complexity of the residential typologies suggests the need for a complete review of purpose group definitions. It is clear why this point was raised and notes that the purpose group definitions have not changed significantly since AD B (1985 edition).

Implication for AD B – Without more guidance being provided, the sector will experience different levels of compliance and AHJs will apply AD B as 'best they can'.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Adding clarity for the users of AD B by conducting a wide-ranging review of purpose group definitions of residential, specialised housing, quasi holiday/short stay residential use, HMOs and thereafter all other purpose groups.

2) Adding clarity for the users of AD B providing guidance on reasonable fire safety provisions in specialised housing, quasi holiday/short stay residential use.

3) Adding clarity for the users of AD B where former dwelling houses become mixed-use with self-contained flats and several HMO rooms, under the same roof.

6.1.7 Survey Issue 1f: Means of warning and escape (Blocks of flats, Student accommodation and Sheltered housing)

Background – Survey Issue 1f considers together, AD B Volume 1 paragraph 1.10: *Blocks of flats,* Paragraph 1.11: *Student accommodation* and paragraph 1.12: *Sheltered housing.*

One respondent stated that some designs for new blocks of flats now include for detection and alarm in common parts. Another respondent believed the arrangement was becoming normalised because of public expectation.

Between 2019 and 2021, BRE Global inspected and reported on several building fires, where it was observed that such interlinked detector / alarms were indeed being added to common corridors. This is clearly a different position to that which was the norm when AD B (2006 edition) was being revised and the request in the mid-2020s is for AD B to provide clear practical guidance.

Observations were made by some survey respondents on evacuation alert systems, but this was prior to provisions being introduced in AD B (2019 edition including 2022 amendments) for evacuation alert system(s) for buildings with a storey higher than 18 m above ground level. One respondent made the general point that the trigger for whole building alerts should be 11 m and that this threshold should apply in specialised housing, particularly when the building was built from combustible construction. Trigger heights and the 11 m threshold are discussed further below.

Driver – There is no single driver.

One theme in Dame Judith Hackitt's (May 2018) report [259] *Building a Safer Future, Independent Review of Building Regulations and Fire Safety*, was that new technologies and techniques may emerge and be used to circumvent the guidance in an attempt to 'game the system' – see also Survey Issue 1b (above) on how a single trigger (the 11.0 m dimension in particular) makes it susceptible to being a 'gamed' threshold. It was notable that between AD B (2006 edition) and the Grenfell Tower fire of 2017, construction actors became increasingly emboldened to argue with the AHJs points of compliance and interpretation with the guidance of AD B and amending designs to avoid 'triggering' a requirement – a typical example such as avoiding the requirement *"…more than 18.0 m…"* threshold for the provision of firefighting shafts.

It is noted that in AD B (2019 edition including 2022 amendments) the language around thresholds uses a mix of "*more than*…" and "*X m or more*…" triggers. Using a double trigger and citing a dimension and a number of storeys would help to avoid gaming the system e.g. when considering the requirement for evacuation alerts at paragraph 15.17 could read:

> *"In blocks of flats […] with: **either** a habitable storey at 18 m (or more), **or** where the building has six (or more) habitable storeys, above ground level […] an evacuation alert system […]"*
>
> *(BRE's Emphasis in Bold)*

The more floors a development has, the greater the financial return. By reducing storey heights, and raising external ground levels, it would be possible to introduce a fourth floor (i.e. achieve a fifth storey) at just under 11 m and therefore avoid many of the new provisions which only trigger at "*11 m or more*". It is of concern that by lowering storey heights, to secure an additional storey, would have the ability to change all the parameters on which current fire safety provisions are based.

Additionally, this could change the potential fire dynamics within properties by reducing time to flashover in a compartment, more rapid smoke spread beyond the compartment of fire origin and jeopardising evacuation(s) where residents of other flats may have to pass through a smoke layer rather than passing beneath it, should they choose to leave. Reduced storey heights could also negatively impact rescue and firefighting work.

Evidence –There is no direct evidence available, as this point is respondent-driven i.e. it is derived from '*practitioner viewpoint(s)*'.

The news reports of the fires at Samuel Garside House, Barking, June 2019 [260], Richmond House, Sutton, September 2019 [261], Pankhurst Avenue, Brighton, September 2019 [262], The Cube, Bolton, November 2019 [263] and New Providence Wharf, Poplar, May 2021 [264] contain the ostensible complaint that the alarms in the common parts of the building were not working. In the mid-2020s, BRE Global notes a public and news media perception that smoke detectors located in a smoke-filled corridor should sound an alarm throughout the building.

Whilst conducting research for this project, a fire in the Bronx, New York, USA on 9th January 2022 was of relevance to the stay put debate in combustible structures and the need for early warning. On this occasion, a fire broke out on the third floor of a split-level apartment, in a 19-storey residential block. The fire resulted in 17 fatalities and over 60 injuries. The Fire Department New York (FDNY) conclude the origin and cause was a faulty space heater. The principal building defect, allowing spread of smoke and fire was defective door closers that did not close fire doors and cause them to latch. The media reported residents' accounts of fire alarms being present in the common areas, but since they were frequently sounding, residents endured them rather than reacted to them.

This fire in the Bronx, New York, USA was also of interest to Survey Issue 1b (above) on combustible construction since the FDNY requires landlords to post (in a conspicuous location in their residential building) a fire safety plan, based on whether the building is comprised of combustible or non-combustible construction. In the case of combustible construction, the FDNY guidance is that residents should leave the building immediately. In the case of non-combustible construction, the guidance is to "stay put" if safe to do so [265].

BRE Global observes that the fires of significance cited above, with the exception of the fire at New Providence Wharf, Poplar, May 2021, all occurred in buildings with a top storey that would not trigger the new requirement for an evacuation alert system to BS 8629: 2019 *Code of practice for the design, installation, commissioning and maintenance of evacuation alert systems for use by fire and rescue services in buildings containing flats* [266].

Even the draft BS 9991 gives mixed messages relating to the trigger for the provision of evacuation alert systems. The guidance of paragraph 10.1 is for evacuation alerts to be installed in buildings '*with a storey <u>at</u> 18 m or more…*'whilst paragraph 52.3 (which AD B (2019 edition, incorporating 2020 amendments concurs with) sets the trigger as *'…a storey <u>more than</u> 18 m above ground level…'*.[i.e. in all probability, buildings with a seventh floor above ground level].

One survey respondent pointed to the sophistication of modern fire alarms and that they do not need to immediately sound when one head actuates. The respondent argued that:

> *"… heat detectors can be used to signal confirmed fires, confirmed fires can be used to evacuate flats on that floor, whilst not signalling other flats. Confirmed fire signals can be sent to an alarm receiving centre who can review CCTV before calling the FRS and the FRS can have manual controls (based on BS 8629) to further evacuate the building…"*

Implication for AD B – There is confusion in industry as to whether communal alarms are required or not.

In combustible construction, should AD B follow the New York, USA approach with guidance pointing to immediate evacuation from buildings comprising combustible construction? If so, some form of alarm would appear appropriate in the common parts. What would the trigger height be?

The challenge arising from this Survey Issue suggests AD B could look at:

1) Research and consideration as to the part a 24/7 remote-monitored single-knock or double-knock detection and alarm system could play in instigating a controlled evacuation in <u>combustible construction</u>. Research and consideration could be given to how such a system may link to evacuation alert technology to BS 8629: 2019.

2) The part detection and intermittent alarm could play in initially alerting occupants in non-combustible construction, to a fire event occurring somewhere in the building. Research and consideration could be given to how such a system may link to evacuation alert technology to BS 8629: 2019, adding clarity for the users of AD B by stipulating an either / or trigger of height and number of storeys (whichever triggers first). Such clarity should help to prevent future gaming of the system.

3) Adding clarity for the users of AD B by stipulating an either / or trigger of height and number of storeys (whichever triggers first). Such clarity should help to prevent future gaming of the system.

4) Research and consideration of the effect of lowering storey heights on the precepts of the current fire safety guidance.

6.1.8 Survey Issue 1g: Number of escape routes, Small single stair buildings, Flats with balcony or deck access and Escape routes over flat roofs and Smoke control in common escape routes (natural and mechanical ventilation)

Background – The first hot spot location occurred between paragraph 3.27: *Number of escape routes,* through to and including paragraph 3.30: *Escape routes over flat roofs*.

The second hot spot location occurred between paragraph 3.49: *Smoke control in common escape routes,* through to and including paragraph 3.54: *Smoke control of common escape routes by mechanical ventilation*.

The two hot spots in Survey Issue 1g are considered together because they both relate to section 3: *Means of escape in the common parts of flats,* and because of the overlapping nature of some of the comments. Another significant reason for considering them together is that AD B (2019 edition including 2024 amendments) and the 22nd August 2022 circular: *Single stair provisions in very tall residential buildings etc* [267] have, to varying extents, added further clarity.

Driver – There is no single driver. The survey highlighted a range of issues, some of which are identified here. This Survey Issue 1g, encompasses two hot-spot locations, both of which came from AD B (Volume 1) Section 3: *Means of escape in the common parts of flats* – this section was the second most commented on in AD B (Volume 1) behind section 10.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

The subject matter was sometimes interwoven with themes discussed in other points made by respondents. The number of escape routes relating to residential schemes appeared to be problematic for some respondents.

In March 2024, AD B (2019 edition including 2024 amendments) came into effect and now provides clarification on some of the points raised.

The transitional provisions mean that the 2024 amendments do not come into effect until 30th September 2026. Moreover, the guidance of AD B (2019 edition including 2020 and 2022 amendments) can continue to be used where a (Full Plans) building control application is made and works on that proposal commence on 30th September 2026 and are sufficiently progressed by 31st March 2028.

The guidance in AD B (2019 edition including 2024 amendments) at paragraph 3.30 states:

> *"Flats should be served by more than one common stair if either of the following applies.*
>
> *a. The flat is on a storey that does not meet the criteria for a single escape route or a small single stair building (see paragraphs 3.27 and 3.32).*
>
> *b. The building has a top storey of 18 m or more in height […]."*

Note the height trigger. The provision applies if the building has a storey **at** or more than 18 m above ground level (BRE Global's emphasis **in bold**). The provisions for evacuation alerts apply if the building has a storey more than 18 m, as do the provisions for firefighting shafts. Note that where there is a need for a second firefighting shaft, paragraph 15.5 provisions apply if the building has a storey **at** or more than 18 m above ground level (BRE Global's emphasis **in bold**).

The concept of a double trigger is discussed in Survey Issue 1f (above) and AD B may wish to revisit wording of triggers to ensure commonality of approach and consider further the use of a double trigger wherever possible to avoid potential gaming the system.

It is noted that the Minister of State for DLUHC, announced the amendment to the statutory guidance AD B, regarding second stairs in certain buildings, as though it would become a 'policy' – see the full statement to the House of Commons on 17th April 2024 [268] which included the following:

> *"[…] The introduction of a second staircase in tall buildings is a balanced and proportionate policy. It is the latest in a series of measures which minimise both the risk and impact of rare, but high-consequence, incidents […]."*

The inclusion of guidance at paragraph 3.30b in AD B is not binding. The wording in the introductory section of AD B (2019 edition, including 2022 amendments) – *How do you comply with Building Regulations,* includes the following:

> *"The approved documents set out […] one way to comply with the Building Regulations.*
>
> *And*
>
> *"There may be other ways to comply with the requirements than those described in an approved document. If those responsible for meeting the requirements prefer to meet a requirement in some other way than described in an approved document, they should seek to agree this with the relevant building control body at an early stage."*

If it is intended that second staircases are a 'policy' requirement, [Ibid] in relevant buildings with a habitable storey at or higher than 18 m above ground level (or having seven or more storeys), the provisions in the statutory guidance at 3.30b above will need to become:

1) a building regulation

   or

2) a new Schedule 1 relevant requirement e.g. B1(2) that states clearly that the B1 requirement (or part of it) may be met only by complying with another 'relevant publication'

   and

3) a relevant publication may follow the principles of the former *Mandatory rules for means of escape in case of fire* guidance document, which was in force between 1985 and 1992.

See also Example 2 (above) which considers the concept of statutory guidance and mandatory rules co-existing.

Following the Grenfell Tower fire, guidance was issued by the Ministry of Housing Communities and Local Government *Advice for Building Owners of Multi-storey, Multi-occupied Residential Buildings (January 2020)* [252] in support of the Building Safety Programme and the work of the Independent Expert Advisory Panel (EAP). This guidance document consolidated 22 individual pieces of advice issued following the fire into one summary document. The advice represented the EAP's position on the action that building owners should have been taking to immediately address the risk of fire spread from unsafe external wall systems. The document was far ranging and at section 9, it addressed smoke control systems, with paragraph 9.10 stating:

> *"The Smoke Control Association provides advice on issues related to smoke control systems and have published a guide "Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes)" [the SCA guide]. This is available on their website, along with other specific advice […]"*

The issue for AD B is that this building owners' guidance document identified the SCA guide as providing reasonable provision for smoke control in corridors. The SCA document considers measures for smoke control in corridors from which there is single direction of travel up to 30 m.

The guidance in AD B (2019 edition including 2024 amendments) is very different, with paragraph 3.30a. making it clear that if the travel distance in single direction exceeds 7.5 m, then more than one stair will be needed. The same consideration (as described for more than one stair 3.30b. (above)) would apply if the provisions of 3.30a. are to be considered 'policy'.

The SCA position and the latest AD B (with 2024 amendments) are incompatible, and clarity is required – see also Survey Issue 1d (above) on *Alternative approaches*.

Since its issue, the *Advice for Building Owners of Multi-storey, Multi-occupied Residential Buildings (January 2020)* guidance document has been withdrawn. The reason cited on the Government website was that:

> *"The Consolidated Advice Note has in some circumstances been wrongly interpreted and has been used to justify instances of an excessively risk-averse approach to building safety. The Consolidated Advice Note has therefore been withdrawn to ensure that it is not used to justify disproportionate assessments."*

BRE Global understands that the excessively risk-averse approach (referred to), related to cladding and not *Smoke Control to Common Escape Routes in Apartment Buildings.* The loss of the reference to the SCA guide is problematic since travel distances, in single direction, exceeding 7.5 m is a design choice which was not apparent to the same extent, when AD B (2006 edition) was being considered. The vast majority of residential blocks, built since 2010 (when the first edition of the SCA guide was issued) have extended travel in corridors up to 30 m long.

Paragraph 3.49 of Volume 1 AD B (2019 edition including 2024 amendments) makes it clear that:

> *"… some smoke will get into the common corridor or lobby from a fire in a flat. There should therefore be some means of ventilating the common corridors/lobbies to control smoke and so protect the common stairs."*

It goes on to acknowledge that a secondary benefit of the ventilation is that it affords:

> *"…some protection to the corridors/lobbies."*

It appeared some respondents sought clarification as to the distinction between the ventilation required to protect a common stair and the ventilation required to provide some protection to common corridors and common lobbies. Specifically, in corridors and across lobbies, the responses to the survey suggested more clarity would be welcome as to why:

1) horizontal travel in a single direction is allowed in unventilated corridors (to a maximum of 7.5 m) as shown in diagrams 3.7a and 3.8c in AD B Volume 1 (2019 edition including 2024 amendments)?

2) ventilation is only required where travel across a lobby in a small single stair building increases from 4.5 m to 7.5 m and whether this is to protect the stair or to aid tenable conditions to facilitate horizontal travel across the lobby?

3) irrespective of the distance across a lobby, in a building served by a single common stair having a floor above 11 m (but less than 18 m) ventilation is required (as shown in Diagram 3.7b of AD B Volume 1 (2019 edition including 2024 amendments)) and whether it is required to protect the stair or aid tenable conditions to facilitate horizontal travel across the lobby?

The difference between the mid-2020s and when AD B (2006 edition) was being considered, may be the weight of ongoing concerns relating to how modern design is approached, and why it is that industry does what it does in relation to extended corridors, and whether the current guidance (some 18 years after the last review) should now be thoroughly reviewed.

Another welcome clarification in the AD B (2019 edition including 2024 amendments) concerns protection of evacuation lifts. Previously AD B (2019 edition including 2022 amendments mentioned evacuation lifts twice. The new document mentions them 24 times but there are no provisions to ‘require’ them, AD B only suggests provisions to protect them where they are provided.

It is noted that, in London, unless AD B provides commentary confirming when evacuation lifts should be provided, it may fall to local planning officers to decide on the technical aspects of compliance, and in other Core Cities and Combined Authorities a different approach may be adopted. This will result in a varied picture of compliance across England, which will be a highly undesirable outcome. One respondent identified that BS 9999: 2017 Annex G had retained the same guidance on evacuation lifts for approximately 30 years, and that Draft BS 9991 was still under consideration as was the Draft prEN 81-76: *Safety rules for the construction and installation of lifts – Particular applications for passenger and goods passenger lifts – Part 76: Evacuation of persons with disabilities using lifts* (June 2022) [269]. The survey respondent asked for clarity on provision and protection and use of evacuation lifts.

Technical guidance and diagrams of lift lobby and stair lobby layouts within the AD B would be welcome.

See also Survey Issue 1d (above) on *Alternative approaches* and Theme 1 Issue 1 (below) on *Tall buildings and single stairs and the limits of application (scope) of AD B* and Theme 1 Issue 2 (below) on *Tall buildings and single stairs and the physiological limitations of firefighters*.

The issue of smoke control in corridors also encapsulates issues around dignified escape and these matters are discussed in Example 10 (above), Survey Issue 1c (above) considers *Management’s role in evacuation* and Theme 1 Issue 5 (below) on *Tall buildings and single stairs and dignified escape*.

Some of the issues covered in Examples 7 and 9 (above) and Theme 1 Issue 1 (below) on *Tall buildings and single stairs and limits of application (scope) of AD B* and Theme 1 Issue 2 (below) on *Tall buildings and single stairs and the physiological limitations of firefighters* should also feed into the Theme 7 (below) concerning a complete review of B5 guidance. The Fire and Rescue Service's National Operational Guidance document, Generic risk assessment GRA 3.2 *Fighting fires in high-rise buildings*, should help inform the next B5 Review.

By way of another example, AD B (Volume 1) paragraph 3.29 suggests one can use alternative guidance routes when dealing with balcony or deck approaches. Deck approaches that were common when AD B (2006 edition) was being considered, were likely to be extensions of a building's concrete frame and its floor slabs. Thermal bridging was also less problematic at the time. In the mid-2020s it is common to see deck approaches constructed from hybrid materials e.g. a steel frame with composite wood or timber joists, boards, balustrades and screens. The guidance can be seen as problematic in that rather than being instructional, using "*should be"* it is optional, in that it uses "*may be".*

This point links back to Survey Issue 1a (above) on the scope of AD B and the observation by one respondent that the wording in Section 7 of the Building Act 1984 might suggest that if the guidance says '*may be*…' then not paying heed to what follows after it, may still be proof of compliance with the document, since the compliance is optional. Moreover, this is an example of not using a guidance document in its entirety.

Implication for AD B and Future direction – Industry will continue to design corridors until the AD B (2019 including 2024 amendments) comes into effect, which may be as late as 30th September 2026 (or 31st March 2028, if a development is able to take advantage of the transitional provisions). These questions will likely arise prior to and after the new AD B comes into effect, hence the suggestions below.

Unchanged, the document will preside over a breadth of interpretation (which may result in single-points-of-failure). Single-points-of-failure being one authoritative person in an AHJ or a fire engineering practice imposing their 'view' on how AD B should be interpreted in the absence of express nationally applied guidance and clear triggers. It is reasonably foreseeable that this will lead to a varied picture of what compliance looks like, between professional practices, AHJs and cities.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Paragraph 3.30b of AD B (2019 edition including 2024 amendments) to consider whether if it is left as guidance in AD B it suffices, or whether if intended as an instructional 'policy' (noting the language used in the written statement to Parliament in April 2024) the case needs to be stated more firmly, using regulation and or mandatory rules on compliance.

   1.1) What mitigation might be reasonable / required for historic tall single stair buildings?

2) Paragraph 3.30a of AD B (2019 edition including 2024 amendments) and whether this paragraph is also intended as guidance (as shown currently in 3.30b of AD B (2019 edition including 2024 amendments), or if it is intended to be a co-linked instructional policy.

   2.2) Mitigation that might be reasonable / required for low-, mid- and high-rise blocks of residential buildings with single direction horizontal travel in extended corridors up to 30 m long, based on past and present guidance from SCA?

2.3) Research into real life effectiveness of current provisions for smoke control under various / challenging conditions – see also Theme 1 Issue 1 (below) on *tall buildings and single stairs and the limits of application (scope) of AD B* and Theme 1 Issue 2 (below) on *tall buildings and single stairs and the physiological limitations of firefighters*.

3) Adding clarity for the users of AD B as to the circumstances that give rise to the corridors in Diagrams 3.7a. and 3.8c. being unventilated in contrast to the lobby as shown in Diagram 3.7b., 3.8a. and 3.8b. being ventilated.

4) Adding clarity for the users of AD B when designers are following the SCA guide for extended travel in corridors in the interim period until AD B (2019 edition including 2024 amendments) comes into effect.

5) Adding clarity for the users of AD B as to the technical specification for evacuation lifts as well as the protection to lobbies serving them.

6) Whether the technical guidance for evacuation lifts should fall to Town and Country Planning and local planning officers or Registered Building Control Approvers.

7) Adding clarity for the users of AD B on acceptable and unacceptable features / layout of evacuation lift lobbies.

8) Adding clarity for the users of AD B Volume 1 paragraph 3.29 whether the guidance is intended to be instructional, using "should be" rather than the current optional language which uses "may be".

6.1.9 Survey Issue 1h: Provision of cavity barriers, construction and fixing of cavity barriers and openings in cavity barriers and Cavities in flats, Provision of cavity barriers, and Pathways around fire-separating elements

Background – Client preference and Local Authority Town Planning vision may act as joint co-drivers of the number, and form, of signature buildings which appear in England's core cities. Another driver is likely to be architectural precedent. Building envelope design including building shape and or façade design and the presence of balconies and terraces is always pushing boundaries.

Driver – There is no single driver.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

Building envelopes are considerably more complex now than they were in 2006.

Implication for AD B – The issues surrounding cavity barriers in the mid-2020s have become very complex and now warrant a re-consideration. In BRE Global's experience of conducting post-fire inspections under the Investigation of Real Fires contract (see section 3.4.7 (above)) it was usually cavity barriers, more than any other detail, which was the focus of a large part of each fire investigation. These cavity barriers were frequently missing, incorrectly installed, damaged, or inherently defective and thus it was not surprising that fire and smoke spread unseen in cavities.

A feeling amongst survey respondents, was that building shape, facades (including the plethora of materials used in the make-up of façades) and interfaces between materials and façade systems have become more complex and varied than they were in 2006. The Centre for Window and Cladding Technology was 16 years old [270], and the Society of Façade Engineering [271], only one year old when

AD B (2006 edition) was being considered. It was not until 2013 that the first Journal of Façade Design and Engineering was published [272]. One can conclude that the knowledge base, relating to façade engineering, was at an embryonic stage when AD B (2006 edition) was being considered and now, in the mid-2020s it is far more established and mature.

BRE Global noted one survey respondent's detailed submission regarding the contribution that building shape can make to fire plume spread, spill, and draw, over (including up and down) external surfaces. It is clear that much more needs to be known about this subject. Building shape, façade shape and the performance of cavity barriers in such building envelopes appears to be a complex set of interacting features that would need to be considered in toto when assessing the fire safety of complex envelopes.

All of the foregoing suggests Diagram 8.1 in AD B Volume 1 and Diagram 9.1 in AD B Volume 2 have fallen below the radar-of-relevance to the modern practitioner.

Subjecting a representative portion of a proposed building's envelope to a large-scale test would be the most reliable method of determining performance of multiple systems acting together. It is hard to see how, in the early stages of large-scale testing of building envelopes such test could avoid considering building shape (whether leaning, twisting, stepping, recessing and more) façade design (including interfaces between different materials and systems) balcony arrangements (systems) and the effect of wind acting over the portion of a proposed building's envelope.

Ultimately, fire engineering modelling could, in time, predict how fire plumes might spread over a building's envelope, but large-scale testing would offer the evidential tool from which the modelling could learn and be validated. Large-scale testing in the short term, at least, has a place until modelling can be a reliable predictor of outcome. The first challenge before embarking on large-scale testing would appear to be the need to determine what defines building shape, façade design and balcony design, when considered in toto, as being 'complex'. The complexity would be born of how these features interact and that complexity would be compounded when the action of wind is considered during fire testing. The second challenge having determined that the envelope is complex is to agree a test methodology (with wind action(s) to be included) and acceptance (pass / fail) criteria.

It is hard to see how if large-scale testing is not considered a way of demonstrating compliance, how such complex systems would demonstrate performance compliance.

Some survey respondents felt that AD B does not provide meaningful guidance on cavity barriers that adequately reflects the complexity of modern design. The number and nature of the points raised were many and varied:

i) cavity barriers between fire separating elements and external walls,

ii) congested zones in external walls,

iii) the performance criteria for cavity barriers and the mixed message on this given by AD B,

iv) cavity barriers to suit complex façades and complex building shapes,

v) cavity barriers (or fire stopping) in volumetric modular construction and how the detail can be inspected post installation,

vi) the additive principle,

vii) dropping fires and

viii) the cavity tray dispensation, effective from 1st June 2022, under the Building Act 1984.

Cavity barriers between fire separating elements and external walls

Some survey respondents identified Diagram 8.1 (AD B – Volume 1) and Diagram 9.1 (AD B – Volume 2) as needing work and revision to make them relevant for modern designs. Both diagrams are similar to Diagram 33 of AD B (2006 edition) which was, in turn, a visual consolidation of information from Table 13 and Diagram 31 from AD B (2000).

One survey respondent provided sketches of five common modern external wall 'typologies.' The sketches showed the respondent's thinking on typical detailing at junctions with compartment floors for:

i) external thermal insulation composite systems (ETICS),

ii) rainscreens,

iii) curtain walls,

iv) masonry outer skin constructions, and

v) cast concrete outer skin constructions.

These sketches conveyed the point that Diagrams 8.1 and 9.1 had become too simplistic to be of practical use when considering modern designs.

Another respondent contributed to the debate regarding cavity barriers, fire stopping, and spandrel panel detailing in modern external walling systems – the suggestion was that CWCT Technical Note 98 [273] provided useful details for the treatment of spandrels and full height glazing and, if considered acceptable, could be referenced in AD B guidance.

The guidance in Diagrams 8.1 and 9.1 is broadly indicative of the 'principles' of cavity barrier locations and these principles have remained unchanged for 18 years. The compliance bar may be lowered as a consequence of construction professionals having to interpret what various modern details should look like, based on broadly indicative and historic guidance. The lack of contemporary guidance may be considered counterproductive and serve to lower the compliance 'bar'. If there is a guidance vacuum it is likely individual actors' personal experience will fill the void. If there is no ground to challenge such views, this could lead to a varied 'picture' of what compliance looks like across England. Revision in this area is required.

Congested zones in external walls

To maximise efficiency in the design of building services, residential buildings are frequently planned with bathrooms and kitchens 'mirrored,' either side of compartment walls. In addition, repeating layouts can result in stacking of bathrooms and kitchens, throughout the height of a building. It is common therefore, to find air intake and air exhaust ducts, serving bathrooms and kitchens, running in ceiling voids, either side of and close to compartment walls.

These ducts should pass through the external wall construction and terminate at the outer most face of the external wall and the 'edges' of the opening should be closed using cavity barriers. They should not exhaust air into the cavity, since this may affect the performance of mechanical extraction, reduce the quality of the 'intake air', reduce the thermal performance of wall insulation and cause accelerated corrosion of metal parts and fixings. Should fire enter the cavity because a duct terminates within it, then further flame and smoke may be able to re-enter the building via other co-located ducts. One respondent identified the need for AD B to consider guidance on cavity barrier provision in these ductwork-congested zones in external walls.

Where a building has cantilevered balconies, it is highly probable that the balcony fixings will also be located in this already congested zone. Consideration of such congested zones is proving problematic for designers and constructors.

We have seen buildings with thin wall slim rigid rectangular ventilation ducts and PVC flexible ventilation ducts (slinky tube type) terminate in cavity walls, where the duct was observed to:

1. pass through the inner skin (of the cavity wall) and made to terminate flush with the inner face of the inner leaf or

2. pass through the inner skin and made to terminate approximately mid-cavity or

3. pass across the cavity towards the outer skin and made to terminate close to or abutting an outer grille but without a positive connection being made to the grille.

The common feature with all three types of termination of ventilation duct was the lack of closer material around the opening. The provisions in AD B (2006 edition) required that:

> *"Cavity barriers should be provided to close the edges of cavities, including around openings."*

It took until the AD B (2019 edition) for the following words to be added (bold emphasis by BRE Global):

> *"[…] including around openings (such as […] and **entry / exit points for services**)"*

Experience suggests that industry was interpreting the need to close edges of cavities around openings as applying to windows and doors, even prior to the AD B (2006 edition). However, what was noticeable to BRE Global during its fire investigations, in relation to cavity barrier provision around windows and doors, was the lack of attention to detail. Inspections, carried out by BRE Global, revealed horizontal and vertical cavity barriers which seldom overlapped as well as barriers which seldom were 'tightly fitted'.

Accordingly, it appears that industry had a blind spot when it came to the need to close edges of cavities around *all* penetrations including ducts and entry / exit points for services.

Given the location of air intake and air exhaust ducts (likely being high on an external wall) it is reasonably foreseeable that fire could enter such unclosed cavities and that congested zones are problematic. The detail may represent a weakness in compartmentation, potentially resulting in lateral fire and smoke spread – on the line of a compartment wall. Moreover, because of the stacking of bathrooms and kitchens, throughout the height of a building, the detail may represent a secondary weakness, allowing smoke and possibly fire to track back into compartments above the location of fire origin. See also Issue 2: *Physiological limitations of firefighters* (below) and the effect of Part O on duct sizing and use of recycled PVC ducts.

For the first time, AD F (2006 edition) included whole building ventilation rates and whole house ventilation rates. Between 2006 and mid-2020s, these whole building and whole house systems have become more common and more complex.

An additional consideration is new Building Regulation Schedule 1 requirement Part O: *Overheating* [274] which came into effect 15th June 2022. One industry expert's view [275] is that Part O compliant systems may typically utilise larger air handling units, larger ducts and acoustic dampers. Where a Part F: *Ventilation*-compliant-design, for purge ventilation, typically necessitates a boost in flow rate of up to four-times the background flow rate, a Part O: *Overheating*-compliant-design requires a boost in flow rate of up to ten times the background flow rate[Ibid]. The same expert's view is that it is better to provide larger air handling units and much larger ducts than has previously been the case (to comply with Part F) to move more air (quietly) than would be the case with smaller units operating at faster flow rates.

Heating, ventilation and air conditioning contractors (HVAC) seeking to reduce their carbon footprint may, wherever possible, specify slim flat rectangular ductwork made from recycled products[Ibid]. It is hard to be certain of the reaction to fire properties of ductwork (and possibly dampers) made from recycled material. If congested zones were congested and 'complex' before, then, with the addition of Part O, it seems they are likely to become even more congested and 'complex'. A consideration, of where ducts pass across the external wall, is whether the edges of the opening should be closed using just cavity barrier material or sealed using bespoke sleeves or barriers. If the latter are used, their performance is likely to be compromised if the slim plastic-walled ducts, which they are intended to wrap around, run tight to the compartment wall or floor or if ducts run adjacent to each other.

Lastly, fire growth characteristics in a typical apartment reflective of pre and post 2022 changes to Part F: *Ventilation*, Part L: *Conservation of Fuel and power* and Part O: *Overheating*, should be carefully considered. The new Part O guidance is requiring up to 2.5 times greater boost ventilation than Part F: *Ventilation*, currently requires. This is important since Part O envisages these flow rates running in all flats in a block, on a handful of very hot nights June to August. It needs to be understood how these schedule 1 requirements, when acting in concert, may materially affect a fire strategy in combustible and non-combustible construction typologies. They will also need to be considered to determine if they have a material effect on the fire and rescue phase and general firefighting phase.

<u>The performance criteria for cavity barriers and the mixed message on this given by AD B</u>

Some survey respondents believe paragraphs 5.20 and 5.21 (AD B Volume 1) and 9.13 and 9.14 (AD B Volume 2) provide a mixed message on cavity barrier performance. These paragraphs appear to be describing the 30 minutes integrity and 15 minutes insulation performance criteria for cavity barriers, as 'aspirational'. Paragraph 5.21 (identical wording is used in paragraph 9.14) says of 'standard' cavity barrier materials including:

> *"a. Steel, a minimum of 0.5 mm thick.*
>
> *b. Timber, a minimum of 38 mm thick.*
>
> *c. Polythene-sleeved mineral wool, or mineral wool slab, under compression when installed in the cavity.*
>
> *d. Calcium silicate, cement-based or gypsum-based boards, a minimum of 12 mm thick."*
>
> that:
>
> *"These [materials] do not necessarily achieve the performance specified [i.e. 30:15]."*

The guidance that certain generic materials may not achieve the performance criteria of 30:15 has the potential to be viewed by some, as being a legitimate justification for offering a lesser provision, and by others, as a green flag to 'game the system'.

'Standard' cavity barrier materials (a. to d. above), should be tested to demonstrate reliable performance and proprietary materials, when incorporated into end-use façade systems should be tested to prove performance over time.

AD B (1985 edition) cited 3 mm thick steel as being an effective cavity barrier without the need for further justification. The thickness of a cavity barrier formed in steel was revised downward in AD B (1992 edition) to just 0.5 mm thickness. BRE Global has been unable to identify the evidence basis behind this reduction to 0.5 mm thickness.

Thin gauge steel, formed into a tray and set behind a rainscreen panel, will experience thermal expansion and contraction forces as well as wind induced façade movement forces – as predicted in paragraph 5.23 a) (AD B Volume 1) and 9.16 a) (AD B Volume 2). Long-term performance of cavity barrier 'trays' when installed as part of a façade system should be evidence based.

Timber at least 38 mm thickness is also deemed to be a natural cavity barrier without the need for further justification, yet timber shrinks over its life [276]. Tangential and radial shrinkage of softwoods is well documented. A piece of 50 mm Scots pine batten can be expected to shrink by up to 4 mm and a 75 mm batten by up to 6 mm[Ibid] such long-term shrinkage is likely to result in deterioration of performance of timber cavity barriers, over time. Testing to include the effect of ageing would add value to this debate, and this would be even more valuable at scale.

We have been unable to identify guidance elsewhere in AD B or in other approved documents where the provisions stated are considered acceptable even though they *"do not necessarily achieve the performance specified".*

Moreover, when trying to close a cavity around multiple ducts, as described in congested zones (above), with products which '*do not necessarily achieve the performance specified'* is not tenable. The single sentence after entry 'd' in paragraph 5.21 AD B (Volume 1) and paragraph 9.14 AD B (Volume 2) with its tacit approval of cavity barriers achieving something 'approximating' the 30:15 standard, will result in a varied picture of compliance across England. Without a review and clarification of this statement it will serve to make it much harder for AHJs, seeking to maintain the 'compliance bar' at a tangible / measurable threshold with respect to Schedule 1 requirement B3(4) *Internal fire spread (structure)* which requires that:

> *"The building shall be designed and constructed so that the unseen spread of fire and smoke within concealed spaces in its structure and fabric is inhibited."*

Another consideration regarding the performance of cavity barriers was recently identified in a Collaborative Reporting for Safer Structures UK (CROSS-UK) report ID 1231 (Published 20th November 2023) [277] in relation to the Schedule 1 requirement B3(1) which requires that:

> *"The building shall be designed and constructed so that, in the event of fire, its stability will be maintained for a reasonable period."*

The reporter, on this occasion noted that:

> *"Some forms of construction, such as some panel walls, some floor systems, and some light framing solutions rely on their enclosing sheathing/linings to protect the structural elements located within a cavity. Such systems rely on the integrity of these linings to achieve their rated fire resistance."*

The report argues that cavity barriers around window, door or other openings may play a role in protecting structural elements:

> *"structural elements [that] are protected by a system (e.g. an internally plasterboard lined external wall construction with loadbearing studs). […] One of the objectives of the cavity barriers [around opening(s)] could be to contribute*

> *to the protection of the loadbearing wall components in the case of a fire penetrating the opening.*
>
> *Thus, the required performance of the cavity barrier for the project should be considered accordingly, notwithstanding that compliance with ADB guidance requires the fire resistance for loadbearing external walls to be considered only from the inside face and that cavity barriers have a fire resistance of 30 minutes for integrity and 15 minutes for insulation."*

The report considered how a fire plume, exiting a wall opening e.g. a typical window (in a post flashover fire) has the potential to attack the wall above, on its external surface. The fire in the compartment of fire origin will attack the internal surface of the wall (likely lined in plasterboard). The flame front exiting the opening has the potential to attack both vertical and horizontal cavity closers. The report concludes that:

> *"Typical E30 and I15-rated cavity barriers, recommended for purposes of resisting unseen fire spread, are unlikely to provide sufficient protection to the sheathing studs and columns."*

The difference between the mid-2020s and when AD B (2006 edition) was being considered is that this CROSS observation has only just been made.

The Panel that reviewed the CROSS report, commented in December 2023, that in many cases the area directly above a typical window opening may not be loadbearing.

In timber framed buildings, it is common to find the floor joists bearing onto a sole plate (typically 94 mm x 42 mm timber) which, in turn, will be strutted onto the lintel of a window or door opening below, via 'cripple' studs. Accordingly, the area above a window opening in a timber framed structure could easily be loadbearing. Given this scenario, fire could be attacking structural members on both sides of the wall and within a cavity, simultaneously. Should a fire attack the studding between lintel and sole plate of floor above, it is also reasonably foreseeable the floor above could drop slightly at first but sufficient to allow fire and smoke to enter the floor void. If a floor is formed of modern engineered joists with open webs the fire and smoke could extend throughout a floor 'zone'. Moreover, in most timber structures all walls are structural in that they must collectively act to resist wind load (racking) and therefore vertical diaphragms are also structural.

With traditional solid timber joists, conventionally spaced (i.e. at 400 mm-centres or 450 mm-centres), if a fire enters the floor void via a penetration or a localised ceiling failure, the flame plume will attack a volume of floor void that is a function of the joist spacing. Such traditionally joisted floors were prevalent when AD B (2006 edition) was being considered. On the other hand, with engineered floor joists, with open webs (installed at the same centres), the flame plume will attack a volume of floor void that is a function of the length x breadth of the entire floor void. Such engineered joists are increasingly common in the mid-2020s.

Additional research may therefore be needed to understand the robustness of lightweight timber to timber connectors, and web strut to timber flange connections, during fire events. The question being whether such floors need greater fire resistance from the ceiling below to prevent fire attacking these connections over an entire floorplate. When flaming does enter the void, it may result in a sudden over pressure, if fuel has entered and 'pre-loaded' the entire floor void ahead flaming entering the void. It is conceivable that when flame enters a floor void, the fire in room below may have reached flashover temperature. This may also be a consideration for steel floors formed by cellular beams. Again, a flame plume will attack a volume of floor that is a function of the length and breadth of the entire floor void.

Cavity barriers to suit complex façades and complex building shapes

There is no agreed and 'approved' large-scale system test methodology, suitable for modern complex facades. One respondent queried whether it is even possible to test open state cavity barriers from 'each side separately'. Another respondent expressed concern that current testing does not adequately consider dropping fires; and these are discussed below. If the 'mixed message' (above) is not addressed, it is hard to see where the driver comes from for industry to pursue evidenced based experimental or test data for bespoke cavity barrier systems in actual end-use systems. Moreover, if some materials do not necessarily achieve the performance specified [i.e. 30:15], what gets designed and accepted may become increasingly subjective and variable.

It was common in the early-2000s for facades to use full fill cavity barriers with a DPC 'tray' dressed down and over the barrier and for cavity ventilation to be introduced just above the tray. However, as rainscreen construction was growing in popularity over the late 1990s and into the 2000s, these systems required an open ventilation void behind the outer skin, so a DPC dressed full fill cavity barrier was not acceptable.

Testing of open state cavity barriers in the 2000s remained 'problematic'. Testing had to adapt around the closest procedural fit i.e. to BS 476-20 [278] with further specific guidance adapting around BS 476 Part 22 (for non-load bearing elements). The BS 476 Part 22 [279] test applied principally to other end uses. The difficulty with open state cavity barrier testing was that there would always be an initial 'fail' as some flame and smoke was to be expected to rise in the test cavity until the intumescent material on the leading edge of cavity barriers swelled and closed the cavity.

Some survey respondents questioned test procedures for open state cavity barriers as not being 'reflective' of the way they are used in modern buildings. These respondents pointed to CWCT guidance documents which they felt could be referred to in AD B, e.g. CWCT Technical Note 98 *Fire performance of facades – guide to the requirements of the Building Regulations* and / or the Association of Specialist Fire Protection (ASFP) Technical Guidance Document TGD 19 *Fire Resistance Test for 'Open-State' Cavity Barriers used in the external envelope or fabric of buildings* [280].

TGD 19 for the first time set test requirements with open state cavity barriers in mind and established failure and measurement criteria and how results could be applied.

Built-up systems (not individual products) should be capable of being subjected to large-scale system testing which should challenge in-use performance. AD B may wish to consider providing guidance that goes further than these standard guidance documents (i.e. Technical Note 98 or TGD 19) and advocate large-scale testing as the only meaningful way to determine satisfactory performance when complex facades, complex building shapes and balconies all interact.

When the AD B was being considered for revision, in the summer of 2005, the predominant 3-D shape of buildings (in England's core cities) was essentially rectangular prism cuboid – a shape largely unchanged since the introduction of the broadly functional regime of building regulations on 11th November 1985. By the mid-2020s it has become more common to see challenging building shapes. It is also highly probable that increasingly challenging building shapes will continue to be seen in London and England's eleven core cities of Belfast, Birmingham, Bristol, Cardiff, Glasgow, Leeds, Liverpool, Manchester, Newcastle, Nottingham and Sheffield. Architects and their clients, over the preceding 18 years, seem to have developed an appetite for adventurous shaped buildings and desire them to have a complex palette of materials on the façade [281]. It is increasingly 'common' to see buildings and façades leaning, twisting, stepping, oversailing and recessing. Architectural e-journals increasingly show aspirational buildings following parametric design shapes and buildings utilising features like fins and sails. Different fire spread outcomes may be experienced depending on wind strength (and direction) and façade shape – see Fire Safety Journal March 2022 on the *Effect of wind speed and direction on facade fire spread in an isolated rectangular building* [282]. One survey respondent considered the shape, form and features of a building to be significant influencing factors driving the behaviour of fire (with particular emphasis on corners and edges) [283]. It appears that not enough is known of the fire dynamics and fire spread potential where a façade leans (forwards or backwards), twists, steps, oversails, recesses, curves and / or incorporates green walls or vertical forests (and has an interaction with balconies) and the contribution of windspeed on these fire dynamics and fire spread potential also needs to be better understood. Large-scale testing of building facades should be considered to gain a better understanding of these variables.

The 'complex façade' is now commonplace. Guidance in AD B on these details is now required.

One recent fire that highlighted the effect of façade shape and wind strength (and wind direction) occurred at the residential block, the Torre del Moro, Vigentino, Milan on 29th August 2021 at approximately 17:30 (local time) [284]. The Torre del Moro was an 18-storey building with approximately 3.0 m wide integral balconies on the South West and North East elevations. The balconies were clad in a double skinned façade comprising aluminium composite material (ACM). The façade was formed into long curve-like 'sails' with short return (end-walls) by approximately 6 m at one end and 2 m at the other end. The South West and North East elevation 'sails' were offset from each other. Both elevations became involved in the fire, with the South West elevation façade being completely destroyed by the fire. The fire entered flats at various levels. The ACM provided the principal fuel for this particular fire.

Another recent fire that highlighted the effect of façade shape and wind strength (and wind direction) occurred at 77 Avenue del General Aviles, Valencia, Spain on 22nd February 2024 [285]. Local Fire and Rescue Services were called to a fire on the fourth floor of a part 14-storey, part nine-storey apartment building at 17:30. Ten people died in this fire, and many were injured. The media reported that the cladding was an aluminium composite material (ACM). BRE Global observed video footage of the fire which showed burning material which flowed and dripped from the edges of cladding panels – typical of a polyethylene cored metal composite material. It was very apparent from video footage of the fire that wind played a significant part in the fire spread. Flames could be seen to be fanned both upwards and downwards over the South East facade, seemingly being channelled between adjacent lines of stacked private balconies. At no point did any of the video evidence reveal the presence of remnants of horizontal and vertical cavity barriers – these may have been present but destroyed during the fire and firefighting operations. The building included a deep recess between the 14-storey part and the nine-storey part. Wind could be seen to drive flame into this recess, which was the site of particularly intense burning and it appears that the intensity of the fire in this location may be in part attributable to the re-radiative effect of the recess' geometry.

The wind speed on the afternoon of the fire was reported on the Time and Date website [286] to have been between 19 to 20 miles per hour – a 'fresh breeze' (as it would be described on the Beaufort scale). Later (at 16:24 on 23rd February 2024) the BBC reported that wind was believed to have been gusting at 40 miles per hour, suggesting a consistent wind speed of 30 miles per hour, equating to no more than a 'strong breeze' (on the Beaufort scale).

On the subject of wind gusting, see Example 9 *Deep dive – Roof testing and classification reports, roof terraces and Solar mounting standards* (above) which calls for a review of roof testing standards in order to be more robust in the face of wind. The example considers the need for either faster wind speeds during the testing or, at very least consideration of wind gusting across the surface of the test sample.

Even where a modern building has straight vertical walls, the 'palette of materials' used can make cavity barrier selection difficult. Barriers are not tested with materials in combination i.e. in their end-use arrangement. It is unclear therefore how, in the early stages of a fire, unseen spread of smoke (and possibly fire) in external wall cavities can be prevented, especially where open state barriers are used. Another consideration that testing does not capture, is how the barriers may perform over time (with building movement, weathering and ageing, either acting independently or in concert).

When BRE Global interviewed fire commanders and studied the video footage of the fires at Premier Inn, Bristol, July 2019, Beechmere, Crewe, August 2019, Pankhurst Avenue, Brighton, September 2019 and The Cube, Bolton, November 2019, it was apparent that wind proved to be a primary factor in driving flames, emerging from the building, across compartment lines. These buildings were comprised of combustible construction; accordingly, the detailing may require researching and testing in order to find more robust ways of terminating fire separating elements and external walls.

<u>Cavity barriers (or fire stopping) in volumetric modular construction and how the detail can be inspected post installation</u>

One respondent pointed out that there is confusion in the industry as to whether the batts used between volumetric modules are, i) firestops, used to seal joints in a fire-separating element (like a compartment floor in a building) or, ii) cavity barriers closing 'natural' cavities in the construction. See Survey Issue 1b (above) regarding approved documents, combustible construction and property protection and Glockling's description of the modular 'problem':

> "[3-D modular] *compartments [are] essentially suspended within a lattice of […] voids"*

The guidance on this should be clear and unambiguous so that there is uniformity of interpretation and consistency across England. Gaps between modules in a typical residential building of the order of 20 mm to 40 mm width (notional) have been closed or sealed using friction-fitted fire-resisting batts. Such batts are vulnerable to being dislodged during installation and cannot be inspected post installation.

It should be noted that AD B Volume 1 (paragraph 5.19) and Volume 2 (paragraph 9.4) set a standard for compartment walls and how they should be 'completed' i.e. that:

> *"It is not appropriate to complete a line of compartment walls by fitting cavity barriers above them. The compartment wall should extend to the underside of the floor or roof above."*

It is strange that there is no equivalent statement of intent regarding the imperative of continuity of compartment floors. Whilst it may be considered that this would have been far less of an issue when AD B (2006 edition) was being considered, by in the mid-2020s it is now a pressing theme.

It is noted that AD B Volume 1 (paragraph 5.22 and 5.23) and Volume 2 (paragraph 9.15 and 9.16) both give guidance on the fixity of cavity barriers (which are expected to achieve only 30 minutes Integrity and 15 minutes of insulation). The seals provided to maintain the fire stability, integrity and insulation of a compartment floor would, on account of their needing to meet a higher performance threshold, need more exacting testing and or fixity standards.

A burst water pipe or leaking waste pipe are both reasonably foreseeable events that can be expected to occur in residential use buildings. Small fires necessitating the use of firefighting media (water) to extinguish them are also reasonably foreseeable events in residential use buildings. Whether as a result of a burst or leaking pipe or a small fire event, it is reasonably foreseeable that one or more batts may become wetted (even sodden) at some point(s) during the life of a building. The consideration then is whether compression-fit mineral fibre batts, thus wetted, will slump and become misaligned upon drying? Moreover, key structural brackets and wire rope connections may also become wetted, in these airflow-restricted and inaccessible spaces. The inability to inspect batts, between modules, after initial installation or a reasonably foreseeable event(s) (described above), would also seem to warrant further consideration and research.

Views expressed in the survey questioned how one might inspect cavity barriers in mullions and transoms of a 'complex façade', which cross compartment floors and walls. Additionally, the point was raised as to whether some voids in extrusions and behind / under gaskets and cleats are too small to consider.

The additive principle

A substitute approach, occasionally advanced by designers (but for which there is no guidance), comes into effect at slab level, in lieu of full provision around windows and doors at heads jambs and cills. By way of example, a façade with full height windows may result in the heads of windows aligning with the underside of floor slabs, and cills of windows aligning with finished floor level. The additive approach suggests that rather than providing a barrier at head and cill of windows (and to the jambs) as well as at each floor slab level, upgrading the barrier at floor slab level to a 90-minute rating would suffice. However, it is improbable that one could purchase a barrier rated 90: 45 (integrity: insulation). One respondent asked why it is that cavity barriers continue to be rated at only 30: 15? In lieu of fire rated spandrel panels, is the additive approach acceptable in such circumstances? Could guidance be provided?

Dropping fires

Open state cavity barriers are problematic for dropping fires (i.e. fires they were not intended to control) particularly in timber-built cavity wall structures. Burning brands, associated with falling cavity fires, can come to rest on a barrier typically one or more floors below the point of fire breakout. Having landed on the barrier, flaming or smouldering combustion may follow as membrane and / or sheathing board(s) combust. The fire can potentially, thereafter, grow upwards with some embers again likely falling down to yet lower levels only to repeat the dropping fire process. BRE Global believes research is needed on dropping fires. See also Survey Issue 1b: *Approved documents, combustible construction and property protection* (above) on emerging vulnerable details (with cavities).

Cavity tray dispensation under the Building Act 1984

This was introduced 1st June 2022. The requirements of Regulations 6(3) and 7(2) are dispensed with in relation to cavity trays, typically formed of ethylene propylene diene monomer (EPDM). This dispensation 'lapsed' on 1st December 2023. If Government does not re-visit and extend the dispensation, metal trays could become the norm and potentially feature in some justifications as doubling up as the cavity barrier. Such trays may be either galvanised steel 0.5 mm thick (or thicker), accordingly, see the discussion (above) on mixed message and the 30: 15 (integrity: insulation) performance criteria for cavity barriers.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Adding clarity for the users of AD B by considering a wide-ranging review of the current cavity barrier provisions, and whether re-working the guidance, (into a dedicated cavity barrier section in AD B) would bring about better understanding and compliance with Schedule 1 requirements B3 and B4.

2) Whether the time has come for a new Schedule 1 requirement addressing: cavity barriers, fire stopping and fire sealing.

3) Factors of safety that could accommodate reasonably foreseeable design / detailing / workmanship transgressions using, as inspiration, the way robust standard details were considered for Part E: *Sound compliance* [287].

4) Industry and industry / Government collaborations, offering 'evidence based tightening or relaxation of rules'.

5) Adding clarity for the users of AD B by conducting a wide-ranging review to include:

    i. diagram 8.1 (AD B – Volume 1) and Diagram 9.1 (AD B – Volume 2) and whether both could be updated to be reflective of modern typologies

    ii. new guidance on congested zones in external walls, suggested solutions where there are multiple duct penetrations and balcony fixings

    iii. consideration of the current guidance that cavity barriers "[…] *do not necessarily achieve the performance specified [i.e. 30:15]"*

    iv. cavity barrier efficacy (at larger scale) in 'complex facades' and 'complex building' shapes

    v. a test protocol to consider fire attack from each side, and within the cavity simultaneously as identified in the CROSS report and FAQ 13.

    vi. Research into the performance of open web joisted floors when a flame plume enters an entire floor void thereby exposing lightweight timber to timber and strut to flange connections to very high temperature over the entire floor area.

    vii. Research into the performance of open web joisted floors and cellular beam supported floors to over pressures, which may occur if fuel has entered and 'pre-loaded' the entire floor void ahead flaming entering the void.

    viii. The need for post installation inspection of cavity barriers / fire stops (filling gaps in the discontinuous compartment floor) for modular construction.

    ix. Merits and de-merits of the additive principle.

6) the underlying considerations relating to cavity barrier efficacy at large-scale including:

    i. Wind induced building movement or movement induced by thermal expansion and contraction, long-term shrinkage of organic cellulosic material (e.g. timber and shrinkage across the grain).

    ii. Performance of thin gauge steel, and whether at just 0.5 mm-thickness (reduced from 3 mm-thickness in AD B 1992 edition) it can be an effective cavity barrier (especially over long lengths, with typical simple side-lap joints and when installed behind thin façade materials, prone to temperature change and movement.

iii. The stack effect in continuous ventilated voids, e.g. behind facades. Note that it may be worth considering if there is a stack effect occurring in tall 3-D modular buildings, on account of interconnected voids.

iv. Aligned research, which might look at the effect of building shape and balconies, and the effect of wind on fire plumes, fire growth and fire and smoke spread.

v. The compatibility of barriers when closing a continuous cavity with a varying 'palette' of façade materials.

7) Adding clarity for the users of AD B by considering dropping fires in combustible construction and how cavity barrier provisions could better cope with dropping fires.

6.1.10 Survey Issue 1i: Sprinklers and rooftop extensions

Background – See Example 2 (above) that considers the guidance in AD B when a residential building undergoes a rooftop extension. A wider point being made in Example 2 is that rather than spreading the guidance between the approved document, circular letters, FAQ response(s) and CROSS-UK reports, consideration might be given to regular consolidation of the AD B guidance.

Driver – As Example 2 (above).

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

The viewpoints included a desire for industry more generally to be adopting sprinkler and water mist installations. This desire was not accompanied by a rationale explaining that in mid-2020s the construction technologies, building design, and / or building use was markedly different to that which was prevalent when AD B (2006 edition) was being considered. A request emerging was for AD B to provide clearer direction on sprinkler provision and whether this meant throughout a building or just the newly formed storey.

Implication for AD B – As Example 2 (above).

The guidance in paragraph 7.4 of AD B (2019 edition including 2024 amendments) states that sprinklers should be installed throughout a building, which possesses a habitable storey at or higher than 11 m, above ground level.

In contrast, the circular letter: *The application of building regulations where additional storeys are provided to existing buildings* (February 2020) softens the guidance – see paragraph 4 which states:

> *"…some work on the original part of the building will be necessary. This may not always be set out in the approved documents and building control bodies should consider carefully the application of the building regulations to these projects…"*

It is unrealistic to provide guidance for every situation, however, the AD B guidance should clarify whether the guidance is applicable to new build and 'other', as it appears readers of AD B tend to assume it applies mostly to new build.

The response to FAQ Question 20, which was placed on the DLUHC website on 23rd August 2022 (this became Question 24, following the addition of four more FAQs and answers on 14th March 2024) is still open to interpretation. Some respondents would appear to remain uncertain whether sprinklers are needed in the whole building or not.

See Example 2 (above) regarding the Lakanal House Coroner's Inquest and the Rule 43 letter of 28th March 2013, which made critical observations about AD B. See also Survey Issue 1j.1 (below) on sprinkler types, the extent of coverage and combustible construction.

Example 2 (above) identifies a potential scale of demand for vertical extensions on detached buildings (and atop of terraced properties) that simply did not exist in 2006, when AD B was last substantially revised [288]. In addition to the Regulations applying to detached and terraced buildings, other restrictions on a building's age and height apply. Buildings which are intended to be vertically extended must have been built between 1948 and 2018 and prior to being extended, they must be between three and seven storeys tall. Vertical extensions on buildings meeting the above criteria may become commonplace as the market matures [289] [290]. It is also reasonably foreseeable that developers of such vertical extensions may seek to use modular and lightweight constructions [291] [292]. It may then be possible, on a case-by-case basis, to demonstrate that the existing foundations do not need to be strengthened / underpinned where modular construction is used for the new storeys. Moreover, it may be possible to satisfy Local Authority planning departments' preference for sustainable construction, rather than demolition and rebuilding, when using modular construction (see Survey Issue 1b (above) which considers the growing desire for sustainable forms of construction).

The challenge arising from this Survey Issue suggests AD B could look at:

1) Adding clarity for the users of AD B wishing to consider its scope of application – see also Survey Issue 1a (above).

2) Adding clarity for the users of AD B on alternative guidance – see also Survey Issue 1d (above).

3) Adding clarity for the users of AD B on alternative guidance for material alterations and changes of use and retaining the clarity in AD B rather than spreading the guidance between the approved document, circular letters, FAQ response(s) and CROSS-UK reports.

4) Regular consolidation of AD B guidance to be vehicle to improve construction productivity by improving certainty of interpretation rather than uncertainty. Certain consistency and a better picture of compliance, nationally.

5) Linkages with Survey Issue 1f (above) on means of warning and escape from flats including student accommodation and sheltered housing.

6) The potential to game the system and circumvent the 11 m trigger.

6.1.11 Survey Issue 1j.1: Sprinklers, extent of coverage and combustible construction

Background – The background issues include modern living, overheating (climate change) and combustible construction. See also Survey Issue 1b (above) on the approved documents, combustible construction, etc.

Driver – There is no single driver.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)'*.

There was some support from respondents that AD B should provide clear guidance on the circumstances when sprinklers should be used in common corridors landings and stairs (the common parts). There were some who asked whether water mist systems can be used and if so, under what circumstances. Water mist systems are more common in the mid-2020s than they were when AD B (2006 edition) was being considered.

AD B (2019 edition with 2024 amendments) 3.2 (d) states:

> *"Fires in common parts of the building should not spread beyond the fabric in the immediate vicinity. In some cases, however, communal facilities exist that require additional measures to be taken."*

A similar sentiment has existed since AD B (1992 edition) at paragraph 2.3 (d).

Moreover, AD B (1992 edition) at paragraph 0.32 described the outcome of the scale of protection afforded to protected stairways as producing "[...] *virtually 'fire sterile' areas […]*". This wording was retained in AD B (2006 edition including April 2019 amendments) at paragraph B1.ix. When AD B (2019 edition) came into effect, the expression *virtually 'fire sterile'* no longer applied to protected stairways, it applied to a consideration of the status of the common parts.

AD B (2019 edition, including 2024 amendments) at paragraph 0.6: *Management of premises* expanded on the concept of *virtually 'fire sterile'* spaces thus:

> *"The Building Regulations* […] [assumes that buildings] […] *will be properly managed. This includes, for example, keeping protected escape routes virtually 'fire sterile."*

And in AD B (2019 edition with 2024 amendments) at Table B4: *Minimum periods of fire resistance,* after note 2, states:

> *"**NOTE**: Sprinklers should be provided within the individual flats, they do not need to be provided in the common areas such as stairs, corridors or landings when these areas are fire sterile."*

The user of AD B might reasonably think that if they were to follow the linear route to compliance, the common parts would be fire sterile by virtue of:

- the surfaces i.e. end-use wall and ceiling lining systems achieving European classification B-s3,d2, and
- the compartment walls between flats and common corridors achieving 60: 60: 60 minutes fire resistance (stability: integrity: insulation), and
- the flat entrance doors achieving FD30(s) fire resistance (integrity only), and
- the services running through common corridors being run in vertical protected shafts.

Given the above four points, the user of AD B might think the provisions would naturally confer virtually *'fire sterile'* status on a common corridor. Whilst researching for this project, BRE Global noted that City of London Corporation-run housing estates in the boroughs of Camden, City of London, Hackney, Islington, Lewisham, Southwark and Tower Hamlets and, independently of the City, the London Borough of Hammersmith and Fulham have upgraded the fire resistance of flat front doors from 30 minute to 60 minute fire resistance [293] [294], suggesting that there may be a trend towards a more general adoption of FD 60(s) doors in the market in the mid-2020s.

Paragraph 0.6: *Management of premises* speaks of the need to maintain a building in a compliant state. It is unclear what attributes render a corridor no longer virtually 'fire sterile' at design and construction stage. AD B could look at adding clarity for users of the document to understand when the common parts are not fire sterile and therefore warrant sprinkler provision.

See section 3.4.6 (above) *Challenges that relate to B3: Internal fire spread (structure)* and Theme 1: Issue 2 (below) *Tall buildings and single stairs and the physiological limitations of firefighters* that both draw attention to ever increasing standards of thermal insulation. See also Example 9 (above) *Choice of membrane and thermal insulation* which considers the potential thermal uplift associated with the Future Homes Standard 2025 and how:

> *"In BRE Global's opinion, […] when it comes to conservation of fuel and power, the construction industry has a record of going further than the minimum provisions set out in Part L."*

If modern buildings had the tendency to overheat in summer, they may be more susceptible to overheating after 2025 once standards settle, and industry decides how much further than Part L it will go in terms of airtightness and thermal insulation. This is clearly a mid-2020s issue, that was not of the same scale of influence when AD B (2006 edition) was being considered.

In corridors of apartment buildings, communal heating and domestic hot water pipe runs (if long) can lead to problematic overheating. If excess heat cannot be removed using a corridor's mechanical powered shaft smoke extract system, on its 'environmental mode' setting, the overheating will need to be addressed by mechanical cooling in order to comply with new Schedule 1 requirement Part O: *Overheating*. A respondent observed that mechanical cooling typically involves installing one or more fan coil units to serve a corridor and that these represent a fire risk. The respondent was therefore of the opinion corridors should be sprinklered.

See also Example 6 (above) on the risks associated with charging e-bicycles and other e-d/v's, powered by lithium batteries. The potential for unauthorised charging of e-bicycles and scooters in common corridors and / or explosive fires involving mobility scooters, when located just inside a flat, adjacent to a flat's front door, all suggest the concept of the 'fire sterile' common corridor is already beginning to be challenged.

Risks of disproportionate outcomes of fires in combustible construction, the Part O considerations and the fire risks associated with lithium-ion powered mobility scooters (located just inside a flat) are completely new mid-2020s issues, that were not around when AD B (2006 edition) was being considered.

The foregoing suggests a shift in AD B guidance on the meaning of *'fire sterile'* and what the reader is expected to take into consideration. Given that sprinklers would be required in non-sterile common parts, it remains for AD B to consider providing guidance on when to recognise that a common corridor is not fire sterile and when to consider sprinkler protection.

Might some or all of the construction typologies, that are described in the *Manual to the Building Regulations – a Code of Practice* (chapter 7) i.e. very large or very tall buildings, large timber buildings and / or buildings that incorporate modern methods of construction, require sprinkler provision in their common parts and if so, guidance will be required.

See also Survey Issue 1b (above) on *the approved documents, combustible construction (etc)* and Survey Issue 1d (above) on the *alternative approaches*. If it is agreed that the risk of fire entering a common corridor is increasing with modern living, a precautionary approach might be relevant.

Implication for AD B – whether AD B should consider the fire risks in and the fire risks threatening common parts and the fire risks associated with combustible construction generally.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Adding clarity for the users of AD B by considering when to recognise that common parts (at design stage) need sprinkler provision.
2) Adding clarity for the users of AD B by considering when to recognise that common parts of a block undergoing an airspace extension need sprinkler provision.
3) Adding clarity for the users of AD B by considering when to recognise that common parts of a building undergoing a material change of use needs sprinkler protection.
4) The potential to game the system and circumvent the 11 m trigger, if such trigger was used for sprinkler provision in common parts.

6.1.12 Survey Issue 1j.2: Sprinkler types, extent of coverage and car parks

Background – See also Example 3 (above) *Deep dive – Electric vehicles and underground car parks* and Theme 1: Tall Buildings and single stairs, Issue 3 (below) *Guidance on ventilation of basements* and schedule 1 requirement Part S: *Infrastructure for charging electric vehicles*.

Driver – There is no single driver.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)'*.

BRE Global has been unable to identify any large-scale contemporary research programmes on electric vehicle car fires in enclosed underground car parks. In underground car parks, consideration also could be given to the use of car stackers, very low storey heights, and the changing shape, size and construction of modern electric vehicles.

There is some evidence in the media that cars are getting longer and wider. Research by a car finance company [295], the Telegraph (article 19th February 2023) [296], the Telegraph (article 27th August 2023) [297] and the Guardian (article 28th February 2022) [298], all point to the fact that cars are longer and wider and have more surface area than they did in the 1970s and 1980s; and they are heavier too.

Because of the changes to motor vehicle design and technology, research could revisit the speed of fire spread to adjacent vehicles across empty parking bays and the implications of a vehicle battery entering thermal runaway.

In addition to considering the speed of fire spread, research could consider the intensity of such fires and their effect, if any, on key structural details e.g. at the heads of reinforced concrete columns; where punching shear through a floor slab is a typical consideration. If electric vehicles are heavier, then concrete slabs in such car parks will be carrying more load. It is possible that firefighting tactics become defensive rather than offensive where electric vehicles are involved (for reasons of firefighter safety). Until wider research is conducted it may be that the precautionary approach should be to assume that the Fire and Rescue Services will not commit personnel into a developed fire in a basement car park where multiple electric vehicles are involved or likely to become involved. This may mean structural members are exposed to hot temperatures over a longer period, and as additional vehicles become involved there may be peaks of intense burning rather than steady-state burning.

Given that the first mass-produced all-electric car was launched in the USA in 2008, one can conclude that this is a modern issue that was not on the agenda when AD B (2006 edition) was being considered for revision. See also Theme 1: *Tall Buildings and single stairs* Issue 3: *Guidance on ventilation of basements* (below).

Modern commercial or mixed use buildings are frequently constructed with underground car parks and those spaces frequently have the following additional features co-located with the cars: skips, cardboard compactor(s), loading bays, van parking (some underground car parks even have parking space for large van(s) and / or a lorry and / or coach(es) parking).

Guidance would be welcome on how to avoid negative interactions, between suppression and ventilation in places like van, lorry or coach parking and in loading bays and in vicinity of skips and compactors. The survey raised the premise on which the 10 air changes per hour metric was used as being suitable for all car parks from smallest to largest.

There was some surprise that sprinklers are not required in car parks for light vehicles. Several respondents pointed to the increased use of electric vehicles and asked what current research there was for fires in underground car parks.

Some observed that building shape prevented natural ventilation to opposing faces of a car park and suggested systems involving impulse jet fans and extract shafts, need to be considered in conjunction with sprinklers.

One respondent asked the question if it was reasonable to have underground car parks where the building above is combustible construction?

As part of this hot spot group, a question was raised about the use of Personal Protection Systems (PPSs) for single room use and whether these should be referenced in the AD B. By way of example, consider a common purpose group 1b, type of building work, involving the conversion of an integral garage to a habitable room i.e. a bedroom (with ensuite facility). A reasonably common reason for undertaking such conversion work might be to create accommodation for a family member, who might otherwise become institutionalised in a care environment, due to a medical dependency. When it comes to residential conversions and adaptations of this nature, it is very unlikely that the AHJ will have a conversation with the building owner about the resident, for whom the space is being formed, on the subject of their ability to make unaided escape from the room.

On completion of the works, it may become readily apparent to an AHJ (by virtue of the presence of lifting devices, rails and a powered bed) or as part of a residential care review that the resident will be incapable of making unaided escape from the bedroom. Assuming the bedroom could be the room of fire origin, a PPS may contribute to the maintenance of tenable conditions in that room, long enough for family members to be alerted to the fire alarm and for them to give assistance to begin to escape. If the resident is unable to enter or leave the bedroom without assistance and if family members providing the 24/7 care live elsewhere in the house e.g. on an upper floor, the individual in the conversion room is at risk of being trapped in event of fire.

AD B might wish to consider providing guidance for such occurrence and reference to standards such as LPS 1655 [299] which support these types of systems or address the point raised by some respondents who wanted to know when water mist systems to BS 8458: 2015 [300] could be considered for inclusion more generally in AD B guidance.

Implication for AD B – Should AD B guidance be underpinned by research into car park fires and efficacy of sprinklers and smoke extraction, particularly where more vehicles are likely to be electric? This seems particularly relevant where Schedule 1 requirement Part S: *Infrastructure for charging electric vehicles* (introduced in June 2022) applies?

The challenge arising from this Survey Issue suggests AD B could look at:

1) Research and consideration of the fire safety features necessary in underground car parks and the influence of electric vehicles and electric vehicle charging infrastructure.

2) Research and consideration of the fire safety features necessary to accommodate other features common in underground car parks in city centre settings e.g. skips, cardboard compactor(s), loading bays, the presence of small or large van and lorry parking bays and even coach parking.

3) Research and consideration of how smoke ventilation should be designed, particularly where impulse fans are intended, and how such systems may impact on sprinkler protection in car parks and specifically loading bays.

4) Adding clarity for the users of AD B on alternative guidance e.g. when to consider deluge systems.

5) Adding clarity for the users of AD B on alternative guidance e.g. under what circumstances might PPS or water mist systems be suitable alternatives for conventional sprinklers.

6) Adding clarity for the users of AD B on sprinkler provision when undertaking material alterations and changes of use and retaining the clarity in AD B rather than spreading that guidance between the approved document, circular letter(s), FAQ response(s) and CROSS-UK reports.

6.1.13 Survey Issue 1k: B4 Intention and Introduction

Background – The survey highlighted a range of issues which tended to coalesce around the intention behind Schedule 1 requirement B4. The comments included: consideration of re-entrant angles, B4 needing a re-write, what constitutes acceptable and unacceptable degrees of fire spread over walls, composite plastics used in construction more widely, fire loads in modern buildings, views on the 18 m threshold and whether it should trigger at a lower threshold, downward or dropping fire spread (challenging convention), timber and combustible construction generally.

Driver – There is no single driver.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)'*. There have been post-survey clarifications (as recently as 2024) on many of the themes covered under B4.

Since the survey, which was conducted as part of this study, Government issued two new Approved Documents, which came into effect on 1st December 2022 and one issued on 29th March 2024 (which comes into effect 30th September 2026 or 31st March 2028, depending on transitional provisions). AD B (2019 edition including 2022 amendments) further addressed combustible materials in the external walls of buildings, by introducing a ban on metal composite materials, at any height, on any building. The AD B (2019 edition including 2024 amendments) introduced the requirement for more than one stair when either a flat is on a storey that does not meet the criteria for a single escape or if the building has a top storey of 18 m or more in height.

Government consulted on *Sprinklers in care homes, removal of national classes, and staircases in residential buildings* between December 2022 and March 2023. The revision to AD B (2019 edition including 2024 amendments) closed the matter regarding trigger(s) for more than one stair in residential buildings. Ongoing consideration is being given to the removal of national classes, sprinklers in care homes and the guidance around key paragraphs 10.6 and 10.7 AD B Volume 1 and 12.6 and 12.7 Volume 2.

BRE Global highlights three matters, which it suspects may not emerge from the December 2022 to March 2023 survey. Two matters are also listed under Theme 9: *New ways of building – Other* (below) i) composite plastic wood-effect material (where these products are currently being used in fencing and decking) ii) unusual fire spread resulting in melting, flowing flaming roofing material. Both matters came to BRE Global's attention when conducting Fire Investigations in 2021.

Fires involving composite plastic wood-effect material i.e. fencing and patios (raised decks) have the potential to yield large quantities of very dense smoke and are characterised by very fast fire spread. Whilst conducting investigations into real fires, BRE Global recorded several instances of fires starting in gardens / outbuildings, where the fire spread into dwellings, via fencing. On more than one occasion in 2021, a fire in a garden spread to other gardens and entered a terrace of properties (causing extensive damage). BRE Global is concerned that fencing and patios (raised decks) are not currently considered to be 'controlled' yet the threat of fire spread from outside a dwelling into neighbouring dwellings is a proven threat. Moreover, it is reasonably foreseeable that the quantity (and density) off smoke produced when composite plastic wood-effect material combusts has the potential to enter a dwelling (if windows and doors are open) and render the internal escape route difficult to negotiate (e.g. this could be the case with a terrace of town houses).

The second consideration for AD B is how roof coverings which melt, flow and drip when burning can be classified as these characteristics are not part of pass-fail criteria when conducting a BS EN B_{ROOF} (t4) test see also Example 9 (above). One fire that BRE Global investigated involved man-made roof tiles on a low-rise (three storey) block of flats, the fire began mid-afternoon in September 2021. The video evidence showed that the fire could spread by flowing and dripping. Fire was believed to have started on or under the roof and involved one or more photovoltaic panels. The initial fire would have been confined to one compartment. BRE Global's research revealed that within 11 minutes of the first 999 call, the whole roof surface was burning (with flowing and dripping quite apparent). Within 30 minutes of the first 999 call, the Fire and Rescue Service had to retreat from the second floor due to concerns over firefighter welfare as ceilings were reportedly collapsing. Approximately 70 residents self-evacuated, but had the fire occurred at night and or had there been more dependant residents, with mobility issues, BRE Global's concern was that ceilings were failing in 30 minutes – throughout the top storey. A B_{ROOF} (t4) pass should mean no penetration occurs during testing within 60 minutes. Tiles made using resin would appear to need consideration.

One last matter considers dropping fires in cavity walls and this has been discussed in Survey Issue 1h (above) on the provision of cavity barriers, etc.

Implication for AD B – Should AD B guidance extend to composite plastic wood-effect material particularly where fencing and external patios are constructed on small residential plots (or on roof terraces) where the fencing and / or patio may be built against or very close to the external wall of the building?

The second consideration for AD B is how roof coverings which flow, melt and drip can be classified, since these characteristics are not part of pass-fail criteria when conducting a BS EN B_{ROOF} (t4) test, see also Example 9 (above).

For dropping fires in cavities see Survey Issue 1h (above).

The challenge arising from this Survey Issue suggests AD B could look at:

1) Research into the fire classifications to BS EN 13501-1 for different types of composite plastic wood-effect material that is used for fencing and patios (raised decks) in England.

2) Adding guidance in AD B to alert users to the risk of a garden fire growing and spreading to multiple dwellings.

3) Whether Schedule 1 Relevant requirement B4(1) needs to be supplemented to control this form of fire spread from land outside the dwelling into dwellings.

4) Research and consideration of the fire safety features surrounding modern combustible roof tiles and slates which may melt, flow and drip and cause fore to spread via dropping ceilings.

6.1.14 Survey Issue 1l: External surfaces, Materials and products, Cavities and cavity barriers, Materials, Material change of use and Additional considerations

Background – The survey highlighted a range of issues, some of which are identified here. This Survey Issue 1l, encompasses two hot-spot locations, both of which came from AD B (Volume 1) Section 10: *Resisting fire spread over external walls* – this section was the most commented on in AD B (Volume 1).

Driver – There is no single driver.

The first hot spot location occurred between paragraph 10.5: *External surfaces,* through to and including paragraph 10.8: *Cavities and cavity barriers*.

The second hot spot location occurred between paragraph 10.12: *Materials,* through to and including paragraph 10.15: *Additional considerations*.

The two hot spots in Survey Issue 1l are considered together because they both relate to section 10: *Resisting fire spread over external walls,* and because of the overlapping nature of some of the comments. Another significant reason for considering them together is that changes to building regulations, guidance documents, circulars and frequently asked questions that came into effect after the AD B (2019 edition, with 2020 amendments) have, to varying extents, added further clarity.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

This subject matter is interwoven with themes discussed in Example 5 (above) *Deep dive – Volumetric construction, etc* and Survey Issue 1h (above); *Provision of cavity barriers, etc elements.*

Whilst considering themes emerging in this hot spot, one respondent, by way of introduction to themes around external surfaces, materials and products and cavities and cavity barriers, cited a proposed 200 m tall single-stair tower, constructed from combustible construction, that the designers believed was a 'common enough' building situation. The respondent believed AD B had not kept pace with what industry perceived to be a common building type and suggested different terminology be used instead of the word 'common'.

BRE Global observes that in the 18 years since AD B (2006 edition) facades that might have been thought of (in the early 2000s) as adventurous, but fairly rare, have become adventurous and 'common enough'; particularly in city-centre settings.

Complex cavities beneath façade materials and systems

In the mid-2020s, we see designers' inclination to use a broad palette of materials and end-use systems to form a building's envelope. The e-publication, Architects Datafile, (available online since 2014 [301]) has run eight annual supplements dedicated to building envelope design. This is taken from the editorial page from the February 2017 edition:

> *"[…] building envelopes are becoming increasingly diverse as architects, designers, planners and developers explore fresh, creative ways of expressing a building's individuality through the design, interpretation, application and combination of exterior building materials."*

Since AD B (2006 edition) building envelopes are now more diverse, and the Architects Datafile supplements capture the diversity and complexity of 'common enough' building envelopes from the 20-teens through to the mid-2020s. A 'common enough' building design, found in England's core cities, may comprise a complex building shape, enveloped in a flowing or undulating or multi-faceted façade (where the cavity behind is likely to widen and narrow). Moreover, different material types and systems are commonly used to form modern building envelopes with three or four (and often more) different materials and systems comprising the façade. Frequently, these systems will have different depth cavities behind and interfaces between respective systems which will need to be 'resolved'.

Additional considerations for the modern building envelope are described in Examples 7 and 9 (above) as designers incorporate balconies, private terraces and communal terraces and garden(s) into their building envelopes. Such envelopes are more common in the mid-2020s than they were when AD B (2006 edition) was being considered.

It is not unreasonable therefore to suggest that more needs to be known about these complex building envelope interactions, and their potential (collectively) to impact on fire propagation and fire spread, particularly in the cavities behind the façade materials and systems and at interfaces.

Perceived complexity of fire test reports

One respondent believed that the guidance on external surfaces has evolved to become increasingly complex. This respondent felt that to interpret fire test reports now requires professionals with a detailed understanding of fire research chemistry to unravel the meaning of them. Other respondents felt classifications, more generally, may not reflect end-use systems in their entirety and tended to be product based. Some of those referring to classification / testing reports were clearly concerned at the need to correctly 'interpret' results for end-use situation(s). Another respondent made the following point about combinations of materials:

"Frequently products being developed to meet new regulations do not currently have the necessary test certification in place or isn't [sic] tested in the specific combination of materials […] which creates uncertainty and risk for the industry and specifically developers and contractors."

It appears that what is different in the mid-2020s, to the time when AD B (2006 edition) was being considered, is that practitioners are increasingly likely to ask questions about fire classifications and field of application reports; but it seems some may need guidance in interpreting the information provided.

The AD B (2006 edition) was very clear that users of the document had the choice of referencing either national standards, or the European classification system. What is different in the mid-2020s is that Appendix B of AD B Volume 1 (2019 edition including 2024 amendments) at paragraphs B10 and B18, makes it clear that the approved document sets out its preference for the European classification system:

- BS ENs 13501-2 to -4 for fire resistance

  and

- BS EN 13501-1 for reaction to fire.

This is further re-enforced with the decision to move to the sole use of EN standards in the future. (See AD B (2019 Edition including 2024 Amendments) with effect March 2025). 'Lay-users', following this signposting in AD B to BS EN classification reports (and the underlying test reports), may find such reports are either increasingly complex to interpret or the report is not absolutely categoric about the field of application, then this would appear to be a matter for AD B to be aware of and support with revised guidance.

This issue of interpretation feeds back to the apparent 'interpretation issues,' identified in the Coroner's Rule 43 letter to the Secretary of State for Communities and Local Government of 28th March 2013, following the Lakanal House fire of 3rd July 2009 – see Example 2 (above) and the criticism that:

"…A*D B is a most difficult document to use…"*

"…*that* [revisions of AD B should be] *expressed in words* […] *which are intelligible to the wide range of people and bodies engaged in construction* [including refurbishment of buildings] *and not just to professionals who may already have a depth of knowledge of building control matters*".

A counter argument may be that it is not AD B's role to help professionals update their technical knowledge (and become competent at interpreting classification reports). It may be more appropriate for this to be addressed by legislation, registration and qualification.

New requirement 7(2), revised (and new) guidance in AD B and frequently asked questions

The revisions to the Building Regulations by the *Building etc. (Amendment) (England) Regulations 2022, with effect December 2022* [302], the revisions to AD B in 2022 and 2024 and new guidance (by way of frequently asked questions) between August 2022 and March 2024 and some of the CROSS-UK reports have gone a long way to superseding many observations made by respondents to the survey.

The answer to Question 15 on the Government's *Approved Document B: Fire safety - frequently asked questions* webpage (updated on 14th March 2024) (FAQs (March 2024)) considers the provisions of AD B Volume 1 (2010 edition including 2024 amendments) in Table 10:1 *Reaction to fire performance of external surface of walls.* The same content is reproduced in AD B Volume 2 at Table 12.1. The subject matter of Question 15 relates to timber cladding and draws the reader's attention to results of testing where the timber cladding is:

> *"[…] conducted on timber in plank form, forming a flat and homogeneous timber surface, over a plasterboard substrate, with heating primarily from the outermost surface."*

The subject matter of Question 16 relates to understanding fire classifications for a product in different situations and states:

> *"[…] the same material or product can achieve different classifications when using a variety of forms, fixings, orientations and combinations with other materials, e.g., different substrates. Designers should be cautious in assuming general reaction to fire classifications to materials or products and should instead consider the field of application set out in the test report for the product and account for the form and orientation, along with the specific jointing, mounting, and fixing methods employed in the test."*
>
> *and*
>
> *"[…] Some materials or products may rely on additives or treatments that have a specific maintenance requirement that is necessary to achieve their reaction to fire classification, e.g., a fire retardant coating."*

The FAQs are self-policing in that they hold a mirror to provisions that should be being applied and focus on the need to address and clarify matters in future editions of AD B (see Example 2 (above)). The guidance from these FAQs would be less likely to be missed, if the content of the answer was to be imported to AD B, along with some judicious educative text. For example, to emphasise that one should not assume 9 mm-thick timber can be considered to be equal to a product and end use system capable of achieving European Class C-s3,d2.

<u>Potential to restrict use of material with a Class E classification</u>

Recent experimental work by BRE Global, see section 3.4.7 (above) on *Investigation of Real Fires: Balconies Screens / facades*, is also relevant here. In the mid-2020s, there is a greater focus on selecting compliant external surfaces and this necessitates testing the surface material in conjunction with next adjacent material(s) and voids (to a total depth of 200 mm). AD B may be clearer if it was to revisit the guidance cited in Table 10.1 in AD B Volume 1 (which is the same as Table 12.1 in AD B Volume 2) where 'No provisions' is currently cited as an option. AD B may wish to set thresholds if a designer intends using a Class E material. These thresholds could be a function of:

- building use (including information on occupancy profile), height, location and size

  and,

- the fire growth rate index, smoke growth rate index and the total heat release. All three of these measurements are recorded during an SBI test.

When AD B (2006 edition) was being considered, there was no specific guidance on balconies. The guidance on balcony construction appeared in AD B (2010 edition with 2022 amendments). We have been unable to identify any large-scale reaction to fire testing of balconies, when they are formed of a Euro Class (EN13501-1) B, C, D or E system. The evidence behind the guidance of AD B Volume 1 Paragraph 10.10b (the same as Volume 2 Paragraph 12.11b) is unclear. This current guidance suggests balconies adopting an alternative to systems, capable of achieving either an A1 or A2-s1,d0 reaction to fire classification, need to achieve both the following conditions:

> "i. Have an imperforate soffit which extends to the full area of the balcony, achieves a minimum REI 30 rating and is constructed of materials achieving class A2-s1, d0 or better.
>
> ii. Materials achieving class B-s1, d0 or worse extending beyond the boundary of a single compartment should include a band of material rated class A2-s1, d0 or better, a minimum of 300 mm in width centred on that boundary line."

<u>The 'No provisions' guidance and 300 mm wide fire stopping</u>

Several respondents were concerned that 'no provisions' sends the wrong message regarding compliance. This could result in the structure of balconies, balcony facades and balustrade screens being built from timber or composite plastic wood-effect material (see Survey Issue 1k (above) where that material may have a class E fire classification. See also section 3.4.7 *Balcony screens / facades* (above) which discusses how a class E classification comes about. It is possible to achieve a class E classification to (BS EN 13501-1) based on the small flame test alone.

Whilst AD B (2006 edition) included the same 'No provisions' guidance (in Diagram 40) for buildings not exceeding 18 m in height, a designer in the mid-2020s may conclude that with all the revisions to both Regulation (7(2)), the revised editions of AD B, the introduction of FAQs, and emergence of CROSS-UK reports, such matters would have been considered carefully and therefore the use of a Class E material and end-use systems would be better than 'No provisions'.

Section 3.4.7 (above) includes the following cautionary text:

> *"The ability to quote a classification based on the reaction to the small flame test alone should be 'marked' in some way, so that industry can give due consideration to the lack of complete SBI data. Could AD B revert to provision of educative text to emphasise the need to complete both tests? Could AD B consider setting limiting thresholds, which can be derived from the SBI test? An 'E' classification may not tell the reader of a fire test report the implication of deploying a particular end-use construction on certain more sensitive purpose group buildings?"*

See also Survey Issue 1b section 6.1.2 (above) regarding the temptation to 'game' the system and the potential to reduce storey heights and or raise ground levels to achieve buildings of five storeys (just beneath the 11 m threshold). This gives rise to concerns that timber balconies and facades could be used on large footprint low-rise developments falsely 'gaming' the 'No provisions' guidance.

BRE Global has been unable to identify any large-scale research showing that 'fire stopping' just 300 mm in width, centred on the line of compartment walls and floors (see option ii, in AD B Volume 1 Paragraph 10.10 b or Volume 2 Paragraph 12.11b) would be sufficient to prevent fire spread up, down and across a timbered or composite plastic wood-effect balcony structure. See also Survey Issue 1k (above) which includes the cautionary text regarding use of composite plastic and the smoke production:

> *"[…] it is reasonably foreseeable that the quantity (and density) of smoke produced when composite plastic wood-effect material combusts has the potential to enter a dwelling (if windows and doors are open) and render the internal escape route difficult to negotiate (e.g. this could be the case with a terrace of town houses)."*

Intumescent coatings

One respondent believed that more needs to be known about fire retardant coatings and the need for continuing control.

AD B users would benefit from additional text providing guidance on how one should know when to re-apply intumescent '*additives or treatments'*. This is relevant since fire retardant timber is most commonly sourced after a chemical has been driven deep into the cell structure of timber under pressure, in autoclaves. How one knows that a brush or roller application will achieve the correct fire classification could be expanded upon in AD B. It is unclear how one would know when the additive or treatment has leached out of original pressure treated material. Perhaps continuing control could be discussed in AD B, including for low-rise buildings i.e. those 11 m or less in height.

Guidance to apply not just to new build

The guidance in AD B could also reach out to those engaged in refurbishment of buildings, undertaking material change of use, or conducting fire safety risk assessments / safety case reviews (for a high risk building) if it could make clear the recommendation for testing. Testing (indicative) of existing buildings could be performed if sufficient material could be removed, and subjected to both the small flame test and, the SBI test to determine its 'aged' fire classification to BS EN 13501-1.

Class C material on storeys beneath those with Class B material

For assembly / recreational and 'other' building types (but not 'relevant' or residential uses) with elevations more than 1.0 m from boundaries, the guidance in Table 10.1 in AD B Volume 1 or Table 12.1 in AD B Volume 2, is that compliance would be achieved if a building had a Class C surface from ground level to 18 m and a Class B surface above this level. BRE Global is not aware of research showing such an arrangement of materials and end-use systems having been tested. It is a reasonable hypothesis that would assume a rising heat flux may be sufficiently large (developing over the lower six storeys) to negate the better classification from 18 m and above.

If there is no test evidence of satisfactory performance, then consideration could be given to exploring whether a rising fire plume could continue to spread over / through a Class B material (end use system) from 18 m and above, at the same rate, as though it had a Class C classification. This may also point to a maximum building height where this guidance is appropriate.

A respondent made some points on AD B (2010 edition with 2020 amendments):

> *"What is meant by 'external surface'? 10.5 refers to the 'outermost external material'. What does this mean for a composite material used on the external wall? Should the overall product achieve the classification given in Table 10.1, or does this just refer to the outer skin of the composite [material]?"*

This question suggests that users of AD B are trying to understand how a product should be proven to have an appropriate fire classification – (see section 3.4.7 (above)) which confirms that a classification to BS EN 13501-1: 2018 draws data from the small flame test to BS EN ISO 11925-2: 2020 and the attack by single burning item (SBI) test to BS EN 13823: 2022.

What is different in the mid-2020s as opposed to the time when AD B (2006 edition) was being conceived was that many actors in the industry in the early 2000s were still using the national standards. In conclusion, it is probable that users of AD B would welcome educative text in the document clarifying the importance of testing before construction and testing of pre-existing construction where the classification is unknown and that the small flame test considers samples having a thickness of 60 mm or less and the SBI test considers an end-use build-up of up to 200 mm thickness.

One respondent pointed to a possible unintended consequence associated with implementation of Regulation 7(2) in relation to insulated render systems (using thin coat render (TCR)). Traditionally, insulated render systems used plastic corner beads, this changed with the implementation of Regulation 7(2) in December 2018 and corner beads are not granted an exemption under Regulation 7(3). The observation from this respondent was that the bond between TCR and steel corner bead may perform less favourably in a fire than TCR and plastic corner beads. Perhaps there should be some consideration of this.

<u>Points made more generally</u>

Other respondents made comments on surface spread of flame over walls and various criticisms on the ban on the use of combustible materials. Respondents' dissatisfaction with the ban on combustibles will have been considered when the DCLG went out to consultation in January 2020 (until May 2020) Approved Document B consultation paper *'Review of the ban on the use of combustible materials in and on the external walls of buildings'* (the review). The changes implemented as a result of the consultation can be found online [303]. Responder's comments included:

1) Broad support for BS 8414-1 and BS 8414-2 and the data that can be gleaned from such a test.

2) A suggestion that curtain wall guidance was required and that these systems need a test similar to BS 8414.

3) Issues around spandrels as needing further consideration. This was also covered in the review, and Government responded that it intended studying issues relating to spandrels and balustrades glazed with laminated glass.

4) A request for clarity in AD B at Section B4 on the fire resistance performance of the curtain wall at slab edge. This was also covered in the consultation and the Government acknowledged there may be room for better definitions.

5) A request for clarity on thermal breaks e.g. if these were thermal breaks within frames like windows and curtain wall or big thermal bridges at slab edges? One respondent asked about scale, extent and triggers and asked:

    - What is classed as a cavity in terms of the provision of cavity barriers?
    - Does this include small cavities such as those in aluminium extrusions?
    - Cavities in a shadow box / spandrel?
    - Cavities in a glazing unit?

6) A suggestion that paragraph 10.6 is still vague about scope. It can be interpreted as meaning all components except 'gaskets, sealants and similar'; alternatively, the respondent believed it can be interpreted as specific to the components listed. Some respondents claimed that industry was split on this, and sought clarity, taking modern methods into account.

7) BRE Global notes the AD B (2019 edition including 2022 amendments), and that the new guidance for buildings with a storey between 11 m to 18 m does add additional clarity.

8) A recommendation that research be undertaken to identify the risk that a timber framed curtain wall would present. Members could be substantial. How should designers and regulators consider curtain walls with framing from timber and what test method would be suitable?

9) The perception that hospitals had, in effect been overlooked. BRE Global observes that this was largely addressed in the AD B (2019 edition including 2022 amendments). One respondent suggested that, irrespective of building height, a hospital should not be enveloped in combustible material meeting the 'No provisions' criteria.

Implication for AD B – It is apparent that practitioners are still in need of further guidance.

This need for further guidance, stems from many of the themes discussed in Survey Issue 1h (above) as well as the complex interactions that occur between building shape, interfaces between different end-use cladding systems, voids behind the 'cladding,' cavity barrier detailing, the effect of balconies and the effect of wind.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Adding clarity for the users of AD B by considering the recommendations in Survey Issue 1h (above) since many of the future direction considerations that applied to Survey issue 1h apply equally to this Survey Issue.

2) Whether research into the combined effect of building shape, different cladding systems, the interfaces and cavities behind such cladding systems, the presence of balconies, and the effect of wind during a fire event, could result in revised guidance in AD B.

3) Whether the field of application referenced in fire test reports could be much more tightly defined and be consistent between fire test laboratories and audited.

4) How frequently the content of departmental circular advice notes, FAQs and CROSS-UK reports are assimilated into AD B guidance to bring clarity to industry.

5) Adding clarity for the users of AD B by clarifying Note 3 in table 10.1 in AD B (2019 edition including 2024 amendments) Volume 1 and Note 3 in table 12.1 in AD B (2019 edition including 2024 amendments) Volume 2 that if timber at any thickness needs to be tested in its end use orientation to determine its European reaction to fire classification to BS EN 13501-1 and one must not assume timber will achieve a European Class C.

6) Restricting the use of Class E materials and end use systems on certain buildings and removing the 'No provisions' guidance.

7) Limiting the use of Class E material and end use systems, based on SBI data: i) the fire growth rate index FIGRA, ii) smoke growth rate index (SMOGRA and the total heat release (THR).

8) Continuing controls for certain buildings so that efficacy of intumescent coatings on timber can be tested and corrective action taken if the intumescent has leached out due to weathering.

9) Whether evidence exists to show that satisfactory performance is achieved on a tall building (e.g. an assembly building, where the subject building is located at 1.0 m or more from relevant boundaries) where a Class B material (end use system) is constructed from 18.0 m and above.

6.1.15 Survey Issue 1m: Access and facilities for the fire service

Background – The survey highlighted a range of issues. This Survey Issue encompasses one principal hot spot location and several wide-ranging comments made by survey respondents or by members of the Technical Steering Group.

Driver – There is no single driver.

There was a hot spot between paragraphs 13.1 and 13.4: *Provision and design of access routes and hardstandings.*

Other comments were made which related to:

- Introduction to B5 and the Intention of B5: *Access and facilities for the fire service*
- Paragraph 14.4 and 14.8: *Design and construction of fire mains*
- Paragraphs 15.2 and 15.7: *Provision of firefighting shafts*
- Paragraphs 15.8 and 15.9: *Design and construction of firefighting shafts*

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

A selection of respondent observations included:

1) *"The importance of Fire and Rescue Service (FRS) personnel, on accessing a building at ground level, being able to enter a firefighting shaft, directly. The undesirability of designs which require firefighters to 'walk' through a reception or other space(s) in order to access the internal firefighting shaft."*

2) *"The undesirability / danger of having connection between a ground floor undercroft car park and ground floor stair / lift lobbies. The latter are offered with just a 0.4m² ventilated lobby. Impulse fans in the car park are shown to 'nudge' smoke away from the lobby door on the car park side. However, AHJs rarely have sufficient depth of technical understanding to critically appraise the CFD modelling input criteria. This results in reports show successful post fire smoke clearance. Reports need to show performance during a fire to keep hot expanding gases away from the stair lobby."*

3) *"The undesirability of designs which require firefighters, on accessing a building, first to ascend a short staircase in a protected shaft to a 'transfer slab' (say at first or second storey) level, to then 'transfer' to the main firefighting shaft, a short walk away."*

Buildings constructed in mid-2020s are more likely to have these extended routes of travel between the building's entrance and the firefighting shaft, since our experience is that stair cores are seldom on / adjacent to the wall through which principal access is made, most frequently they tend to be central to a building's footprint. This tendency to place the core centrally is more likely in taller buildings for structural reasons. Moreover, if the stair core is located to afford a degree of solar shading function, and the entrance door to the building is on a Northerly elevation, the travel through a building could be extensive. Also, it is BRE Global's experience that buildings are increasingly designed with large transfer slabs at an upper level say first or second floor level to allow blocks to rise from the slab. This allows open space on lower floors for another purpose group use. If data on this (over practitioner viewpoint) is required, a research programme may be needed to determine how different things are in the mid-2020s than they were when the AD B (2006 edition) was being considered.

4) *"Contraflow and hose laying problems in stairs."*

5) *"Calls for wayfinding and evacuation alerts to apply to all multi-occupied buildings irrespective of building height."*

6) *"A call to consider toxicity of smoke produced by materials combusting. What could / should be done to better protect firefighters?"*

7) *"The importance of locating fire mains outlets at each floor, within the protected enclosure of a stairway and in a protected refuge/firefighting lobby adjacent to the stairway and firefighting lifts. This enables the fire service to connect to an outlet within the stairway at the bridgehead (two clear floors below the incident floor where firefighters deploy from) to protect the stairs and connect to a second fire main outlet at the fire incident floor within the protected lobby. This will eliminate the need for firefighters to jam stairway doors open with hoses, preventing the protected stairs from becoming smoke logged."*

8) *"Consideration for simultaneous evacuation should the need arise, including width of stairs."*

9) *"The observation that there is a tension between Evacuation lifts versus the stay-put strategy and the conflict between AD B and the London Plan on this."*

10) *"Firefighting in buildings served by a single stair will be a consideration for many years until the AD B (2019 edition including 2024 amendments) comes fully into effect."*

11) *"The importance of considering firefighting procedures adopted by different FRSs. For example, one FRS's high-rise firefighting strategy may be very different to another service's high-rise firefighting strategy. This suggests a wider review may be appropriate."*

12) *"There is benefit in the provision of an interface between a centrally addressable fire alarm system and a social alarm system. This can ensure that the Fire and Rescue Service can be alerted to the need to provide assistance to an individual(s) prior to any decision to initiate a phased or simultaneous evacuation procedure."*

BRE Global noted another respondent's view that rather than a bleep, or tone (to signify actions i.e. '*get ready / be aware*' or '*evacuate now'*) residents would welcome FRS's audible 'interventions' to advise, reassure, calm and instruct them on when and by which route they should make their escape, e.g. "…Use staircase 2 and evacuate the building immediately…"]

However, BRE Global notes the paragraph 10.1.1: *Audible evacuation alert devices* from BS 8629: 2019+A1: 2023 [304], which states:

> *"It is not recommended that voice messages, rather than audible alert tones, be used, because it is not always appropriate to give a definitive verbal instruction to evacuate (e.g. it might be inappropriate for residents to evacuate if the common parts are untenable for escape)."*

If AD B agreed with this view, that there is real merit in the evacuation alert being able to be 'switched over', to transmit voice instructions, then British Standard BS 8629: 2019 +A1: 2023 would need amending first.

The responsible person should be required to undertake monthly checks and report on the system's status, faults and rectification of faults, in much the same way as they are required to undertake monthly checks of lifts and notify the local FRS under *The Fire Safety (England) Regulations*: 2022 No.547.

13) *"The design of smoke control systems needs reviewing, particularly the tenable limits for firefighters in corridors when the door of the flat of fire origin is opened."*

14) *"Since AD B (2006 edition) was being considered, the FRSs nationally, were required (see FRS Circular 32/2006) to "adopt firefighting techniques that provide for an additional covering jet from the bridgehead to protect firefighting personnel actively involved in the incident/rescue/firefighting. It is important that this operational procedure is given the strongest consideration and adopted for all high-rise incidents."*

15) *"Custom and practice changes require wider review."*

16) *"Firefighters may need to carry very heavy controlled dividing breeching valves onto the fire floor, for laying an attack hose-line and the covering (safety) hose-line from the same outlet. To alleviate issues with flowrates now seems the time to require 150 mm-diameter rising fire mains (dry or wet). BS 7974-5 has included and promoted 150 mm-diameter rising mains, since 2014."*

17) *"Need to reduce the weight of equipment required to be carried, enable two lines per floor to be laid in safety whilst keeping the stair door closed. This will also have an impact on venting designs."*

The call for separate staircases in blocks of flats, has largely been answered with AD B (2019 edition including 2024 amendments), see Survey Issues 1d and 1g (above). The provisions in the AD B (2019 edition including 2024 amendments) for more than one stair will trigger if a block of flats has a top storey of 18 m or more above ground or if the criteria for a single escape route is not met. However, it may take until the mid-2030s for all new buildings under design or construction to be following the guidance regarding the provision of additional stair(s). Also, there has been a marked growth in the number of blocks of flats served by a single stair, where such buildings also have extended travel in corridors and the corridors are provided with mechanical smoke extraction. This marked growth has occurred between the time when AD B (2006 edition) was being considered and the mid-2020s.

18) *"The belief that the provision of dedicated fire-fighting lifts and smoke-control being under FRS personnel control, etc have been designed out and relaxed."*

See the NFCC *Provision of multiple routes for evacuation of residential buildings – Opinion Paper* in Survey Issue 1b and 1c (above), which considers the need for *redundancy in firefighting provisions like lifts.*

19) *"The observation that mobility impairment is one of the underdeveloped considerations in AD B."*

See Example 11 (above) which considers equal opportunity when it comes to considering means of escape.

20) *"Issues around water supply and lack of acceptable water pressure / flow."*

21) *"Consideration of reliability of water supply and whether memoranda of understandings are needed between the various FRSs and National Water Companies, and what undertakings are required if the FRS is to draw water from alternative sources i.e. canals, rivers, reservoirs or ponds?"*

22) *"Considering that more land is developed in the mid-2020s than was the case when AD B (2006 edition) was being considered, it is reasonable to conclude that unless water supply infrastructure has been upgraded throughout England, the water pressure may be an increasing concern for FRS fire scene incident commanders. This observation is borne out by BRE Global's experience investigating real fires."*

23) *"The suggestion that firefighting tactics are increasingly defensive rather than offensive and if this is so, might this signal a need to change perceptions from internal firefighting to external firefighting?"*

24) *"Calls to consider the maximum reversing distance and turning circles for modern pump and aerial reach appliances. The observation that there have been advances in vehicle technology e.g. rear cameras / sensors. Some counties have narrower pumps that could access longer narrower lanes. Guidance being critical of designs using bollards at the 20 m mark (to prevent an appliance reversing more than 20 m). This could be counterproductive especially if the driver can and is willing to reverse further."*

25) *"It may be the case that a FRS, from a neighbouring county, may occasionally be the first responder at a fireground, and their pump and or aerial platform vehicles may be different sizes to the 'host' authority."*

26) *"What to do about land-locked buildings which can only be accessed through other buildings?"*

27) *"Consideration of sprinkler or mist systems, where the distance between a parked pump appliance and the furthest point in a building exceeds 45 m."*

28) *"Ongoing issues with vehicles parking over fire hydrants and / or along fire access routes and many instances of pump appliances not being able to park adjacent to dry risers which are seldom adjacent to a firefighting shaft."*

29) *"Whether the 280 m^2 requirement for a hydrant is outdated? Should all new developments have hydrants and when should additional hydrants be provided i.e. should the triggers relate to occupancy profile, compartment size, building height, building size / volume?"*

30) *"How to eliminate poor choices in design e.g. one respondent cited a firefighting shaft, which was to be formed using cross laminated timber (CLT). Even in buildings without a floor at 18 m or higher above ground level, designs have included CLT stair enclosures. One respondent believed all protected stairs should be enclosed in non-combustible and robust construction including a fire resisting 'lid' and no reliance should be placed on the use of plasterboard to achieve the requisite fire resistance."*

31) *"It is also unclear where the 10 air changes per hour requirement for venting of heat and smoke from basements (using mechanical smoke extract) and the requirement to ventilate car parks, that are not open-sided) (using mechanical ventilation) came from. What is the objective supposed to achieve?"*

32) *"Why does paragraph 16.11 of AD B (Volume 1) and paragraph 18.11 of AD B (Volume 2) discourage the installation of sprinklers in car parks? There is significant evidence of serious fires occurring in car parks. The statement that they do not pose is significant hazard is outdated. The guidance is based on outdated empirical data of car park fires, such as might have occurred in the latter part of the 20th century. The guidance around car park fire precautions requires careful reconsideration."*

See also Example 3 *Deep dive – Electric vehicles and underground car parks* (above) and Survey Issue 1j.2 (above).

33) *"Better guidance on the location of basement car park extract points is necessary as there have been instances of vents being located directly beneath residential apartments and their fenestration. This has led to concern about fires exhausting smoke out and then back into upper floor level compartments/apartments."*

Implication for AD B – The majority of the 31 respondent observations have merit and require consideration and response. It has not been possible to quantify the scale of decline or worsening of provision that we see in the mid-2020s, for each of these 31 observations when comparing the scale of compliance with the provision when AD B (2006 edition) was being considered. It may be possible to research each item to try to evidence the 'degradation' in the scale of compliance from early-2000s to mid-2020s.

The challenge arising from this Survey Issue suggests AD B could look at:

1) conducting a review of the B5 provisions with view to providing updated guidance paragraphs from the Introduction section and Section 13: *Provision of access routes and hardstandings* through to Section 16 *Construction of outlet ducts or shafts*.

2) whether in addition to updating guidance paragraphs, some paragraphs need to be omitted or new paragraphs provided.

6.1.16 Regulation 38: Fire safety information

Background – The survey

Driver – There is no single driver.

There was a hot spot at Introduction to Regulation 38: *Intention*

Comments were made which were relevant to paragraph 17.3: *Essential information and* Paragraph 17.6: *Additional information for complex buildings.*

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

Most of the comments identified that the regulation had no teeth. The Regulation required that:

> *"The person carrying out the work [should] give fire safety information to the responsible person not later than the date of completion of the work, or the date of occupation of the building or extension, whichever is the earlier.*
>
> *and*
>
> *"fire safety information" means information relating to the design and construction of the building […] the services, fittings and equipment provided […] which will assist the responsible person to operate and maintain the building or extension with reasonable safety."*

The Regulation 38 in force at the time of the survey did not require that the information needed to be shown to the AHJ. Accordingly, there was no official requirement for the AHJ to voice an opinion on the quality and quantity of information being sent to the responsible person. Moreover, there was no requirement to ensure the responsible person acknowledged receipt of the information and that they accepted it as being comprehensive and sufficient.

> One respondent said:
>
> *"[Regulation 38] was/remains non-effective in practice (perhaps Gateway 3 may partly resolve this for in-scope buildings) However non-HRB buildings may be the far more complex and in need of wayfinding and information to the fire crews than other simpler forms of buildings."*
>
> Another said:
>
> *"Regulation 38 is not being 'enforced'."*
>
> Another said:
>
> *"[…] relevant information should be submitted to building control before completion for checking because in my experience many of the commissioning documents/certifications [are not] in accordance with the relevant BS or BS EN standard."*
>
> Another said:
>
> *"[…] combustible structures should be explicitly included in the definition of complex buildings, thereby requiring a fire safety strategy and procedures for operating and*

maintaining any fire protection measures. This should include the importance of maintaining the plasterboard in an imperforate state, information to residents and [how and when] periodic checks [should be conducted].”

Another said:

“Mobility impairment is probably one of the most underdeveloped [parts of the guidance].”

The call for premises information boxes has been superseded by AD B (2019 edition including 2022 amendments) for blocks of flats.

Lastly, one respondent made this point:

“There is much talk of ‘as-built’ fire strategies […] - these are practically impossible to deliver, in most cases [since] […] Fire engineers […] are typically not retained beyond RIBA 4, sometimes 5. […] [Fire engineers] will not routinely be engaged to supervise or assure the works [and therefore] cannot […] produce a document that assures that the final configuration of premises is acceptably safe.”

Regulation 38 information should include evacuation of people with mobility issues and disability more generally, see also the discussion in Example 11 (above).

The Building Regulations etc (Amendment) (England) Regulations 2023 (SI 2023 No. 911) at Part 2 Regulation 13 [305], amended Regulation 38 with effect on 1st October 2023.

The new Regulations 13.2A to 13.2B(b) introduced by these Regulations require that:

“[…] The responsible person must give the person carrying out the work a notice acknowledging receipt of the fire safety information and confirming the information provided is sufficient to enable them to understand, operate and maintain the building (and the fire safety systems in it) after the building work in question.”

And

“[…] the person carrying out the work must give a notice to the relevant authority—

(a) confirming that they have given the fire safety information to the responsible person […] and

(b) stating that they have received the notice from the responsible person [confirming they have received the information and that it is sufficient for their purposes] or where they have not received the notice [from the responsible person], stating the steps taken to obtain the notice from the responsible person and the dates they were taken.”

Whilst these amendments are welcome there is still no vetting stage as the regulations do not require the information to be shown first to the AHJ. Additionally, the ability for the AHJ to say the quality of information is sufficient still needs consideration.

The building control approval process sometimes sees a design team making one or more commitment(s) and undertaking(s) on behalf of the responsible person, to secure Notice of Passing of Plans. Invariably, such commitment(s) and undertaking(s) will be matters of resourcing that the responsible person needs to understand they become liable for on completion.

A very common expression used by some design teams, when seeking to demonstrate compliance to the AHJ, is that *"the building will be highly managed".*

Implication for AD B – The changes made in 2023 were intended to give the regulation teeth. This has not materialised.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Conducting a review of Regulation 38 and the guidance in AD B relating to it.
2) The time it will take for the AHJ to 'discharge' Regulation 38 information and the resource they would need, to carry this additional work into effect.
3) The ability of the AHJ to prevent handover and completion from taking place until satisfied the Regulation 38 information is up to the right standard and that the responsible person accepts the information.

6.1.13 Appendix B: Performance of materials, products and structures

Background – The survey

Driver – There is no single driver.

There was a hot spot at Appendix B.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

<u>A selection of respondent observations included:</u>

1) *"Disappointment at the loss of guidance previously provided by Table A8: Typical performance ratings of some generic materials and products. One respondent cited Entry 3 in former Table A8, which related to plasterboard (whether painted or not…) as achieving national fire performance rating Class 0. Others were also disappointed at the demise of Table A8 since it was considered useful in providing rule of thumb classifications."*

BRE Global interprets this as meaning that the removal of the guidance has led to confusion and a varied picture of compliance across England, which is an undesirable outcome. If Table A8 needed review, that would have been preferable over Table 8's removal. Accordingly, since AD B (2019 edition) with the loss of Table A8, there is a more varied picture of compliance across England.

1) *"Disappointment at the loss of guidance that former Table A5: Notional designations of roof coverings could provide. One respondent had an issue with concrete paving slabs, which can be found weighing-down an inverted roof. The respondent felt that the maximum gap between slabs that would still achieve an AA national designation or a B_{ROOF} (t4) classification could probably have been given in AD B guidance (as a rule of thumb)."*

2) *"Many manufacturers are not testing roofing systems and relying instead on the Annex of Commission Decision 2000/553/EC that can enable a roof to be unrestricted under the national building regulations. See also Example 9 Deep dive – Roof testing etc (above)."*

3) *"Many green roofs are being designed and built as a common form of construction. The suggestion is that guidance could have been given in AD B. See also Example 9 Deep dive – Roof testing etc (above)."*

BRE Global interprets 2) to 4) is as meaning that a revised Table A5 may have been an ideal place to provide guidance on these three respondent observations. Accordingly, since AD B (2019 edition) with the loss of Table A5 there is a more varied picture of compliance across England.

1) *"There should be a 'cut-off' date whereby product suppliers can no longer refer to testing to national class."*

2) *"One respondent asked for guidance in the current Table B4 to make clear that insulated plasterboard cannot be assumed to perform in the same manner as ordinary plasterboard."*

3) *"One respondent argued that it was preferable to have simple rules of thumb over complex interpretation of fire test reports, by unqualified individuals. Standard solutions that do not take hours of research to approve would be preferable. This respondent cited difficulty in obtaining full fire test reports and, went on to explain that when they are finally provided, they can be difficult to interpret."*

4) *"Guidance is needed on the fire resistance testing of downlighters."*

5) *"One respondent asked for a review of the construction of compartment walls using combustible materials, with a focus on tall higher risk buildings."*

6) *"Interpreting Tables B3 and B4 can be confusing."*

BRE Global notes the answer to Question 14 on the Part B FAQ webpage My building element could be described by several of the items in Table B3. Which one should I apply?

See Example 2 (above): Actors want to know what is and is not acceptable and seek consistency of interpretation.

In BRE Global's experience, construction actors would sooner have the certainty of misery over the misery of uncertainty.

See also Survey Issue 1l (above) which encourages AD B to 'upload' other guidance e.g. in departmental circulars, Part B FAQs and CROSS-UK reports to the AD B guidance. Regularly.

1) *"One respondent argued that periods of fire resistance given in Table B3 should be qualified such that they should not apply to combustible construction where the fire strategy is stay put."*

The Structural Timber Association *Structural timber market research: residential sector report October 2022* [306], states the following:

> *"Figures from the National House Building (NHBC) suggest that timber frame market share has developed from 19% in 2015 to 22% in 2021 and that market*

conditions, as described above, present the opportunity for this to develop to circa 27% by the end of the forecast period (2025)".

See Survey Issue 1b: *Growing desire for sustainable forms of construction*, which shows the direction of travel using off site manufacture and sustainable forms of construction. See also Example 5 *Deep dive – volumetric construction Fire testing of combustible construction, monitoring the cooling period after standard testing* which considers how heavy massy construction has shown itself to be fire robust in extended duration fires. Lastly, see Survey Issue 1f (above) which shows that in the case of combustible construction, the Fire Department New York guidance is that residents should leave the building immediately on discovering a fire.

In conclusion, it would not seem appropriate to apply the same period of fire resistance to all construction typologies, without considering the construction typology, occupancy profile, building size and location and whether the fire strategy is stay put or simultaneous evacuation.

1) *"Frequently products are placed on the market which do not have the necessary test certification in place, or the [system] is not tested in the specific combination at hand."*

2) *"Standards being written by different bodies such as Local Planning Authorities and the Greater London Authority that do not reflect align with the building regulations and British Standards, [this is very undesirable]."*

3) *"The fire requirement is unclear for adhesives (for example for sandwich panels). How does one go about checking the quantity of adhesive used in the manufacture of sandwich panels?"*

Implication for AD B – The appendices are important for the educative text and the rules of thumb (that used to reside in tables like Table A5 and Table A8).

The challenge arising from this Survey Issue suggests AD B could look at:

1) Conducting a review of the content of Appendices in the AD B (2006 edition with 2019 amendments) and comparing the text in those appendices with the text in the present AD B (2019 edition including 2022 and 2024 amendments).

6.2 Arising from the survey hot spots AD B Volume 2 (2019 edition including 2020 amendments)

6.2.1 Survey Issue 2a: Alternative approaches

Background – The background issues include modern living, overheating (climate change) and combustible construction. See also Survey Issue 1b (above) on the approved documents, combustible construction, etc.

Driver – There is no single driver.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

A selection of respondent observations not previously raised in Survey Issue 1 included:

1) *The importance of providing guidance on very tall buildings.*

There are a greater number of tall buildings in city centres in the mid-2020s than the early-2000s. See also 6.3.1 Theme 1: Issue 1: *Tall buildings, single stairs and the limits of application (scope) of AD B* (below).

1) *Clarity on where the guidance does and does not apply i.e. this may not be appropriate for a warehouse with high bay racking. [attempts to use AD B for such buildings have been noted].*

Implication for AD B – The comments made under this section have already been covered in the text and worked Examples (above), specifically Survey Issue 1d and more generally Survey Issues 1a to 1c.

The challenge arising from this Survey Issue suggests AD B could look at:

1) The text and worked Examples (above), specifically Survey Issue 1d and more generally Survey Issues 1a to 1c.

6.2.2 Survey Issue 2b: Design for horizontal escape

Background – The survey highlighted a range of issues, some of which are identified here.

Driver – There is no single driver.

There was no single hot spot but there were comments around the following:

- Paragraph 2.7: Single escape routes and exits
- Paragraph 2.10: Alternative escape routes
- Paragraphs 2.13: Open spatial planning

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

A selection of respondent observations included:

1) *"Lack of clarity as to whether (e.g.) a store room in an office occupancy should apply office TDs or storage/other non-residential TDs. Document could be clearer in this regard. Another asked for […] further clarity (possibly diagrams) on how*

and where travel distances are measured from [particularly in] hotels. Lastly, there has been a tendency for designers to use travel distance as though it were direct distance (in other words longer distances with no consideration of layout) because layouts are not known. Several respondents made comments about interpretation of direct distance and travel distance."

It does not appear that there are circumstances in the mid-2020s that make these more 'complex' issues to resolve, than was the case in the early 2000s. If Government wanted research to be carried out into any or all of these observations, it may be more costly to conduct than simply adding short guidance paragraph(s) in AD B.

1) *"AD B recommends escape should not be within 4.5 m passed a void edge. […] [users of AD B would appreciate educative text on] how the 4.5 m figure has been arrived at."*

It does not appear that there are circumstances in the mid-2020s that make these more 'complex' issues to resolve, than was the case in the early 2000s. It may be the case that buildings with atria and atria-like spaces are more common. If Government wanted research to be carried out into any or all of these observations, it may be more costly to conduct than simply adding short educative text in AD B.

Implication for AD B – If further guidance was provided, it would be welcome.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Research or simple text additions to AD B to address these points.

6.2.3 Survey Issue 2c: Residential care homes – General provisions

Background – The survey highlighted a range of issues, some of which are identified here.

Driver – There is no single driver.

There was no single hot spot but there were comments around the following:

- Paragraph 2.34: General provisions
- Paragraph 2.35: Planning for progressive horizontal evacuation
- Paragraphs 2.41: Fire detection and alarm
- Paragraphs 2.46: Sprinkler systems

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)'*.

<u>A selection of respondent observations included:</u>

1) *"Sprinklers should be mandated in all care homes as over time occupants' ability to evacuate will reduce and they will become dependent on the staff."*

2) *"Sprinklers should not be used to justify travel distances being extended. Regardless of a future requirement for sprinklers maximum travel distances should be reviewed as part of the review (based on all people's capabilities)." [BRE Global notes the December 2022 to March 2023 consultation by DLUHC]* [307].

3) *"Remove the option to dispense with self-closers if sprinklers are provided. [A] fire may emit smoke and toxic species which will [down wash] spread [and] may prevent evacuation and result in fire death."*

4) *"Paragraph 2.34 states that residential care homes should generally be designed for progressive horizontal evacuation. This may also be appropriate in other types of care homes."*

Renewed consideration needs to be given to all types of specialised housing. The specialised housing sector in mid-2020s is completely different to the sector when AD B (2006 edition) was being considered.

See also 3.4.2: *Specialised housing and care homes* (above). See also Example 7 (above) which suggests co-living schemes can now be used for elderly and retired persons. See Examples 10 and 11 (above) for other considerations relating to the specialised housing sector and dignified escape, respectively.

1) *"Paragraph 2.35 discusses compartment walls and floors. […] In a lightweight timber frame construction, the fire resistance to these compartment walls and floors is provided by plasterboard. […] It is unreasonable to rely on a material that can be relatively easily damaged to provide the required fire resistance. This appears to be an inappropriate application of AD B to combustible structures, when the original guidance [post war] building studies] assumed non-combustible construction."*

See Example 10 (above) which confirms why this is more of an issue in the mid-2020s than was the case when AD B (2006 edition) was being conceived.

1) *"A Housing Learning and Improvement Network Technical Brief No. 5 [177] points to timber frame being a favoured construction method, accounting for 60% of the new builds of extra care accommodation."*

An Extra care home is not the same as a Care home and further research could be conducted to see the scale of uptake of timber framed buildings in Care homes or apply a precautionary principle.

BRE Global notes the December 2022 to March 2023 consultation by DLUHC to require sprinklers in Care homes irrespective of height. This is clearly a new issue in the mid-2020s that was not part of the AD B (2006 edition) guidance. See also Examples 10 and 11 (above).

1) *"An L1 standard [of fire detection and alarm] […] should be provided in [all new and converted] residential care homes. [Where a building is comprised of combustible construction] there should be detection in the roof space. Alternative sounder solutions [should be considered] for care homes, particularly where residents can't cope with loud noise or are bed-ridden."*

2) *"[When a Care home undergoes a material alteration] application of 'consequential improvements' should [apply, to uplift standards rather than allow the application of the no worsening paragraph in regulation 4(3)]."*

There do not appear to be circumstances in the mid-2020s that make these suggestions more pressing than they were in the early 2000s. However, since more people reside in care homes, than ever before, and more care homes are being built from combustible construction, than ever before. To gather this information would require additional research, which could be commissioned. It may prove more costly to conduct such additional research, than to simply add short guidance paragraph(s) in AD B covering all seven points.

Approaching it from a different angle, Government was considering the introduction of sprinklers in all care homes irrespective of height (this was one of the strands of the consultation from December 2022 to March 2023. One could conclude these seven considerations are just progressive, appropriate and precautionary, for a wider review of this sector. There could be a complete review of the provisions for the whole of the specialised housing sector.

Implication for AD B – if further guidance was provided it would be welcome.

The challenge arising from this Survey Issue suggests AD B could look at:

1) adding clarity for the users on AD B in the form of additional guidance requiring sprinklers in all care homes irrespective of height the reinstatement of the need to provide door closers.

2) adding clarity for users of AD B on travel distances should be based on individual's capabilities as well as speed of travel of the elderly. Travel distances should not increase for residents in such buildings because of the provision of sprinklers. Some residents may require extra 'pre movement' time to ensure dignified escape.

3) research into the provisions for the whole specialised housing sector and this needs to be iterative research.

4) adding more onerous provisions for care homes built (or undergoing material alteration) where the fabric of the building is comprised of combustible construction.

5) adding clarity for users of AD B regarding the L1 fire detection and alarm installation, the extent of coverage (to suit the type of construction) and the most favourable method of raising the alarm, voice activated?

6) adding clarity for the users of AD B that for care homes (and other typologies in the specialised housing sector) there should be a requirement to uplift standards i.e. Regulation 4(3) disapplies for this typology.

6.2.4 Survey Issue 2d: Design and protection of escape stair

Background – The survey highlighted a range of issues, some of which are identified here.

Driver – There is no single driver.

There was no single hot spot but there were comments around the following:

- Paragraph 3.32: External escape stairs
- Paragraph 3.35: Access lobbies and corridors
- Paragraph 3.36: Exits from protected stairways
- Paragraph 3.38: Use of space within protected stairways
- Paragraph 3.39: Gas service and installation pipes in protected stairways
- Paragraphs 3.40 and 3.41: Basement stairs

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)'*.

A selection of respondent observations included:

1) *"Regarding fire resistance of areas near to external stairs, the current guidance requires that the escape route is provided with fire resistance from the inside of the building only. [On low rise 'residential' use buildings (e.g. block of flats with a storey just below 11.0 m or if a building has a fifth storey] and in non-residential buildings of any height] combustible cladding could be [within] close proximity to an external escape route and/or an external escape stair."*

This risk applies equally to internal stairs, see Diagram 3.3 of AD B Volume 2 (2019 edition including 2024 amendments) and external stairs, see Diagram 3.4 of AD B Volume 2 (2019 edition including 2024 amendments). A fire in one part of a building could exit a window (or other opening) and involve the external surfaces of a building. This is a risk for low-rise residential and high-rise (non-relevant) buildings.

There is a fire risk to internal stairs, see Figure 7 in Example 7 (above) which depicts fire spreading over a mid-height communal terrace (this could be applicable to an office or mixed-use building, or other). Flames could threaten more than one stair core. If a building had an external stair(s) rising from an accessible terrace, serving several floors above there is also a risk of fire on the terrace rendering the external stair(s) unusable.

1) *"There is no guidance on Ancillary accommodations (including kitchens) except specific very high risk as in B3 [and how they could affect access corridors]. However, in larger buildings [and complex, yet common, mixed-used buildings] ancillary accommodation forms a large part of an development - perhaps refer to BS 9991 and BS 9999? […]*

2) *Ancillary accommodation includes engineering services and such accommodation as common amenity areas, refuse rooms, kitchens and covered car parks. Ancillary accommodation generally presents a greater fire hazard than areas under normal use because the accommodation might only be visited occasionally and is thus not under regular surveillance, or it presents a higher fire load. For guidance ancillary accommodation see BS 9991: 2015. Alternatively reproduce the table of ancillary use from BS 9999 (table 29)."*

There do not appear to be circumstances in the mid-2020s that make these suggestions more pressing than they were in the early 2000s. However, since more buildings are becoming complex, this is making these issues now appear common. To gather this information on the risks associated with ancillary accommodation would require additional research, which could be commissioned. It may prove more costly to conduct such additional research than to simply add short guidance paragraph(s) in AD B covering this.

1) *"If a stair has lobbies to protect it at upper levels, [the respondent pointed out that Figure 34 from BS 9991: 2015 should be considered for inclusion in AD B guidance as to how to protect the stair at ground floor level]. The Figure shows lobby protection to final exit from a stairway."*

It is noted that BS 9999: 2017 also describes this level of protection to lobbied stairs. There do not appear to be circumstances in the mid-2020s that make these suggestions more pressing than they were in the early 2000s. However, it is worth noting the link between this point and Survey Issue 1m: *Access and Facilities for the fire service* (above). Survey Issue 1m pointed to the undesirability of expecting firefighters to enter a fire building and having to traverse some distance from the 'front door' to the stair core. To gather information on whether this is a greater risk in mid-2020s as opposed to when the AD B

(2006 edition) was being considered, research, could be commissioned. It may prove more costly to conduct such additional research than to simply add short guidance paragraph(s) and Figure 34 from BS 9991 into AD B.

1) *"Changes [should] include a rewording to make it clear that access should not be provided from riser shaft to single stairways and the standards for access from common lobbies specifically explained."*
2) *"The principle described for stairs not to continue down to a basement in single stairway buildings is almost always misunderstood. Applicants believe 'not continue down' means a screen and door separation is all that is required. A diagram showing no connection to a stair serving the upper floors to a basement level would make this clear."*
3) *One respondent observed a trend where commercial buildings (with occupiable storey(s) more than 11 m above ground level) are being designed with a single stair.*
4) *This worrying trend is extending to mixed use buildings and the respondent is seeing hotel / residential schemes served by a single stair, with smoke clearance using a smoke exhaust system typically used in common corridors in flats.*

To gather information on whether observations 4 to 7 represent a greater risk in mid-2020s as opposed to when the AD B (2006 edition) was being considered, research could be commissioned. It may prove more costly to conduct such additional research than to simply add short guidance paragraph(s) and diagrams in AD B.

Implication for AD B – If further guidance was provided, it would be welcome.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Adding clarity for the users on AD B in the form of guidance to protect protected stairways or those intending to use an external stair, from a fire which has broken out from another part of the building and is travelling along the external surface and interstitial spaces of an external wall.
2) Adding clarity for the users on AD B on ancillary accommodation and lobbying of stairs at ground floor in buildings where upper storeys need the protection of a lobby approach to the stair.
3) Adding clarity for the users of AD B in the form of guidance on the 'do's and don'ts' regarding service risers.
4) Adding clarity for the users of AD B in the form of guidance on the 'do's and don'ts' regarding single stairs not continuing down to a basement car park.
5) Adding clarity for the users of AD B in the form of guidance on the 'do's and don'ts' regarding single stairs connecting via a lobby to an undercroft car park, single stairs being used in commercial buildings with a habitable storey at or higher than 11 m above ground level and single stairs being offered in mixed-use hotel / residential (flats) buildings.

6) Adding clarity for the users of AD B in the form of guidance on the 'do's and don'ts' regarding use of Smoke Control Association Guide, see Survey Issue 1g: *Number of escape routes, etc*.

6.2.5 Survey Issue 2e: B3 Intention and Fire resistance standard

Background – The survey highlighted a range of issues, some of which are identified here.

Driver – There is no single driver.

There was no single hot spot but there were comments around the following:

- Paragraph B3: Intention
- Paragraph 7.1: Fire resistance standard
- Paragraph 7.3: Exclusions from the provisions for elements of structure

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

<u>A selection of respondent observations included:</u>

1) *"Interpretation of which period of fire resistance to take when reading table B3 is still confusing. The respondent argues that compartment walls should have the same fire resistance as the elements of structure in tall buildings and not maintain just 60 minute fire resistance."*

BRE Global notes Part B FAQ webpage at Question 14 addresses this for an external wall and an external and loadbearing wall. BRE Global assumes AHJs would be firm and require the more onerous standard if there was doubt. See also Example 5 *Deep dive – Volumetric construction etc* (above) and how heavy massy construction is known to perform in a fire of extended duration.

1) *"Contribution of structure to the fire – noting that for taller buildings the fire resistances were originally based on total burn out. Adjacent buildings – noting that the fire resistance of a building should also consider the implications of collapse on adjacent buildings."*

See in particular Example 5 (above) and combustible construction as mentioned in Survey Issues: 1a, 1b, 1c, 1d, 1d.1, 1f, 1h, 1j.1 and 1k.

1) *"AD B states that the fire load for car parks is well defined but recent events and research has shown that this fire load has changed as both the size and manufacture of cars has changed. These rules need to be reviewed."*

This is covered in Example 3 *Deep dive – Electric vehicles and underground car parks* (above).

1) *"Introduction of compartmentation limits should be reviewed, in particular a limit should be created for office buildings. From a property/sustainability point of view these sizes of single compartment are no longer justifiable. The fire stopping detail should have fire stopping continuing from the slab edge to the external face rather than allow introduction of cavity barriers."*

See Theme 1: Issue 1: *Tall buildings, single stairs and the limits of application (scope) of AD B* (below), which considers that very tall buildings are more common than ever in London. If evidence of a growth in numbers of tall and very tall buildings in England's core cities is required, it should be possible to obtain the data in relation to building trends through separate studies. The concern is that a large fire in a very large office could be difficult to control and extinguish and a collapse, even a partial collapse could result in fire spread to adjacent buildings.

1) *"Table B4 allows […] hospitals […] which are a single storey […] to achieve 30 [minutes] REI. Margaret Law's work and following reports intended 60 minutes for burn out and therefore that should be the minimum. [It should be noted that] a secure mental health facility[y] is an occupancy where it is not desirable to discharge outside. Table B4 suggests shops on the high street would be afforded greater protection than a hospital.*

The total loss of a facility is unacceptable, particularly secure mental health facilities and these matters require more meaningful consideration.

1) *"Several respondents asked for greater clarity when considering if a roof is a floor. […] Surely, we need to protect the fire service when they enter the building and a heavy piece of plant on the roof could cause some serious damage if it were to fall on someone."*

If B5 is to be reviewed in-toto this should also be a consideration.

Implication for AD B – If further guidance was provided, it would be welcome.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Adding clarity for the users on AD B in the form of guidance on interpreting periods of fire resistance when using Tables B3 and B4?
2) Adding clarity for the users of AD B in the form of guidance on understanding fire resistance periods for tall, very tall and ultra tall buildings. The first point might be to define each category.
3) Adding clarity for the users on AD B in the form of guidance on when to require compartment floors in some office buildings.
4) Adding clarity for the users on AD B in the form of guidance on periods of fire resistance in low-rise hospitals.
5) Adding clarity for the users on AD B in the form of guidance on interpreting when a roof is a floor.

6.2.6 Survey Issue 2f: Sprinklers

Background – The survey highlighted a range of issues, some of which are identified here.

Driver – There is no single driver.

There was a hot spot at paragraph 8.14: *Sprinklers.*

<u>A selection of respondent observations included:</u>

1) *"AD B […] specifically refers to a sprinkler system, which is read as ruling out opportunities for considering alternative suppression systems, such as water mist. Alternative building guidance, such as BS 9999 has incorporated the suitability of water mist in its latest version."*

This is covered in Survey Issue 1i, above. Not knowing if water mist can be reliably specified seems to be the contentious matter.

1) *"I cannot understand why purpose group 2 have no sprinkler requirements at any height, surely with the sleeping risk there should be sprinklers at 30 m?"*

This is an extension of thinking, namely, if tighter measures are warranted for general needs dwellings, then surely the same heightened level of would be needed for institutional use and some of the other residential uses. This request would be seen to bring institutional and other residential into line with residential use on this occasion there is no other evidence.

1) *"AD-B should not discourage (e.g. clause 18.11) the installation of sprinklers in car parks. There is significant evidence of serious fires occurring in car parks. The statement that they do not pose is significate hazard is outdated."*

See Example 3 *Deep dive – Electric vehicles and underground car parks*.

1) *"Sprinklers should be required within combustible structures providing residential [institutional and other] accommodation (including in roof voids) to offer an additional layer of protection against internal fires."*

This is more of an issue now, in the mid-2020s than it was when AD B (2006 edition) was being considered. More timber frame buildings are being built, see Example 10 (above) which notes the NFCC website pointing to timber frame accounting for 60% of new builds of extra care accommodation. See also Example 5 *Deep dive into volumetric construction*. Further research, if conducted, may reveal other sectors are also using more timber frame than ever before. See also Survey Issue 1b (above) which shows clearly that planning permission for retrofit is easier if sustainable forms of construction are proposed.

1) "There is currently little/no consideration given to the firefighting techniques required for fighting fires involving modern electrically powered vehicles, in particular the large amounts of water required to control/ extinguish electrically powered vehicle fires."

See Example 3 *Deep dive – Electric vehicles and underground car parks* (above) and Example 6 which looks at issues relating to lithium-ion batteries.

Implication for AD B – If further guidance was provided, it would be welcome.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Adding clarity for the users of AD B in the form of guidance on whether water mist is an acceptable for suppression, or must it still be sprinklers.

2) Adding clarity for the users of AD B in the form of guidance on why only general needs housing requires sprinkler provision but residential institutional and residential other do not.

3) Adding clarity for the users of AD B in the form of guidance on sprinkler provision in underground car parks.

4) Adding clarity for the users of AD B in the form of guidance on combustible construction.

5) Adding clarity for the users of AD B in the form of guidance on how it is that firefighters intend tackling fires in car parks where electric vehicles are increasingly the dominant vehicle.

6.2.7 Survey Issue 2g: Construction of compartment wall or compartment floor with other walls

Background – The survey highlighted a range of issues, some of which are identified here.

Driver – There is no single driver.

There was no single hot spot but there were comments around the following:

Paragraph 8.22 and Paragraph 8.23: *Junction of compartment wall or compartment floor with other walls*

Paragraph 8.25 to 8.29: *Junction of compartment wall with roof*

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

<u>A selection of respondent observations included:</u>

1) "[can AD B clarify whether it is unacceptable to have] combustible construction for [accommodation, above an undercroft or basement car park] […] It seems inappropriate, given the amount of fuel loading."

It does not appear that there are circumstances in the mid-2020s that make this a more 'complex' issue to resolve, than was the case in the early 2000s. The question seems to be whether paragraph 11.2 e. clearly signals the need for the separation to be a horizontal concrete slab or equivalent construction comprising just A1 materials? Should such a slab project just past the building line to create the separated part and prevent fire from rising above via the external façade?

1) *"What [are the requirements for treatment of a slab edge] in relation to a curtain wall, which is typically not fire resisting? If a fire stop interfaces with a spandrel, should the fire stop be to the back of the spandrel or to the back of the outer face material of the spandrel?"*

2) *"Clarification (and diagrams) [are] required to illustrate […] the extent of [detailing… if any] when the external wall does not have any fire resistance performance (e.g. an aluminium curtain wall – see clause 8.23)."*

3) *"Should AD B make clear whether the risk [of fire spread occurring at slab edge, could] be completely mitigated with the provision of a sprinkler system or, [should fire rated spandrel panels be provided] for a specified height in front of the floor slab?"*

See also Survey Issue 1l (above).

6) *"AD B Volume 2 should not discourage the installation of sprinklers in car parks, see paragraph 18.11. There is significant evidence of serious fires occurring in car parks. The statement that they do not pose is significate hazard is outdated."*

See Example 3 *Deep dive – Electric vehicles and underground car parks (above).*

1) *"Sprinklers should be required within combustible structures providing residential [institutional and other] accommodation (including in roof voids) to offer an additional layer of protection against internal fires."*

2) *"[…] what is […] the "roof covering" […] in relation to composite insulated panels? Manufacturers of composite insulted panels usually have certification to the LPCB requirements but not those detailed in AD B. this causes confusion as to what is acceptable".*

3) *"Clearer defined terminology for what is meant by deck and roof covering should be considered. It may help to split this by application type and have distinct guidance for flat roofs and pitched roofs and how to deal with this junction."*

See also Examples 7 and 9 (above).

1) *"It would help to distinguish between thermoplastics and thermosetting insulations for [roof constructions]. […] Our understanding would be that thermosetting materials as part of a system that meets the Broof (t4) criteria could be taken over this junction provided the deck/substrate for the roof covering is bedded in mortar."*

Implication for AD B – If further guidance was provided, it would be welcome.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Adding clarity for the users of AD B in the form of guidance on whether combustible construction is suitable on the storey immediately above a car park.

2) Adding clarity for the users of AD B in the form of guidance on the requirements of paragraph 11.2 e. A diagram may be a good way to depict the separated part between undercroft or basement car park and the accommodation above and whether the first storey above the car park should be constructed from non-combustible materials?

3) Adding clarity for the users of AD B in the form of guidance on treatment of slab edges where curtain walls pass.

4) Adding clarity for the users of AD B in the form of guidance on sprinklers in car parks.

5) Adding clarity for the users of AD B in the form of guidance on sprinkler provision in roof voids above combustible construction serving residential (institutional) and (other).

6) Adding clarity for the users of AD B in the form of guidance on terminology for what is meant by deck and roof covering. Diagrams may be a good way to depict this.

7) Adding clarity for the users of AD B in the form of guidance distinguishing between thermoplastic and thermoset insulation for roof constructions.

6.2.8 Survey Issue 2h: Cavities

Background – The survey highlighted a range of issues, some of which are identified here.

Driver – There is no single driver.

There were comments around paragraph 9.1: *Cavities*

The first hot spot location occurred at paragraph 9.2: *Provision of cavity barriers.*

The second hot spot location occurred at paragraph 9.3: *Pathways around fire-separating elements-Junctions and cavity closures.*

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)'*.

This Survey Issue attracted the highest number of comments in Part B3. The points raised have already been discussed either in the main text, worked Examples or Survey Issue 1 (above).

A selection of respondent observations included in abridged form:

1. *"Curtain walling passing compartmentation lines […] definition of an opening in a curtain wall compared to a punch opening window in a solid wall. Limited availability of suitable materials forming a flexible robust weather seal at interfaces with other forms of construction."*
2. *"AD B [considers] that cladding is classed as non-loadbearing [See also title of BS 8414-1 or -2] yet the section on cavities talks about protection of cavities either between two skins of masonry or in loadbearing elements. On non-loadbearing cladding it is unclear if this is a cavity or a barrier is simply required as part of a 'concealed space'."*
3. *"The guidance on cavity barriers doesn't reflect [rainscreen and insulated render] technolog[ies]. The cavity for rainscreen is typically 50 mm upwards, open at top and bottom and also cladding joints and is immediately behind the cladding panel. Insulated render systems have a cavity between 15 and 25 mm and […] the cavity is […] open for […] free drainage only."*
4. *"Diagram 9.1 is confusing in respect of external walls. Its intent is clear in differentiating between locations of cavity barriers and fire stopping but creates confusion as the hybrid cavity wall/curtain wall interface cannot exist. A better way of illustrating this would be to indicate 4 typical conditions: 1) masonry cavity wall + backing wall on slab, 2) curtain wall running past slab 3) open rainscreen + backing wall on slab and 4) precast concrete panel outer leaf with only dry lining to inside (therefore needs fire stopping between the slab edge and the precast)."*
5. *"A cavity is defined as 'any concealed space'. Is this definition appropriate? Should the word 'cavity' be replaced with 'extensive cavity' and then be defined? Do the voids in mullions and transom constitute cavities? Cavities in one form or another exist everywhere."*
6. *"How large does a cavity need to be to require closing?"*
7. *"Is laminated glass permitted in spandrel areas of office buildings?"*

8. *“Is paragraph 12.16 [relevant] for non-relevant buildings?”*
9. *“[Paragraph] 9.13 requires E30 and I15 but then 9.14 gives examples of suitable materials for cavity barriers where arguably the I requirement is waived. Also is Timber still an option?”*
10. *“[AD B could provide guidance on] cavity barriers and fire stops and the difference and scope for use of each in facades. Please also clarify any underlying assumptions made on the fire resistance of the spandrel areas. […] the fire resistance of the curtain walling spandrel is not clearly defined/known.”*
11. *“[should] all penetrations through external walls and roofs should be fire sleeved […] irrespective of whether the element is fire-rated. Where such cavities are fully filled with non-combustible materials (Euroclass A2-s1, d0 or better), the cavity barrier function should be identified as having been met by the non-combustible full-fill material.”*
12. *“We recommend ADB should also stipulate that penetrations through internal walls and floors with combustible insulation cores be fire-stopped.”*
13. *“Penetrations typically include ducts, grills, pipes, cables and rooflights.”*
14. *“We are concerned that existing fire test standards do not adequately reflect the way many modern buildings are constructed, notably but not limited to, buildings constructed using MMC. [Tests including] EN 1366-4 for linear fire stops, EN 1363-1 for open state cavity barriers and CEN/TS 1187 (together with classification standard EN 13501-5) for roof coverings [all] fall unacceptably short of determining whether the systems tested will perform adequately in real-life.”*
15. *“The above tests for linear gap seals/cavity barriers [only] reflect constructions where a cavity […] is bounded by rigid, non-combustible elements comprising concrete blocks.”*
16. *“It might be appropriate to include [the ASFP test method for open state cavity barriers, Technical Guidance Document 19] in AD B.”*
17. *“Further guidance would be useful with respect to situations whereby following the prescriptive guidance would require multiple cavity barriers in close proximity. The prescriptive guidance would recommend a CB at the window head, compartment floor and window cill which could all be within 500 mm of each other. Is this necessary?”*
18. *“Cavity barriers 9.14 gives examples of cavity barrier construction and then states that "These do not necessarily achieve the performance specified in paragraph 9.13. " This is flawed, why give materials that don't give the desired performance?”*
19. *“Diagram 9.2 note 1 states: "used to close the cavity in this arrangement do not need to achieve a specific performance in relation to fire resistance.”*
20. “[Diagram 9.2 at] Note 3 [states] "Materials achieving class B-s3, d2 or worse may be placed within the cavity. " [surely this] should be a non-combustible insulation and that there is still a fire rated closer for safety. This would have minimum impact from a cost benefit analysis perspective.”

21. “Application of cavity barriers into cavities that are not adjacent to the facade, but for example on the edge of external balconies. […] These cavities are not directly in contact with the facade.”

22. “The fire requirement is unclear for adhesives (for example for sandwich panels), coatings, use of laminated glass in balustrades (because this is allowed in vision barrier glazing) and thermal breaks (what can be considered as thermal breaks?)”

Challenging each of these observations to the test, “what is different in the mid-2020s to when AD B (2006 edition) was being considered”, is not needed for *Cavities*. The overwhelming number of observations shows practitioners have a problem. They are trying to resolve real technical issues that have either crept in over time or that they have had workarounds for, in operation for too long.

Implication for AD B – The issues surrounding cavity barriers in the mid-2020s have become very complex and now warrant a re-consideration. In BRE Global’s experience of conducting post-fire inspections, under the Investigation of Real Fires contract (see section 3.4.7 (above)) it was usually cavity barriers, more than any other detail, which was the focus of a large part of each fire investigation. These cavity barriers were frequently missing, incorrectly installed, damaged, or inherently defective and thus it was not surprising that fire and smoke spread unseen in cavities.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Considering the outcomes of Survey Issue 1h above.

6.2.9 Survey Issue 2h.1: Cavities – Construction and fixings for cavity barriers

Background – The survey highlighted a range of issues, some of which are identified here.

Driver – There is no single driver.

There was no single hot spot but there were comments around the following:

Paragraphs 9.13 to 9.16: *Construction and fixings for cavity barriers*

Paragraph 9.17: *Openings in cavity barriers*

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *‘practitioner viewpoint(s)*’.

Half of the points made in Survey Issue 2h were reiterated in relation to construction and fixings for cavity barriers and openings in cavity barriers.

<u>Additional points included:</u>

1. *"For elements of construction prefabricated offsite, fire test methods might need to be further developed to take account of any structural movement affecting fire safety-critical components during transit and subsequent assembly. Alternatively, ADB might either include guidance on the provision of enhanced on-site inspection for pre-installed safety-critical components or require such components to be installed on-site."*
2. *"The interpretation of cavity barriers around openings with 38 mm timber, 0.5 mm steel etc. that may not meet 30/15 fire resistance has always been confusing. Prescribed materials can be used as cavity barriers in a stud wall, partition or around an opening. It is recognised that these materials do not necessarily achieve the normal performance required of cavity barriers."*
3. *"Clause 9.17 is too prescriptive on limits for acceptable cavity barrier openings. In practice it is almost impossible to avoid penetrating cavity barriers with masonry support shelf angle brackets, balcony brackets etc. These must be considered if listing limitations."*

These points and those made in Survey Issue 2h can be read together. The overwhelming number of observations shows practitioners have a problem. They are trying to resolve real technical issues that have either crept in over time or that they have had workarounds for, in operation for too long.

Implication for AD B – The issues surrounding cavity barriers in the mid-2020s have become very complex and now warrant a re-consideration. In BRE Global's experience of conducting post-fire inspections under the Investigation of Real Fires contract (see section 3.4.7 (above)), it was usually cavity barriers, more than any other detail, which was the focus of a large part of each fire investigation. These cavity barriers were frequently missing, incorrectly installed, damaged, or inherently defective and thus it was not surprising that fire and smoke spread unseen in cavities.

The challenge arising from this Survey Issue suggests AD B could look at:

1. Considering the future direction suggestions for Survey Issue 1h (above).

6.2.10 Survey Issue 2i: Special provisions for car parks

Background – The survey highlighted a range of issues, some of which are identified here.

Driver – There is no single driver.

There was a hot spot location at paragraph 11.1: *Special provisions for car parks.*

There were comments around the following:

- Paragraph 11.2: Open-sided car parks - Natural *ventilation*
- Paragraph 11.5: *Mechanical ventilation*

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

A selection of respondent observations included:

1) *"The requirements have hardly changed since the first issue of the approved document.*

   Natural ventilation

   Why 1/40th of the nett floor area?

   What evidence […]?

   Why is the same proportion of floor area, i.e., 1/20th required for a naturally ventilated car park irrespective of size, [whether] 500 m2 or 5,000 m2?

   The surrounding environment, [could have] an adverse impact on the performance of a naturally ventilated car park. [should modelling be carried out on a case-by-case basis]?

   Mechanical ventilation

   Why […] 10 air changes per hour (A/C/H) for mechanical ventilation, irrespective of car park size? What evidence is there to support this requirement?

   A few years ago, BRE undertook a MHCLG (DCLG at the time) sponsored research and test program into the fire loads of modern vehicles. The tests […] identified the extreme temperatures produced by vehicle fires and the potential for fire spread to other vehicles, even across a vacant parking bay. These tests, in my view, demonstrated that the fire load IS NOT well defined as suggested in the approved document. There is a potential for fire to spread rapidly throughout a car park if not controlled by ventilation or sprinklers.

   Electric Vehicles

   The new generation of electrically powered vehicles will bring new fire hazards with them, especially with the risk of thermal runaway, re-ignition and the potential for the emission of toxic gases in the event of fire.

   Research by RISE

   A great deal of research into the hazard of electrically powered vehicle battery fires has been undertaken in Sweden [which should be referenced], to determine what, if any, further UK research should be undertaken. The rush into an all-electric vehicle UK without greater practical investigation could bring with it as yet unidentified hazards."

2) *"Lack of guidance/consideration of modern vehicle technology in car parks. Particularly electric car charging areas and the fire protection around these areas (e.g. cabling to transformer rooms). The […] risk/fire load is expected to be greater than the typical 2kW car fire."*

3) *"Additional consideration could be given to fire resistance of car park floors and [construction of stack pipes (plastic vs cast iron) serving drainage channels] […] [see] the King's Dock fire."*

4) *"There is currently little/no consideration given to the firefighting techniques required for fighting fires involving modern electrically powered vehicles, in particular the large amounts of water required to control/ extinguish electrically powered vehicle fires."*

5) *"[can AD B clarify whether it is unacceptable to have] combustible construction for [accommodation, above an undercroft or basement car park] […] It seems inappropriate, given the amount of fuel loading."*

   "[Can paragraph 11.2 e. in AD B clarify the need for the separation between an undercroft or basement car park and accommodation above to be a horizontal concrete slab or equivalent construction comprising just A1 materials and no a form of construction that is reliant on plasterboard protection?]"

6) *"[…] Could there be a section on greater FR or sprinklers for car parks? Also, a reference to [car] stack[ers] [frequently encountered in private inner city] car parks."*

7) *"The Merseyside Fire and Rescue Service's report into the Kings Dock Car Park fire suggested a number of areas that could be improved in terms of fire safety in car parks, one of which was the design period of structural fire resistance, […] being 15 minutes."*

8) *"Car parks are unique [not simple rectilinear shapes on plan]. [perhaps a diagram of do's and don'ts when it comes to distribution of ventilation is need."*

9) *"Computational fluid dynamic modelling (CFD) is used to justify air flow equivalency.*

   "There is a misunderstanding that the objective under B3 and B5 is for 'post fire venting'. The CFD modellers need to demonstrate that there is […] during-fire-venting, with good distribution of air flow and without stagnant zones."

   "[…] recognition [in AD B of the role] of jet fans and the criteria for their design would be useful."

   "A very clear statement [is needed in AD B that] the venting under B3 and B5 is for during-fire-venting to assist in preventing fire spread under B3 and firefighting access under B5 [and not just] post fire venting as the building regulations."

10) *"A/C/H not based on evidence.*

   When a FRS attend a fire they should be able to establish seat of the fire. Insufficient A/C/H [will fail to] lift [the] smoke layer [unless the car park is] very large. Historically I believe it was regarded that if the car park is over 3000 m^2 – 10 air changes is suitable (former GLC section 20 standard). [Any] smaller and smoke will completely fill the space. Of course, car fires have changed since this principle.

   Ultimately there should be a size under which 10 air changes should not be used as generic design."

11) *“[…] The guidance is based on outdated empirical data of car park fires, such as might have occurred in the latter part of the 20th century. With the increased use of plastics in car design/manufacture and the advent of EVs and rechargeable batteries, the likelihood of hotter and longer duration fires and car fire spread is much greater.”*

    “Better guidance on the location of basement Car park extract points is necessary as there have been instances of vents being located directly beneath occupied floors and their fenestration. This has led to concern about Car park fires exhausting smoke out and then back into upper floor level compartments. [Should the external wall of accommodation above a car park be comprised of A1 and A2-s1,d0 materials.]”

These points are discussed in Example 3 (above), Survey Issue 1j.2 (above) and Theme 1 Issue 3 (below).

Implication for AD B – The issues surrounding car park fires and the effect of lithium-ion batteries and firefighter safety all need to be considered in the round.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Considering research into car park fires off the back of earlier research by BRE Fire spread in car parks BD 2552 (2010) [308] and Fire protection of basements and basement car parks BD 2887 [309] the future direction suggestions for Survey Issue 1h (above).

2) The suggestions made in Example 3 (above) including detailed work on ventilation of basement fires.

6.2.11 Survey Issue 2j.1: B4 resisting fire spread over external walls

Background – The survey highlighted a range of issues, some of which are identified here.

Driver – There is no single driver.

There were comments on paragraph 12.5: *External surfaces*

There was a hot spot location at paragraph 12.6: *Materials and products*

There were comments on paragraph 12.7: M*aterials and products*

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *‘practitioner viewpoint(s)*’.

<u>A selection of respondent observations included:</u>

1) *“No requirement is stated for [residential buildings with a habitable storey at just under 11.0 m above ground and] non-residential buildings [with a habitable storey at just under 18.0 m above ground] when they are located more than one metre from [a] relevant boundary. [However], the building regulations states "the external walls of the building shall [adequately] resist the spread of flame.”*

BRE Global noted that another respondent said *“[the No provisions commentary results in a dangerous lack of safety for low-rise buildings]”.*

BRE Global notes that several respondents made similar points here. The external surfaces and end use arrangements of materials on such buildings may achieve as poor a European classification to BS EN 13501-1 as E or F. Accordingly, a fire spreading over such surfaces could affect internal stairs and quickly render external escape stairs impassible very quickly. See section 3.4.7: *Investigation of real fires* (above) and Survey Issue 1l: *External surfaces, materials etc* for more information on this.

1) *"What is meant by 'external surface'?"*

2) *"Section 12 is unclear [as it contains the same section] that is found in AD B Volume 1. Can it be made clear the guidance only applies to residential (institutional) and residential (other)."*

3) *"Some clear and unequivocal consensus on what constitutes a seal, and a membrane would be useful."*

4) *"Insulated Render systems [formerly relied on] tested and classified […] 'kit' under EN 13501-1 and also it's defining test standard EAD 040083-00-0404* [310] *(replacing ETAG 004). This is causing questions every day on the performance of the system as clients / architects / consultants are not recognising kit testing and ask for all components to be A1 or A2."*

If the standard is not acceptable to AD B then a paragraph clarifying the position is required.

1) *"[Large-scale testing is required] since placing reliance on just reaction-to-fire performance of products [and systems] at bench scale testing may not provide the desired means of ensuring fire safety."*

See also Example 5 *Deep dive – Volumetric construction etc* (above).

1) *"It is [not] practical to construct a building entirely class A1 or A2 products [and systems]. [Accordingly,] we would advocate that all wall structures […] should be subjected to the large-scale BS 8414 tests."*

2) *"BS 8414 provides a method of 'considering' [cavity barrier performance] in rainscreen cladding systems which isn't possible under the current [cavity barrier] testing regime [between lintels]."*

3) *"Under AD B [a] spandrel in Residential (institutional) or Residential (other) must comply with regulation 7(2) [but] the window frame which it is glazed into is exempt. […]. [If laminated glass is unacceptable], toughened glass may be used. Toughened glass [on breaking may] fall in clumps [onto firefighters below]."*

4) *"Laminated glass cannot be used in balustrades. […] The risk [of falling as a result of] a failure with a toughened glass balustrade is higher with greater potential risk to life as a result."*

Points 9) and 10) are discussed in section 3.4.6 *Balconies, spandrels and* glazing (above).

1) *"Is the Building Control Alliance's Technical Guidance Note (TGN) 18* [311] *accepted or rejected?"*

If the Technical Guidance Note is not acceptable to AD B then a comment clarifying the position is required.

1) *"Better guidance would be welcome on the [dos and don'ts regarding] Green Walls. The current guidance document: 'Fire performance of Green Roofs and Walls' [is not at a level to be used as technical guidance]. With the increase in sustainable construction, living walls are likely to become very popular."*

Many of the points have been clarified by revisions to Regulations 7(2) and 7(4). Also, there was a review of how the ban on combustibles was settling in. Accordingly, for the purpose of this report, these points are acknowledged and retained as 'markers'.

Implication for AD B – The issues surrounding External surfaces have largely been discussed in various locations above.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Issues covered in section 3.4.6 *Balconies, Spandrels and glazing* (above).
2) Issues covered in section 3.4.7 *Investigation of real fires* (above).
3) Example 5 *Deep dive – Volumetric construction, etc* (above).
4) Survey Issue 1l: *External surfaces*, etc (above).

6.2.12 Survey Issue 2j.2: Regulation 7(2) and requirement B4

Background – The survey highlighted a range of issues, some of which are identified here.

Driver – There is no single driver.

There were comments on paragraph 12.11 to 12.13: *Materials*

There was a hot spot location at paragraph 12.16: *Additional considerations*

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

<u>A selection of respondent observations included:</u>

1) *"Serious concerns have been expressed by the Grenfell Expert Panel and others about persisting shortfalls in design competence and workmanship in the construction of buildings; and the ability of the construction and property industries to effectively manage the risks in buildings once they are occupied. Evidence from recent fires and from industry unfortunately continues to support these concerns."*

If AD B accepts these persisting shortfalls, these management issues and the construction industry's inability to effectively manage risks, these would be grounds for building-in wider margins of safety. AD B might wish to make clear that when following the linear route (i.e. the paragraphs in AD B) that paragraphs are not to be subject to massaging down by fire science essays. Where a full bona fide, fire engineered solution is adopted, that would be a different matter.

1) *"Investigations into building safety post-Grenfell have consistently highlighted issues with poorly installed or even missing cavity barriers."*

2) *"Reg 7(2) and the ongoing discussion on membranes [used as part of the external wall]. [Membrane is not defined in the regulations. Because membrane*

is only expanded upon in the AD B guidance (which is optional) gives rise to a varied picture of compliance across England.]"

3) *"Table [12.1] [now] allows for combustible outer walls for any building not considered a relevant building. This means a hospital under [11 m] with external walls at least 1.0 m from a relevant boundary could be wrapped in combustible material. This is flawed and does not support, defend in place, stay put or progressive horizontal evacuation. The walls should achieve A2-s1, d0 or class A1 irrespective of height."*

4) *"There is a wide body of opinion in the industry which supports the principle that if a membrane is no wider than 250 mm (e.g. for window perimeter sealing applications), there is no need for this classification, hence generic EPDM membranes (Class E) can be used in such locations."*

See section 6.1.14 Survey Issue 1l: *External surfaces, materials etc* (above). AD B may accept Class E material for some buildings and consider restricting the FIGRA and the SMOGRA indices and THR derived from the SBI test and based on the associated EN13501-1 classification. Applying a blanket decision that class E membranes are acceptable can only be adopted if extensive comparative research shows it to be safe. See also *the Government response: review of the ban on the use of combustible materials in and on the external walls of building* [312] (updated June 2022). Note that this post-dates the survey.

1) "There is widespread acceptance that 'seals' such as narrow membranes or self-adhesive tapes will be exempt up to a width of 150 mm, thus covering typical sheathing board joint seals (to themselves and the structure)."

It would be helpful if AD B either agreed or disagreed with this and did not remain silent on the matter. See also the Government response[Ibid].

1) *"We need a test for curtain walling akin to BS 8414 [and guidance in AD B]."*

2) *"[Could a timber framed] curtain wall be exempt from the Regulation 7(2) requirements?"*

3) *"Having to terminate thermal breaks such as in curtain walling across compartment lines seems disproportionately unnecessary."*

4) *"Regulation 7(3) continues to [result in discussion] over very minor components not relevant to the spread of fire. Would a threshold of the volume of combustible material per unit area of façade suffice?"*

5) *"We cannot find products or design details that deal adequately with the protection of vents that lead into/through external wall cavities, or the transit of rainwater pipes through cavity barriers."*

6) *"There is still confusion on design of parapet upstands."*

See also the Government response[Ibid]

1) *"What is the approach for anti-drumming and material separation membranes. There aren't materials on the market with the same acoustic/durability characteristics that can achieve class A2."*

2) *"The main issue is that no test methods nor acceptability criteria are available for assessing the real fire behaviour at scale."*

3) *"It would be useful to have the BS 8414 test method re-adapted for curtain wall constructions (or a new test method) in a way that it could be used for assessing either the resistance to the fire spread (requirement B4) and the real necessity of providing cavity barriers at level of the compartment floors (requirement B3)."*

Many of the points have been raised under Survey Issue 2j.1: *B4 resisting fire spread over external walls* (above). See also the Government response[Ibid]. Accordingly, for the purpose of this report, these points are acknowledged and retained as 'markers'.

Implication for AD B – The issues surrounding External surfaces have largely been discussed in various locations above.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Issues covered in section 3.4.6 *Balconies, Spandrels and glazing* (above).
2) Issues covered in section 3.4.7 *Investigation of real fires* (above).
3) Example 5 *Deep dive – Volumetric construction, etc.* (above).
4) Survey Issue 1l: *External surfaces, etc*. (above).

6.2.13 Survey Issue 2k: Access and facilities for the fire service

Background – The survey highlighted a range of issues which applied equally to Volume 1 and Volume 2.

Driver – There is no single driver.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

The observations made in Volume 1 apply equally here.

<u>A selection of respondent observations included:</u>

1) *"There has been a case in a building where a fire main inlet complied with the '18 m rule', but access for firefighting personnel into the protected stair was at a distance of over 100 m from the fire appliance."*

This suggests B5 needs review and firmer language may be needed.

1) *"Guidance [is required] […] for basement car parks. [This should be reviewed] in the light of the recent […] car fires. Mechanical smoke ventilation is never designed to cope with heat sustained in these environments and consideration should be given to automatic suppression systems to reduce fire size and fire growth."*

2) *"[Our experience is that designers are] becoming determined to find an alternative [to AD B's B5 guidance] no matter […] the cost."*

3) *"Smoke shafts are the most commonly used solution for the protection of common escape routes in residential high-rise apartment buildings. […] The current lack of*

guidance can lead to short-cutting or misunderstanding with some installers using non-CE / certified products, which for a life safety system in a high-rise building is not acceptable."

4) *"AD B allows the use of Fire Doors opening into a smoke shaft as a solution for allowing smoke to escape into the Smoke Shaft. If a smoke and fire damper is utilised, this would need to be tested and certified to EN12101-8. The Door and Actuator have not been tested together and do not meet the requirements of EN12101-8. This is an area that is being misused by some Contractors and Installers. if a Door and Actuator are utilised together the complete assembly must be tested to EN12101-8: 2011 as a Fire and Smoke Damper would be."*

5) *"One Fire and Rescue Service described receiving an application where the walls of the firefighting shaft were proposed to be CLT."*

This suggests B5 needs review and firmer language may be needed.

1) *"I believe that all firefighting shafts should explicitly be required to be of non-combustible construction, thereby not relying on plasterboard to achieve the required fire resistance. This should include the head of stair ceiling."*

2) *"Greater consideration [should be given to the] installation of sprinklers [in] car parks. [Make it explicit for the users of Volume 1 that, for guidance on undercroft or basement car parks beneath dwellings, the user should revert to Volume 2]."*

3) *"[…] The guidance on car parks needs changing to incorporate Jet fans and consideration of the benefit of sprinklers. [Consider fire safety in car parks] holistically."*

4) *"Widened stair landings to enable firefighters to evacuate persons while kept as horizontal as possible in a stretcher, as a high angle and confined space evacuation would increase the risk to the person."*

5) *"Widened stair widths, would ensure ambulant/wheelchair bound persons can escape (or be evacuated) safely via the stairs in the event that the firefighting lift may not work."*

BRE Global notes Paragraph 6.5: Objective 3 – *Resilience of lift provision* in the NFCC report *Provision of multiple routes for evacuation of residential buildings – Opinion Paper 12th February 2024* which states:

> *"The provision of lifts within the design of the building should also be sufficient that an out of service lift does not mean that occupants have to seek out the alternative lift as their only other means of escape. Lift cores should be designed with a suitable level of redundancy to ensure that, where one lift is out of service, there is still sufficient provision for **both evacuation and firefighting**." [BRE Global's emphasis **in bold**].*

1) *"Voice alarm systems, or evacuation alert sounders under BS 8629:2019+A1:2023?"*

BRE Global notes another respondent's view that rather than a bleep, or tone (to signify actions i.e. 'get ready / be aware' or 'evacuate now') occupants of a building e.g. residential (institutional) or residential (other) would welcome FRS's audible 'interventions' to advise, reassure, calm and instruct them on when and by which route they should make their escape, e.g. "…Use staircase 2 and evacuate the building immediately…"]

However, BRE Global notes the paragraph 10.1.1: Audible evacuation alert devices from BS 8629: 2019+A1: 2023, which states:

> *“It is not recommended that voice messages, rather than audible alert tones, be used, because it is not always appropriate to give a definitive verbal instruction to evacuate (e.g. it might be inappropriate for residents to evacuate if the common parts are untenable for escape).”*

If there is merit in the evacuation alert being able to be ‘switched over’, to transmit voice instructions, then BS 8629: 2019 +A1: 2023 would need amending first.

The responsible person should be required to undertake monthly checks and report on the system’s status, faults and rectification of faults, in much the same way as they are required to undertake monthly checks of lifts and notify the local FRS under The Fire Safety (England) Regulations 2022 No. 547 [240].

1) *Power supplies to fire and life safety equipment is usually problematic - the standards (such as BS 8519) are not well understood. Robust (dual) power supplies for the fire-fighting equipment in tall residential buildings is arguably far more important than for others, because we know (unlike offices and commercial) they will remain in occupation if power fails (where else do the occupants have to go)? This should be picked up by the guidance."*

Implication for AD B – The majority of these 13 observations have merit and require consideration and response. It has not been possible to quantify the scale of decline or worsening of provision that we see in the mid-2020s, for each of these 13 observations when comparing the scale of compliance with the provision when AD B (2006 edition) was being considered. It may be possible to research each item to try to evidence the ‘degradation’ in the scale of compliance from early-2000s to mid-2020s.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Conducting a review of the B5 provisions with view to providing updated guidance paragraphs from the Introduction section and Section 15: *Vehicle access* through to Section 18*: Venting of heat and smoke from basements*.

2) Whether in addition to updating guidance paragraphs, some paragraphs need to be omitted or new paragraphs provided.

6.2.14 Regulation 38: Fire safety information

Background – The survey

Driver – There is no single driver.

The comments under Volume 2 are virtually the same as Volume 1.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *‘practitioner viewpoint(s)*’.

Implication for AD B – The changes made in 2023 were intended to give the Regulation ‘teeth’. This has not materialised.

The challenge arising from this Survey Issue suggests AD B could look at:

1) Conducting a review of Regulation 38 and the guidance in AD B relating to it.

2) The time it will take for the AHJ to 'discharge' Regulation 38 information and the resource they would need, to carry this additional work into effect.

3) The ability of the AHJ to prevent handover and completion from taking place until satisfied the Regulation 38 information is up to the right standard and that the responsible person accepts the information.

6.2.15 Appendix B: Performance of materials, products and structures

Background – The survey

Driver – There is no single driver.

There was a hot spot at Appendix B.

The comments under Volume 2 are virtually the same as Volume 1.

Evidence – There is no direct evidence available, as this point is respondent-driven i.e. it is derived from *'practitioner viewpoint(s)*'.

Implication for AD B – The appendices are important for the educative text and the rules of thumb (that used to reside in tables like Table A5 and Table A8).

The challenge arising from this Survey Issue suggests AD B could look at:

1) Conducting a review of the content of Appendices in the AD B (2006 edition with 2019 amendments) and comparing the text in those appendices with the text in the present AD B (2019 edition including 2022 and 2024 amendments).

6.3 Arising from the workshop sessions for the 14 themes

6.3.1 Theme 1: Issue 1: Tall buildings, single stairs and the limits of application (scope) of AD B

Background – In January 2022, developers withdrew a planning application for a 51-storey single-stair residential tower [313] in Canary Wharf as it became clear that local planning officials at Tower Hamlets Council and officers in the London Fire Brigade were of the same mind that such a tall building should not have only one staircase. In August 2022, later that year, DLUHC, having taken advice on single stair provisions in very tall residential buildings from the Building Regulations Advisory Committee (BRAC), issued guidance on the limits of application (scope) of AD B [267]. The guidance made it clear that such tall buildings appeared to be:

> *'…being designed on the incorrect premise that the guidance [in AD B] is suitable for these types of uncommon building situations'.*

The circular document did not set a threshold for height, above which AD B should not be considered, see also Survey Issue 1a (above) raising near identical theme(s) on scope.

Driver – The drivers behind tall buildings with single stairs as city living, with the need to achieve housing targets on brownfield sites, inner city regeneration and lastly to achieve profitability maximise height and minimise unrented areas and creation of landmark buildings.

Evidence – Data for tall buildings in London can suggest what might be happening or about to happen in other cities with regards to the prevalence of high-rise buildings [314][27]. New London Architecture (NLA), in its annual London Tall Buildings Survey 2021 [315] made the following statements:

> *"…The total pipeline of tall buildings [those having 20 or more storeys] in various stages of planning process across London at the end of 2020 now stands at 587, up 7.9% from 2019…"*
>
> *And*
>
> *"When looking at the overall pipeline, it is clear that residential remains the primary driver of tall buildings in London, accounting for 89.7% of the total pipeline. It is estimated that approximately 92,000 new homes could be provided by this pipeline, which is just shy of two years supply of the housing need for London based on the new London Plan requirements of some 52,000 dwellings per annum."*

[27]See also Highrise articles available on the internet concerning the built environment in Greater Manchester.

When NLA began to publish data on tall buildings (from 2014), the 60 m-tall (20-storey) tower block was selected [316] as:

> *"that was the approximate height of most council-built towers and, thus, a recognisable benchmark for the general public"*

The data in the 2024 survey shows this had risen since 2014 to 78 m-tall or (26 storeys), see Figure 30.

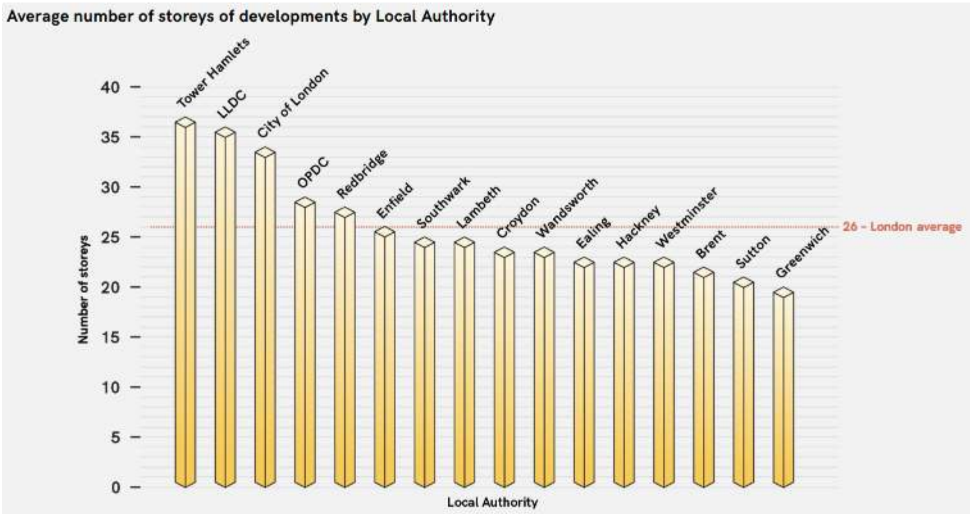


Figure 30 – Average number of storeys of developments by Local Authority (London)
Source: New London Architecture: Tall Buildings Survey 2023: Sustainable Skylines[Ibid]

It is clear that residential blocks (in London) are taller in the mid-2020s than they were in 2006.

The 2021 survey showed that 25 local authorities had one or more tall buildings (i.e. 20 or more storeys) under consideration at varying stages of the planning process. The NLA survey showed that 30 of the 32 authorities have what are called 'opportunity areas,' earmarked in Local Plans, for such taller buildings. The 2021 survey showed that 380 of the 587 buildings were up to 29 storeys, 140 buildings were between 30 and 39 storeys and 64 buildings were more than 40 storeys. It was not established how many buildings were of the order of 50 storeys or more. Lastly, the 2022 building survey showed that the number of planning permissions granted in 2022 was 26% higher than the number granted in 2020, implying a sustained direction of travel.

For residential schemes with a 'material' height consideration (typically those with a fourth floor or more above the ground storey), part B would be substantiated by a fire strategy, which would be submitted to the AHJ for regulatory approval. BRE Global's experience, very few schemes at five storeys or above follow the process anticipated by BS 7974 *Fire safety engineering in buildings* and its supporting published documents (PDs).

The evidence that tall single stair residential buildings are prevalent can be seen in every city; in 2020, in Greater Manchester, a new 60-storey single-stair tower was completed and occupied [317]. See also the media coverage regarding high-rise buildings in other core cities e.g. Liverpool [318]. Until March 2024, it was evident that there was a 'tension' between custom and practice and the guidance intended by the issue of the August 2022 circular.

In 2024, amendments to AD B were published, which made clear that subject to transitional provisions:

> *"Flats should be served by more than one common stair if either of the following applies:*
>
> *a. The flat is on a storey that does not meet the criteria for a single escape route or a small single stair building (see paragraphs 3.27 and 3.32).*
>
> *b. The building has a top storey of 18 m or more in height (see Diagram D6 in Appendix D)."*

It is reasonably foreseeable that there will be a flurry of construction activity to demonstrate projects are *"sufficiently progressed"* by 31st March 2028, in order to continue to use AD B (2019 edition including 2022 amendments). It will probably take until circa 2030 for the transitional provisions to work through and result in the majority of tall residential buildings under design or being commenced on site to be following the 'new' guidance. This is a very long lead in period.

There are now two discrepancies, certainly in London:

1) The guidance of the London Plan (introduced in February 2023) requires a second stair based on a building's height (not storey height) at 30 m. Whether this changes to 18 m waits to be seen.

2) The London Plan does not require a second stair where the travel distances exceed the guidance in AD B for single direction of travel or for small single stair buildings.

It should be noted that the Building Safety Act 28th April 2022 defines higher-risk buildings as those at least 18 m in height or those which have at least seven storeys.

The current AD B (2019 edition including 2022 amendments) is silent on the need for two stairs, in a residential tower, at any storey height, but this does not mean AD B (2019 edition as amended) 'allows' a single stair or 'accepts' that a single stair is acceptable. Also, where AD B is silent on what should happen if a single direction of travel exceeds 7.5 m does not mean AD B is endorsing designs with travel distances in excess of this.

Lastly, the fire safety provisions in the USA could be one point of study, discussion and consideration on the possible future direction of a revised AD B (or other 'approved' – alternative approach). One recently completed tower block in Manhattan, New York, the Steinway Tower (the coffee stirrer building) [319] is 400 m tall and only 20 m by 20 m on plan. BRE Global notes the Steinway Tower has a single core, a scissor stair(s) formed from concrete in a concrete shaft and individual apartments have access to both stairs accessed from different parts of the same flat. The protected lobby in this example provides access to more than one stair. The AD B 2024 amendments make clear that in England this arrangement would be unsatisfactory.

Implication for AD B – Industry would welcome nationally applied guidance in either a revised document or another approved document for high-rise and ultra-high-rise buildings, in the interim, prior to AD B (2029 edition (as amended 2020, 2022 and 2024)) coming into effect 30th September 2026 or 31st March 2028 (under transitional provisions).

The challenge arising from Theme 1 Issue 1 suggests AD B could look at:

1) Adding clarity for the users on AD B in the form of alternative approach guidance for paragraphs 3.30a. and 3.30b. of AD B (2019 edition including 2024 amendments) where the residential building has a single stair with extended travel in corridors (i.e. up to 30 m in dead end situations) and / or where the top habitable storey is higher than 18 m above ground level. Many approved documents include a heading 'Alternative Approach', at the end of each section of guidance stating:
"The requirement can also be met by following the relevant recommendations of X, Y or Z" and "[…] the relevant clauses are…"

2) Whether alternative approach guidance should be considered separately for different construction typologies e.g. heavy massy concrete, lightweight panelised timber 2D, modular 3D volumetric and more?

3) Adding clarity for the users of AD B on provisions to apply dependant on height, volume, construction typology (including whether combustible or heavy massy traditional is proposed) and resident profile.

4) How it can support Registered Building Control Approvers (RBCAs) and Local Authority Building Control (LABCs) until they are upskilled to be able to conduct (in-house) meaningful appraisals to BS 7974 *Fire safety engineering in buildings* and meaningful appraisals of computational fluid dynamic modelling for smoke clearance in corridors.

5) How it is, in the short-term, that RBCAs and LABCs can determine whether reasonable provision has been offered, for residential blocks with either a habitable seventh storey located at / higher than 18 m above ground and / or having corridors with extended single direction travel (up to 30 m long). This is likely to be a problem until circa 2030, since BRE Global believes it could take this long for the transitional provisions of AD B (2019 edition including 2024 amendments) to 'work through'.

6) Whether the goal of preventing tall residential towers from being built with a single stair will ever be achieved by guidance paragraphs 3.30a and 3.30b, or whether a Regulation is required?

6.3.2 Theme 1: Issue 2: Tall buildings, single stairs. Physiological limitations of firefighters

Background – Following the World Trade Centre attack on 11th September 2001, consideration was given to potential implications for the UK Fire and Rescue Services of terrorist events within the built environment. This consideration took the form of a research project, commissioned by the Office of the Deputy Prime Minister and carried out by a Building Disaster Assessment Group (BDAG), that reported on their findings in December 2004 [320]. The BDAG work fed into the review of AD B prior to the publication of AD B (2006 edition).

BDAG looked back at Post War Building Studies and building height, floor area, etc., water supplies / pressures / and hose sizes in tall buildings. The group also looked at the physiological capabilities of firefighters and conducted a separate literature review and report into firefighting in under-ventilated compartments [321].

Driver – The drivers are seen as city living, the need to achieve housing targets on brownfield sites at high densities, inner city regeneration and the profitability of individual projects 'maximising lettable floorplate' and creation of landmark buildings.

Evidence – The BDAG work concluded that the maximum horizontal distance firefighters should penetrate into a compartment fire is 34 m. Recent fires e.g. New Providence Wharf, Poplar (2021) [322] and Twinwell House in Easton, Bristol (2022) [323] and Regent's Quay, Leeds (2016) [324] all show that, although rare, either the fire itself or smoke, can occasionally compromise an escape corridor. The 34 m horizontal penetration would appear to be the maximum distance from the door of the stair lobby to any point on the building floor plate (from where a rescue may need to be made). It would not appear to relate to the furthest point in a flat from the flat's front door. If it did relate to the latter, the 'remaining' portion of travel in the corridor (sometimes up to 30 m in single direction travel) would result in a total distance of travel of circa 64 m. In addition, the examples above show that, although a rare event, corridors can become compromised by smoke.

Carrying a rescued individual through a smoke-filled corridor up to 30 m is an additional stressor for firefighters.

BDAG did not look at the physical effort involved in evacuation of non-fire floors above the floor of fire origin (following an abandonment of the stay put policy) as a pre-stressor to any other 'lifting' work that would be needed on the floor of fire origin. The evacuation of one or more medically dependant / very-dependant residents will also likely result in considerable physiological 'load' on firefighters thereby affecting their capabilities thereafter.

The BDAG work went on to look at reductions to the penetration distance where firefighters had to negotiate stairs before commencing a rescue. The report suggested the horizontal penetration distance would need to reduce from 34 m to 25 m (if firefighters had to ascend 10 floor levels first) and reduce to just 12 m penetration (if firefighters had to ascend 30 floors first).

The obvious consideration is how often firefighters encounter firefighting lifts that are inoperable or that break down during a fire event. Current Home Office data [325] available for a three-year period over COVID-19 (see table A30b – for all fire services) shows usage of firefighting lifts when Fire and Rescue Services attended apartment fires. The following have not been adjusted / rationalised to take account of the COVID-19 pandemic and it is not known why lifts were not used in each instance. The data show firefighting lifts were available and used 16 times per year (on average) and available but not used 44 times per year (on average).

It should be noted that under Article 24 of the Regulatory Reform (Fire Safety) Order 2005 [326], the likelihood of defective firefighting lifts should reduce as landlords now need to undertake monthly checks on the operation of lifts intended for use by firefighters. The implication is that they will be better maintained in the future. It is a reasonably foreseeable event, however, that lifts will break down and be out of action for up to 24 hours. If a second lift is not provided, (giving some measure of redundancy), the obvious question is whether extended travel distances in corridors should be reduced from the commonly applied 30 m maximum. This maximum is referenced in the Smoke Control Association [250] guide, first published in 2010.

The manikin used in the BDAG work, in 2004, was 75 kg. National Health Service (NHS) data [327] show that in 2002 the mean weight of men and women (across all ages for which NHS held data) was 76 kg and in 2021 this had risen slightly to 78.5 kg. The data also show that in 2002 the mean percentage of population considered overweight (including obese persons) was 61% and in 2021 this had risen slightly to 64%. The selection test ('entry level' fitness) for two Fire and Rescue Services required new recruits to carry a 55 kg manikin 30 m [328] [329]. A BBC News item in 2016 [330] suggested that Fire and Rescue Services were beginning to train to rescue obese people. If the manikin used in the BDAG work in 2004 was 75 kg, the overall trends above suggest it would need to be heavier, if the BDAG work was ever to be revisited.

Another consideration is whether conditions in common corridors, in highly insulated airtight high-rise buildings, become untenable at the instant the entrance door of a flat is opened (or shortly thereafter) by firefighters – especially if the fire in the apartment had previously become ventilation-controlled and the air heavily vitiated with products of combustion?

The BDAG work on backdraft fires made this observation:

> *"…Modern building practices such as the installation of well-sealed windows and doors and highly insulated walls may increase the likelihood and severity of a backdraught occurring in the event of a fire. However, it has not yet been determined what effect these factors have on a fire and on the likelihood and severity of a backdraught…"*

The BDAG literature review revealed fire fighters were continuing to be killed or injured in backdraft events with the report stating:

> *"…Present guidance is not empirically based, [and there is no] guarantee that it will operate of be effective, due to wind effects…"*

Another consideration with wind effect relates to tall buildings in city centre settings and whether enough is known of local climate, at street level, and how this may affect air movement in a firefighting stair and lobby and in building corridors. A micro-climate, at street level, can be determined by down draughts, increased wind velocities (particularly at corners) and channelling between tall co-located buildings, resulting in strong gusting vortices at street level. It is likely, during a fire incident, that the FRS will have the principal entrance / exit doors to a building open. The consideration for AD B in mid-2020s, is whether the preponderance of tall buildings in city centre settings have the potential to create microclimates, which could fight against the normal operation of smoke management systems in the firefighting stair and firefighting lobby?

Perhaps all buildings over a particular size, should be required to demonstrate that the microclimate will not impact on the area in front of the entrance / exit doors and, that at roof level there are no local conditions which might cause a smoke extract system to fail to perform as intended.

Some 18 years after AD B (2006 edition) was being considered for revision, designers, regulators and firefighters need to understand the implications of the latest revisions to Part L: *Conservation of Fuel and Power*, Part F: *Ventilation* and the introduction of new Part O: *Overheating* (Part O). When these Schedule 1 requirements act 'in concert', they may produce a set of competing 'conditions' which have previously been unseen. Moreover, the way they interact now may be different when Part L is again revised to accommodate the Future Homes and Buildings Standards 2025. A 12 week consultation was launched on 13th December 2023 to look at what should be included in the Future Homes and Buildings Standards (2025). The Future Homes and Building Standards (2025) is a key part of Government's vision of achieving net zero greenhouse gas emissions by 2050 and will mark a reduction of between 75% to 80% less carbon emissions than homes built to the 2013 Part L standards.

The glass manufacturer Pilkington anticipated [331] that the vision of net zero greenhouse gas emitting buildings would result in glazing needing to achieve a U-value of 0.8 $W/m^{-2}\cdot K$ and therefore triple glazing would become prevalent. Government is suggesting the U-value for glazing remain at 1.2 $W/m^{-2}\cdot K$, but this may change, and the outcome of the consultation will need to run its course.

In 2006, when sampling (to check as-built air leakage, i.e. airtightness testing) was first introduced, the default leakage rate was 10 $m^3/hr/m^2$. From June 2022, this became 8 $m^3/hr/m^2$ and in 2025 the Future Homes Standard will likely require leakage no less than 5 $m^3/hr/m^2$. Designers of some new homes are already achieving leakage rates of between 1 $m^3/hr/m^2$ or 2 $m^3/hr/m^2$. When AD B (2006) was being revised, it was never envisaged that these levels of airtightness would be attained.

Chapter 11 in the BDAG supplementary report *Firefighting in under-ventilated compartments: Literature review* [321] cites many fires where there was a backdraft event, and the possible contribution of double glazing in creating very tightly sealed apartments. A three-storey apartment fire in Manhattan, New York in 1994 (the Watts Street fire) involved a backdraft fire lasting 6½ minutes which:

> *"[…] Issued from the apartment and up the stairway, engulfing the three firefighters at the second-floor landing. The flame persisted for at least 6½ minutes, resulting in their deaths."*
>
> And
>
> *"In [a] simulation, the front door was opened about 20 minutes after the fire had become vitiated, resulting in a backdraught with temperatures in the stairway of over 1200°C."*

There has been some experimentation on airtight compartments [332] [333]. However, we have been unable to identify any real fire research, post AD B (2006 edition) which considers the very latest thermal insulation, airtightness standards and rapid ventilation (cooling) requirements of Part O on fire growth rates, time(s) to flashover (and propensity for backdraft conditions to develop). Such research would need to reflect current design trends for large open plan flats as well as cellular flats and commonly used furniture and furnishing materials. The effect of triple glazing on fire growth in highly insulated, airtight compartments is also an unknown. The effect at upper floors in a very tall building, where the wind would likely be very much stronger, is also unknown, see also Theme 2: *Ventilation / smoke control in modern buildings*.

Might a rapid increase in temperature inside an apartment actuate mechanical cooling ventilation or cause windows in the apartment to auto-open for comfort cooling? How might Part O and Part B systems 'work together rather than fight against each other'? Lastly, smoke from a flat which enters a common corridor may cause a thermostat in a common corridor to trigger comfort cooling via fan coil chiller units. Again, how might Part O and Part B systems 'work together' to prevent unintended and uncontrolled mixing of smoke laden air in escape corridors?

See also Survey Issue 2d: *Design and protection of escape stairs* where respondent(s) have raised concerns that the principle described for stairs not to continue down to a basement in single stairway buildings is almost always misunderstood. Applicants believe 'not continue down' means a screen and door separation is all that is required.

One respondent observed a trend where commercial buildings (with occupiable storey(s) more than 11 m above ground level) are being designed with a single stair. This worrying trend is extending to mixed use buildings and the respondent is seeing hotel / residential schemes served by a single stair, with smoke clearance using a smoke exhaust system typically used in common corridors in flats.

Implication for AD B – The guidance from the BDAG work is nearly 20 years old. Buildings are better insulated and more airtight than in 2006. The circular referred to in Issue 1 now means there is greater uncertainty as to what compliance looks like. For very tall high-rise buildings, the issues highlighted above need mitigation and guidance.

The challenge arising from Theme 1 Issue 2 suggests AD B could look at:

1) Revisiting the BDAG work.
2) Understanding the effect of redundancy (or lack or redundancy where only a single firefighting lift is provided) on horizontal penetration distances, the higher one goes in a tower. See Example 11 (above) and Survey Issue 1c and the NFCC Opinion Paper (February 2024).
3) Including the physiological effect of firefighting and rescue into a wider B5 review. Knowledge would be more accurately informed by realistic fire experiments, at height. Whilst this is aspirational, the need for this knowledge and evidence-based research is clear. Realistic large-scale experiments would give a better understanding of some of the issues at height.
4) Microclimates at street level and whether they could have a significant enough effect on a building's smoke management system (in firefighting stairs and lobbies and corridors). Conditions at roof level that might cause a smoke extract exhaust to fail to perform. When should wind tunnel modelling be required?
5) What to do in the interim, before paragraphs 3.30a. and 3.30b. of AD B (2019 edition including 2024 amendments) come into effect – which may be as late as 2030.
6) What to do if paragraphs 3.30a. and 3.30b. remain as practical guidance rather than the subject of a Regulation.
7) Alternative approaches on travel distances dependant on different construction typologies e.g. heavy massy concrete, lightweight panelised timber 2D, modular 3D volumetric and more.
8) Adding clarity to the users of AD B perhaps in the form of text and / or a diagram showing no connection of a stair serving the upper floors to a basement level.

6.3.3 Theme 1: Issue 3: Tall buildings, single stairs. Guidance on ventilation of basements

Background – This Issue is linked to Theme 3: *Complex footprints* and Theme 4: *Alternative transport: Electric vehicles.*

The BDAG literature review and report into firefighting in under-ventilated compartments also considered smoke ventilation in basements. The concerns of BDAG in relation to basements again related to the dangers of backdraft conditions:

> *"…Venting of basements is a problem due to the lack of natural openings and a particular concern is the guidance on this in the UK Building Regulations [AD B] that allows some spaces in basements to be vented indirectly by firefighters opening connecting doors. Installation of smoke control and mandatory*

requirements for sprinkler systems would improve safety for both firefighter and occupant."

Driver – The drivers are seen as congested sites and the need to utilise floorplates. Basement car parks under very tall structures will invariably have electric vehicle charging infrastructure, another potential (and as yet unquantified) risk.

Evidence – In 2004, two firefighters died when fighting a fire in a basement in Bethnal Green. It was alleged at the inquest in 2006 that both firefighters were in the basement when colleagues opened windows and doors at the rear of the building to create ventilation pathways. The BBC reported that the inquest heard that the decision to ventilate the building resulted in a rapid escalation of the fire [334].

Unlike fighting fires at upper levels, where windows in one or more external walls can be used as a visual cue (assisting firefighters to remain orientated) fighting fires in a basement without such visual cues can be very disorientating. Firefighters needing to descend an internal stair will likely do so against rising hot smoke. Firefighters having descended a flight(s) of stairs need to locate the seat of the fire, necessitating opening doors to rooms likely to contain 'stock'. Ceilings can fail (even partially) which can rapidly change a ventilation condition, a build-up of firefighting water at the lowest basement level adds yet more complexity and material burning can be particularly hazardous / toxic e.g. paints, varnishes, oil(s), cleaners, solvents and boxes of 'stock'. Where proper cross flows of ventilation cannot be achieved, AD B suggests opening connecting doors between rooms to ventilate the space(s).

The BDAG report raises concerns that opening of connecting doors can introduce oxygen to a vitiated (oxygen starved) fire, leading to a backdraft condition. If only one entry route down to a basement is available (only one exit route for firefighters exists) this may be the same route a backdraft might take if connecting doors are opened all the way back to the access point into the building. The deeper the basement the more unknowns there are.

See also Example 3 *Deep dive – Electric vehicles and underground car parks* (above).

Fires in large undivided underground car parks are equally concerning for Fire and Rescue Services. BRE Global reported on experimental work considering fire spread between cars in car parks 2009 [308] and 2010 [335], with the work considering the potential for lateral fire spread across an open (unused car parking space) and vertical fire spread (from a lower to an upper car) in a car stacker. This research is relevant for basement car parks. In the case of vertical fire spread, a dual-level car stacker was used. Both 2009 and 2010 reports acknowledged their limitations, e.g. the amount of lateral fire spread was limited to the number of cars in the test rig; and where four cars were used the fire spread to involve all four cars after 23 minutes.

Implication for AD B – The guidance from the BDAG work is nearly 20 years old. At the time, it suggested the wording in AD B (2002), was incorrect. The wording has not materially changed, with the current guidance of paragraphs 16.2 and 18.2 in Volume 1 and Volume 2, respectively, stating:

> *"[…] each basement space should have one or more smoke outlets. Where this is not practicable (for example, the plan area is deep and the amount of external wall is restricted by adjoining buildings), the perimeter basement spaces may be vented, with other spaces vented indirectly by opening connecting doors."*

The BDAG literature review was clear that opening of connecting doors was an issue of primary concern, leaving firefighters vulnerable to backdraft. The review also treated the 1/40th floor area quantum with scepticism, as it was thought to lack empirical justification. The principle of deep and complex basement ventilation could be part of a wider Part B review.

With tall buildings, there is a high probability that there will be service areas and car parking located in the basement levels. We have been unable to identify any large-scale contemporary research on electric vehicle car fires in enclosed underground car parks that can underpin assumptions about fire safety in car parks. The guidance in AD B (2006) did not benefit from the BRE research project BD 2552 *Fire spread in car parks* which ran between 2006 and 2009 and was reported on in 2010 or the work for the British Automatic Fire Sprinkler Association report (2009) which looked at horizontal and vertical fire spread between cars and the role of sprinklers in suppressing the vertical fire spread. Vehicle size, shape and propulsion method has changed in the years between the research and today. The same research would be useful if it considered modern vehicles and taller (hydraulically operated) stacker systems – see Survey Issue 1j.2 (above) which cites media evidence of the growth in size of vehicles and the static size of car parking bays, meaning cars are closer together in car parks than they have ever been.

In one study, firefighters in USA concluded they use an average of 160,000 litres of water, to extinguish a lithium-ion battery-powered car fire [336]. In summer months, in England, the prospect of using 40 times more water to extinguish a single electric vehicle fire than would be the case if the vehicle were conventional, i.e. powered by an internal combustion engine (at times of hosepipe bans) is clearly not sustainable. The quantity of water needed for a fire involving many electric vehicles is not known. Accordingly, AD B guidance is considered to be 'behind the curve', with respect to car park fire safety.

The challenge arising from Theme 1 Issue 3 suggests AD B could look at:

1) Specific and targeted focus, whilst revisiting the BDAG work on: i) basements (generally), ii) basement car parks (with a mix of vehicle 'species') and iii) basement car parks with fully charged electric vehicles (including combinations of electric cars / minibuses / vans, and electric lorries / coaches. Large modern buildings, common in any English city setting, will frequently have basement car parking for motorbikes, cars / minibuses / vans. Increasingly common in basements are loading bays (for lorries) and even coach parking bays. In time, (see Example 3 *Deep dive – electric vehicles etc* (above)) many parking bays will have fully charged, charging or discharging electric vehicles.

2) Revisiting the BRE research project BD 2552 *Fire spread in car parks*, repeating the work to study electric vehicle fires. Consideration might be given to study lithium-ion batteries' potential to yield quantities of toxic gases during thermal runaway events, their explosive nature during thermal runaway events (i.e. their ability to throw burning fragments some distance from the vehicle of fire origin, or vehicle first ignited) and the effects of off-gassing and explosive burning on persons in the vicinity during escape phase and on firefighters thereafter.

3) The potential worst-case scenario could be modelled after revisiting BD 2552. The potential worst-case scenario would occur when electric vehicles are bumper-to-bumper queueing, to exit a basement car park. This arrangement of vehicles would be a common occurrence in any car park used by spectators of a sporting or music event. Off gassing of one or two electric vehicles should look at the effect on other motorists and persons in the queue or its vicinity. What are the implications for B1? What are the implications for B3, if the FRS adopt defensive tactics?

4) Adding clarity for the users on AD B in the form of guidance on the purpose of smoke ventilation in large underground car parks. See Survey Issue 2i: *Special provisions for car parks* (above) i.e. whether it is for B1 or B5 (or post B5 considerations) would be welcome.

5) Sustainability issues – why is it that other approved documents are increasingly considering sustainability but to date AD B seems immune from such considerations? Society will likely be

increasingly intolerant of the use of very large quantities of water to extinguish a fire in a lithium-ion battery-powered vehicle as the one and only means of dealing with the fire. Driverless vehicle technology has the potential to assist the FRS in dealing with basement car park fires, if the FRS can take control of 'next adjacent' vehicles and drive them away from the zone of influence of the fire.

6.3.4 Theme 1: Issue 4: Tall buildings, single stairs. Single stairs continuing down to basement(s) and lifts opening into flats

Background – The concern voiced by practitioners is that they see single stairs in tall buildings continuing down to serve a basement car park or other basement accommodation. This Issue has been considered in some detail at Survey Issue 2d: *Design and protection of escape stair* (above). Fire strategies are being used to show 'solutions' but the feeling among survey respondents and the Technical Steering Group members was that if solutions are not appropriate (i.e. if two completely separate stairs should exist) then the AD B guidance is being 'worked around'.

One emerging trend identified was commercial space with a habitable storey more than 11 m above ground level being offered with a single stair and mixed use buildings having a single stair and hotel / residential (flats) being designed throughout as though the hotel was residential (flats).

A new trend, emerging particularly in mid- to high-end residential apartment blocks, is the provision of an internal lift shaft running full height of the building opening directly into one's own apartment. Such lifts are often key fob operated and will allow the lift to stop on communal floors but not allow the doors to open into other flats.

Driver – The drivers are seen as congested sites and the need to utilise floorplates and a desire for high-end / 'luxury' design.

Evidence – The evidence is practitioner led, with some survey respondents and some Technical Steering Group members in agreement that these issues are common in London and possibly other core cities and Combined Authorities.

The concern is that there is a lack of real fire / experimental evidence to show that 'solutions' allowing a single stair to continue down to the basement, are effective. This observation is particularly relevant when considering the changing nature of car park design and the change in car technology, from internal combustion engine to battery power.

The concern with 'private' lifts is that they may not maintain compartmentation in a fire event with the potential for fire and or smoke to spread over multiple floors. The expectation is the lift will be in its own shaft (achieving stability, Integrity and Insulation) '*when in a position which might prejudice the means of escape.'* These installations seem to be happening before the evidence is available showing they can perform in practice.

Data on numbers of schemes where stairs continue to basements and lift shafts rise into flats could be collated with the co-operation of Fire and Rescue Services and Building Control bodies.

In the opinion of one respondent, it is essential to conduct periodic and continual appraisal of emerging, modern and innovative construction technologies, designs and building use, to ensure currency of AD B guidance. Conducting a one-off appraisal of the 'issues' in the mid-2020s can only be a snapshot of a moment in time and therefore unlikely to be sufficient to help AD B remain a current document. The process must be iterative.

It was suggested that horizon scanning should be possible if DLUHC, the Building Safety Regulator (BSR) and the Construction Products Regulator (CPR) were able to attend monthly 'technical' meetings (on a rotating basis) of the following bodies:

- Local Authority, District Surveyors Association (DSA) and / or the London District Surveyors Association (LDSA)
- Registered Building Control Approvers (RBCAs)
- National Fire Chiefs Council (NFCC).

An added benefit of embracing such an iterative approach would be feedback on interpretation and use of any revised guidance in AD B.

Implication for AD B – The observation on the stair not continuing to the basement, and unacceptable designs for single stair commercial buildings and mixed used buildings, is that AD B guidance is being 'worked around'. The issue for lift shafts opening direct into accommodation is such a new phenomenon that it appears that AD B does not envisage this type of installation even in the mid-2020s. It is possible that the guidance in AD B that lifts be installed in protected shaft '*when in a position that might prejudice the means of escape'* is also being 'worked around'.

The challenge arising from Theme 1 Issue 4 suggests AD B could look at:

1) The challenges arising from Survey Issue 2d: *Design and protection of escape stair* (above).

2) Adding clarity for the users on AD B on paragraph 3.99 Volume 1 (AD B 2019 edition including 2022 and 2024 amendments) and Paragraph 5.34 Volume 2 (AD B 2019 edition including 2022 and 2024 amendments) when lift shafts run from basement ancillary accommodation up into every flat. The concern is the connecting shaft with landing doors which open into each flat. A programmable key fob ensures only you and your family will ever step out of the lift car into your flat. The potential exists for smoke to spread into the internal halls of every flat.

3) Supporting large-scale experimental work involving stair cores connecting with basements (particularly car parks) and lift shafts connecting flats directly. Large-scale experiments would give a better understanding of some of the issues.

4) A large-scale test facility, which would need to be commissioned.

6.3.5 Theme 1: Issue 5 Tall buildings, single stairs. Dignified escape

Background – Following the Grenfell Tower fire of 14th June 2017, media has debated levelling up the opportunity for disabled people to be able to make their own decision, as to whether to stay or leave a building during a fire event and not to be merely allowed to await rescue. Dignified escape is about 'facilitating' the disabled person to be just as able and capable, during a fire event to leave their home, as would be the case when going about their normal day to day business. Dignified escape is about maintaining the independence of the disabled person even during a fire event.

See section 3.4.3 *Means of escape for disabled people in buildings described as Other than dwellings* (above) and Example 11 which considers equal opportunity in provisions for means of escape (above).

For the specialist wheelchair user, dignified escape marks an end to the indignity of being lifted out of what may be a very specialised and personalised (bespoke) wheelchair to be carried down the stairs or decanted into an evacuation chair or sled and 'lowered' down the stairs, one tread at a time. It is very unlikely that the Fire and Rescue Service would also be able to carry the specialised personalised (bespoke) chair to the entrance storey, leaving the wheelchair user isolated at the foot of a building.

Dignified escape places a demand on the newly constructed building's infrastructure and on the building's management, firstly an evacuation lift is required, and secondly trained staff are needed to manage its use during a fire event.

In London, the Greater London Authority introduced new policy D5(5B) in the London Plan which embraces the notion of dignified escape. The London Plan expects all new buildings in London to have an evacuation lift in each lift core. The guidance is expected to be adopted by all 33 authorities in London and is to be applied in addition to Building Regulations. The guidance in the London plan contains the following:

> *"… [these evacuation lifts are to be] used for evacuation purposes when the firefighting lift is in use by the fire and rescue service… Buildings should be designed and built to accommodate robust emergency evacuation procedures for all building users, including those who require level access. All building users should be able to evacuate from a building with dignity and by as independent means as possible. Emergency carry down or carry up mechanical devices or similar interventions that rely on manual handling are not considered to be appropriate, for reasons of user dignity and independence. The installation of lifts which can be used for evacuation purposes (accompanied by a management plan) provide a dignified and more independent solution."*

The expectation of the London Plan is clearly also about equality of opportunity.

Driver – Equalities legislation and London Plan. It is clear that if other Mayors choose to adopt the same thinking, then AD B will be out of step nationally.

Evidence – The evidence is addressed in the above three sections of this report 3.4.2 *Specialised housing and care homes* (above), section 3.4.3 *Means of escape for disabled people in buildings described as Other than dwellings* (above), section 2.4.7 *Investigation of real fires* (above) and Example 11 which considers equal opportunity in provisions for means of escape (above). See specifically the following sub-headings in each section (summarised below):

- 3.4.2 *Specialised housing and care homes*
    - Sub-heading: Challenges that relate to the introductory sections in AD B

This introduces the concept of a more hands-on, supportive role for management in evacuating persons during a fire event. This is new thinking, and it is a large step forward taken being driven by Town Planning.

- Sub-heading: Challenges that relate to B1: Means of warning and escape and Dignified escape

This introduces the principle of dignified escape and the freedom and independence to choose to stay put or leave a building. The AD B guidance has traditionally not required that refuge spaces be large enough to accommodate all people using wheelchairs or walking aids.

There is an obvious issue that will begin to arise for new buildings regarding travel distance to escape stairs. The use of refuges in stairs is challenged by London Plan Policy D5(5B). The future expectation is that a wheelchair user should be able to get to a lift core.

- 3.4.3 *Means of escape for disabled people other than dwellings*
    - Sub-heading: All of this section is relevant as it provides full context.

- 3.4.7 *Investigation of real fires*
    - Sub-heading: <u>Numbers of persons self-evacuating high-rise residential buildings</u>

This section shows that residents are choosing to self-evacuate high-rise residential blocks during fire events. In time, this may move back to a position where residents are confident (more trusting) to stay put. However, what BRE Global began to see in 2020 and 2021 was validated by the Tomlinson study (December 2022) see Inside Housing. The London Assembly's lead in the London Plan is clearly taking a view that a sea change is required for means of escape. How does AD B respond?

- Example 11 applies to this scenario.

This example deals with all the issues identified above and dignified escape.

Implication for AD B – In the short term, AD B could do nothing and let this be addressed by Town planning in London. In doing so there will be technicalities regarding the of the installation that Planning officers are not best placed to resolve. The guidance in AD B will become more out of touch if other core cities and Combined Authorities adopt the same approach in their City and Combined Authority Plans.

The technical difficulty is that at present, buildings have a mix of lift and stair cores and just stair cores.

Non-disabled people can use stair cores and, up to this point (in London), disabled people were expected to make their way to a stair core and await rescue with a helper remaining with them in the stair. The obvious implication being that where there is a stair there will be a lift core.

The challenge to AD B will come if designers say that disabled people will be somehow 'restricted' to use certain parts of a buildings.

The challenge arising from Theme 1 Issue 5 suggests AD B could look at:

- Whether it is possible / desirable for AD B to embrace what the London Plan requires by way of evacuation lifts and consult on adoption of this into the AD B guidance.

- Building on the focus of the changes introduced by AD B (2019 edition including 2024 amendments) that support the use of evacuation lifts in blocks of flats and the new term in AD B of the 'Evacuation shaft'.

- Adding clarity for the users on AD B in the form of additional guidance on arrangements in evacuation shafts at principal entrance / exit storey level and at upper storey levels.

- Adding clarity for the users of AD B in the form of technical guidance on the standard(s) required for evacuation lifts, diagrams particularly showing independent routing of supply and back up cables and at what point they enter the lift shaft and who controls / drives these lifts.

- The suggestions for AD B itemised under Survey Issue 1c: *Management of premises, Inclusive design and management's role in ongoing inspections and evacuation* (above).

- A large-scale test facility, which would need to be commissioned.

6.3.6 Theme 1: Issue 6 Tall buildings, single stairs. Extra care facilities

Background – This theme is covered in detail in section 3.4.2 *Specialised housing and care homes* (above) and Example 10, which looks at the popular trends in housing for the ageing population (above). This theme is also considered in section 3.4.3 *Means of escape for disabled people in buildings described as Other than dwellings* and Example 11, which looks at equal opportunity when considering means of escape and finally, Survey Issue 1c: *Management of premises, Inclusive design and management's role in ongoing inspections and evacuation*.

What is captured in section 3.4.2 and Example 10 is a sense that in the mid-2020s, the specialised housing sector has become even more complex and specialised. There are so many typologies, users of the AD B will be uncertain which AD B volume to use.

What is captured in section 3.4.3 and Example 11 is a sense that in the mid-2020s, a shift has occurred, whereby disabled people do not want to be facilitated to stay, they want choice. That choice is whether to stay or leave a building, in which there is a fire event, at any time.

The NFCC *Provision of multiple routes for evacuation of residential buildings – Opinion Paper* at paragraph 5.2 suggests in terms of the number of evacuation lifts that:

> *"There is a sufficient number of evacuation lifts for the potential building users, and to account for those times when a lift is unavailable (note: In practice, this means that there will generally be more than one evacuation lift required per stair core or evacuation lobby."*

Driver – Multiple, see the background reasons cited.

Evidence – Multiple, see the background reasons cited.

In paragraph 3.30 in AD B Volume 1 (2019 edition including 2022 and 2024 amendments) there are two triggers requiring more than one common stair. There is no equivalent in AD B Volume 2. Thus, general purpose flats will enjoy a higher standard of escape provision than residential (institutional) and residential (other).

Implication for AD B – In the mid-2020s, the number of specialised housing typologies is far in excess of that which existed when AD B (2006 edition) was being considered. The push for disabled people to have choice whether to stay put of leave a building with a fire in it, was not an option when AD B (2006 edition) was being considered.

The challenge arising from Theme 1 Issue 6 suggests AD B could look at:

1) Adding clarity for the users on AD B on which Volume of AD B should be used for the different types of specialised housing described in Survey Issue 1e: *Purpose groups*.

2) Adding clarity for the users on AD B by revisiting and revising the guidance, particularly in Volume 2 to ensure is its sufficiently comprehensive and current for the different types of specialised housing.

6.3.7 Theme 1: Issue 7 Tall buildings, single stairs. Combustible construction, high-rise and ultra-high-rise

Background – This theme is covered in detail in Example 5 *Deep dive – Volumetric construction, fire testing of combustible construction, monitoring the cooling period after standard testing* (above), section 6.2.1 Survey Issue 1b: *The approved documents (What is an approved document), Property protection and combustible construction* (above), section 6.1.4 Survey Issue 1d: *Alternative approaches* (above), section 6.1.9 Survey Issue 1h: *Provision of cavity barriers, construction and fixing of cavity barriers and openings in cavity barriers and Cavities in flats, Provision of cavity barriers, and Pathways around fire-separating elements* (above), and several other sections in this report.

The AD B (2019 edition including 2024 amendments) introduced the requirement for more than one stair when either a flat is on a storey that does not meet the criteria for a single escape or if the building has a top storey of 18 m or more in height. As is described in section 6.3.1 *Theme 1: Issue 1: Tall buildings, single stairs and the limits of application (scope) of AD B* (above), it will probably take until circa 2030 for the transitional provisions to work through and result in the majority of tall residential buildings under design or being commenced on site to be following the 'new' guidance. This is a very long lead in period.

The ban on combustibles remains for 'relevant buildings' and will prevent external walls being formed using combustible construction, however, it is conceivable that the skeleton of a high-rise building, including columns and floor slabs could be formed from mass timber construction using engineered timber products such as glued laminated timber, and cross-laminated timber.

Driver – Multiple, see the background reasons cited in the sections cross referred to.

Evidence – Multiple, see the background reasons cited in the sections cross referred to.

Implication for AD B – In the mid-2020s, whilst the façade is controlled, it appears possible for a designer to utilise combustible construction for the frame.

The challenge arising from Theme 1 Issue 7 suggests AD B could look at:

1) In particular, the recommendations of section 6.1.2 Survey Issue 1b: *The approved documents (What is an approved document), property protection and combustible construction,* in relation to separate guidance for combustible and non-combustible construction and research into what we mean / desire by robust construction and how to identify whether construction is robust by using extended monitoring during the cooling phase after standard fire testing.

6.3.8 Theme 1: Issue 8 Tall buildings, single stairs. Smoke control to common escape routes and stairs

Background – This theme is covered in detail in Example 5 *Deep dive – Volumetric construction, fire testing of combustible construction, monitoring the cooling period after standard testing* (above), section 6.2.1 Survey Issue 1b: *The approved documents (What is an approved document), Property protection and combustible construction* (above), section 6.1.4 Survey Issue 1d: *Alternative approaches* (above), section 6.1.9 Survey Issue 1h: *Provision of cavity barriers, construction and fixing of cavity barriers and openings in cavity barriers and Cavities in flats, Provision of cavity barriers, and Pathways around fire-separating elements* (above), and several other sections in this report.

The AD B (2019 edition including 2024 amendments) introduced the requirement for more than one stair when either a flat is on a storey that does not meet the criteria for a single escape or if the building has a top storey of 18 m or more in height. As is described in section 6.3.1 *Theme 1: Issue 1: Tall buildings, single stairs and the limits of application (scope) of AD B* (above), it will probably take until circa 2030 for the transitional provisions to work through and result in the majority of tall residential buildings under design or being commenced on site to be following the 'new' guidance. This is a very long lead in period.

Many buildings will continue to be designed and constructed with extended corridors with smoke control in the corridors using the guidance from the SCA. The 'evidence' for the use of the SCA guides comes from limited direct reference to it in the survey, but mostly it is BRE Global's experience and the experience of several members of the Technical Steering Group that the *Guidance on Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes – Revision 3.1) July 2020* [250] is the principal modern design guide for smoke control in buildings with single direction of travel up to 30 m. The guidance in AD B assumes the maximum single direction of travel is 7.5 m.

Driver – Multiple, see the background reasons cited in the sections cross referred to above.

Evidence – Multiple, see the background reasons cited in the sections cross referred to above.

Some respondents queried why we do what we do, when following AD B including:

1) "Why do we not vent a 7.5 m length up to a 'T' junction?"
2) "Diagram 3.7(a) suggests that 7.5 m in unventilated corridor is OK (see the concession to 3.9[a]). Is this considered acceptable because the corridor is 'corridor shaped' and therefore there is only limited chance of one becoming disorientated when travelling 7.5 m? Could guidance commentary be provided?
3) Diagram 3.8 suggests that for distances up to 30 m the whole corridor is vented. Could Diagram 3.8 be redrawn like 3.7(a) with a small area just in front of the door ventilated or does the requirement change at 7.51 m up to 30 m? Could guidance commentary be provided?
4) The whole guidance on what to vent and what not to vent was not clear to several respondents asked for. The request was for guidance commentary to be provided.
5) Could AD B make clear the expectations at foot the of a stair, en-route to the exit. Diagrams would help. Show the route from foot of building through a typical ground floor… what is and is not acceptable e.g. is an electric riser cupboard or a security room, plant room, store, or small office a threat between the door accessing the stair and the exit door from the building?

Section 6.3.1 Theme 1 Issue 2: *Tall buildings, single stairs. Physiological limitations of firefighters* raises the concern over the conditions in common corridors, in highly insulated airtight high-rise buildings. The suggestion is that they may become at the instant the entrance door of a flat is opened (or shortly thereafter) by firefighters – especially if the fire in the apartment had previously become ventilation-controlled and the air heavily vitiated with products of combustion?

The BDAG work on backdraft fires made this observation:

> *"…Modern building practices such as the installation of well-sealed windows and doors and highly insulated walls may increase the likelihood and severity of a backdraught occurring in the event of a fire. However, it has not yet been determined what effect these factors have on a fire and on the likelihood and severity of a backdraught…"*

Implication for AD B – Meanwhile, guidance is needed until the AD B (2019 edition including 2024 amendments) comes into effect. Even then, the new guidance at paragraph 3.30 in AD B Volume 1 (2019 including 2024 amendments) represents a sea change in guidance. Between 2006 and the mid-2020s, the most commonly used design guide for smoke control in common corridors was the SCA guide. It was intended to keep corridors relatively clear of smoke and minimise as far as reasonably practicable the amount of smoke that might enter the stair.

The challenge arising from Theme 1 Issue 8 suggests AD B could look at:

1) The whole issue of ventilation of corridors and how one goes about proving that at height in tall residential towers, the wind force driving flame and smoke back into the corridor can be controlled by the smoke extract system.

2) A programme of research including large-scale experiments may be the only way to realistically see what happens under these physical conditions.

3) Feeding into Theme 7: *Review of B5 Guidance.*

6.3.9 Theme 2: Issue 1 Ventilation / smoke control in modern buildings. Smoke shafts in common corridors and make-up air from the head of the stair

Background – This theme is covered in detail in 6.3.8 Theme 1: Issue 8 *Tall buildings, single stairs. Smoke control to common escape routes and stairs* (above) and Survey Issue 1d: *Alternative approaches* (above).

Driver – Multiple, see the background reasons cited in the sections cross referred to.

Evidence – Multiple, see the background reasons cited in the sections cross referred to.

In BRE Global's experience some of the following could be added to any review:

1) Whether pressure differential systems to BS EN 12101-6 should be used instead of following the guidance for smoke extract shaft systems in the SCA guide.

2) What should be the design fire size for the fire growth stage and the design fire size at the moment the Fire and Rescue Service access an apartment?

3) What input parameters to what models are acceptable as design tools?

4) What about the effect of doglegs and blind partial corners on CFD modelling?

5) What about flat entrance door directly opposite the stair door?

6) What about wind effect in corridors at height 40th or 50th floor?

7) What about under ventilated fires?

8) What about total compartment burn out if on other side of flat front doors there is combustible construction?

9) What about Draft BS 9991: 2021 guidance?

Implication for AD B – Meanwhile guidance is needed until the AD B (2019 edition including 2024 amendments) comes into effect. Even then, the new guidance at paragraph 3.30 in AD B Volume 1 (2019 including 20204 amendments) represents a sea change in guidance. Between 2006 and the mid-2020s the most commonly used design guide for smoke control in common corridors was the SCA guide[Ibid]. It was intended to keep corridors relatively clear of smoke and minimise as far as reasonably practicable the amount of smoke that might enter the stair.

The challenge arising from Theme 2 Issue 1 suggests AD B could look at:

1) The results of the challenge arising from Theme 1 Issue 8.

6.3.10 Theme 2: Issue 2 Ventilation / smoke control in modern buildings. Components of an extract system

Background – This theme is covered in detail above.

Driver – Multiple, see the background reasons cited in the sections cross referred to.

Evidence – Multiple, see the background reasons cited in the sections cross referred to.

In BRE Global's experience, some of the following could be added to any review:

1) Smoke vents to shafts what about dampers and leakage?

2) Have doors ever been tested?

3) Given fire doors are likely to be cut down it is unlikely these will be complete doorsets.

4) Could there be better guidance on testing of 'kit'?

5) BRE Global's experience of conducting post fire investigations reveals the corridor vent is never positioned as high as possible and often the head of the vent is at the same level as the head of the door accessing the stair lobby.

6) A simple diagram in AD B might show the importance of going as high as possible to prevent 'spills' of smoke entering the stair lobby.

Implication for AD B – See the implications in sections above.

The challenge arising from Theme 2 Issue 2 suggests AD B could look at:

1) The results of the challenge arising from Theme 1 Issue 8.

6.3.11 Theme 2: Issue 3 Ventilation / smoke control in modern buildings. Rest points horizontal travel

Background – This theme is covered in detail in section 3.4.2 *Specialised housing and care homes* (above), Example 10 which considers housing for the ageing population (above) and Example 11 *Equal opportunities* when considering means of means of escape. Also of relevance is Example 6 which considers micromobility (mobility scooters) and accessible and adaptable flats.

Driver – Multiple, see the background reasons cited in the sections cross referred to.

Evidence – Multiple, see the background reasons cited in the sections cross referred to.

In BRE Global's experience, some of the following could be added to any review:

1) Consider Specialised housing and the multiple different typologies.

2) What size of refuge is appropriate in a building where the likelihood is that a greater proportion of residents will use a wheelchair than not?

3) Would dividing the corridor into shorter lengths to act as temporary refuges be needed in some of the specialised housing typologies?

4) Is stay put acceptable in combustible construction?

5) Even with more than one stair, should consideration be given in high-rise and ultra-high-rise buildings to rest floors, where some of a descending population can take a breather in a very enlarged refuge? This could form part of the Theme 7: *Review of B5 Guidance.*

Implication for AD B – See the implications in sections above.

The challenge arising from Theme 2 Issue 3 suggests AD B could look at:

1) A complete review of provisions for horizontal and vertical travel for the specialised housing sector.

6.3.12 Theme 3: Complex footprints and the use of modular construction and dropping fires

Background – This theme is covered in section 6.1.9 Survey Issue 1h: *Provision of cavity barriers (etc)*, Example 5 *Deep dive volumetric construction etc* and section 6.3.3 Theme 1 Issue 3: *Tall buildings single stairs guidance on ventilation of basements.*

Driver – The driver is the limited supply of land in congested inner-city sites and the need to maximise the plot for greatest return. A modular or CLT building for residential dwelling/institutional use 10 or more storeys tall is still allowed [337] – it is just that Regulation 7(2) will control the external wall build-up and require use of A1 or A2-s1,d0 materials to BS EN 13501-1 *Classification using data from reaction to fire tests* [189]. BRE Global also notes that modular or CLT buildings to which Regulation 7(2) does not apply is still possible today with 10 or more storeys [338].

In inner city sites, it is likely there will be underground car parking beneath a complicated footprint and so section 3.4.5 *Structural fire resistance and fire separating elements* (above) and Example 3 *Deep dive – electric vehicles and underground car parks* (above) are relevant. In order to maximise returns, many buildings need to be mixed use and tall.

A second driver is that Local Authority Planners prefer sustainable forms of construction over heavy massy construction and planning approval is more likely to be secured if adopting sustainable forms of construction for the rebuilding. This is discussed in section 6.1.2 Survey Issue 1b *The approved documents (What is an approved document), Property protection and combustible construction* (above). Planners also consider the carbon footprint during the construction phase. One modular manufacturer [339] claims their projects can save 50% on programme and 80% fewer vehicle movements. These are attractive statistics for Local Authority Planners.

Also covered in section 6.1.2 Survey Issue 1b: *The approved documents (What is an approved document), Property protection and combustible construction* (above) BRE Global notes several fires in combustible construction, where disproportionate damage occurred. The fires at Samuel Garside House, Barking, June 2019, Premier Inn, Bristol, July 2019, Beechmere, Crewe, August 2019, Richmond House, Sutton, September 2019, Pankhurst Avenue, Brighton, September 2019 and The Cube, Bolton, November 2019, all involved significant elements of combustible construction and brought into focus the question of property protection. Following four of these fires (Premier Inn, Beechmere, Richmond House and Pankhurst Avenue), the remains of each building had to be demolished.

In five of the six fires (above), the fire spread past lines of compartmentation both horizontally in roof and wall cavities and vertically (including downward fire spread) in wall cavities, dropping fires.

Evidence – Multiple, see the background reasons cited in the sections cross referred to.

It is clear that inner city brownfield sites are more likely than not to have complex footprints. Clients still seek basement car parking and where a building is complex shaped the ventilation of the basement will need to be bespoke.

This Item needs to feed into Theme 7: *Review of B5 guidance* because there are considerable issues surrounding ventilation of basements and section 6.2.4 *Design and protection of escape stair* (above).

Implication for AD B – See the implications in sections above.

The challenge arising from Theme 3 Issue 1 suggests AD B could look at:

1) reviewing the challenges arising for all the sections cited above.

6.3.13 Themes 4 and 5: Alternative transport: Electric vehicles and Theme 5: Batteries

Background – Theme 4 is covered in Example 3 *Deep dive – Electric vehicles and underground car parks*, (above) and section 6.1.12 Survey Issue 1j.2: *Sprinkler types, extent of coverage and car parks,* (above). Section 6.1.15 Survey Issue 1m: *Access and facilities for the fire service*, (above) considers, in broad brush terms, various aspects of firefighting. One can foresee that FRSs may choose to adopt defensive firefighting tactics (rather than offensive tactics) in underground car parks, until more is known of the risks to firefighters and the effect of electric vehicle fires on structural elements and when located adjacent to fire resisting partitions.

Section 6.3.3 Theme 1: Issue 3: *Tall buildings, single stairs. Guidance on ventilation of basements,* (above) considers the merit of repeating the BRE research project BD 2552 *Fire spread in car parks* but using a blend of vehicles in testing (including hydrogen gas propulsion) including a selection of fully charged, charging or discharging electric vehicles.

Theme 5: *Batteries* is also covered in Example 3 *Deep dive – Electric vehicles and underground car parks* (above) and Example 6, which considers the role of micromobility in helping to decarbonise transportation (above) and Example 10, which considers the need to provide housing for the ageing population (above). Example 10 considers the requirement under Part M: *Access to and use of* buildings, for there to be space in the entrance hall, adjacent to the entrance door, for charging of e-mobility scooters.

Theme 5: *Batteries* is also discussed in Example 4, which considers Government's intention to decarbonise the UK economy including new build construction and specifically the push for photovoltaics on the roofs of new buildings and when carrying out material alterations (retrofit work). This consideration looks at the likely cause and origin of electrical fires associated with PV installations and the need to revisit research into this area, as well as taking a fresh look at electrical energy storage systems (EESS).

Driver – The driver for electric and alternative fuel vehicles is the phasing out of petrol and diesel vehicles by 2030 and HGVs by 2040. It is driven by climate change and UK commitments to reduce CO_2. The driver for batteries is a little wider than just electric vehicles. When thinking of electric vehicles, we think of lithium-ion batteries. The drive for improved battery technology will always include:

i) speed of charge

ii) size of charge held

iii) battery life, under load

iv) cost

v) weight.

Respondents voiced a range of opinions on alternative transport, including electric vehicles and batteries:

1) *"vehicles are going to become more autonomous, and this may lead to cars that can self-drive and 'pick up' passengers from the front (or rear) of a building. The respondent went on to speculate that, in the long term, this may lead to a reduction in the number of stairs continuing down to a basement car park."*

BRE Global sees that driverless technology could assist the FRS in fighting an underground car park fire, provided the FRS is able to take control of all vehicles, remotely. On arriving at an underground car park fire, containing driverless vehicles, it may be possible for the FRS to drive, by remote control, the 'next adjacent' banks of vehicles away from the car(s) already burning, so that the fire size could be controlled. Indeed, robotics may drag the single (or few) vehicles away from structural members to avoid intense hot spot in any one location.

This would be a considerable breakthrough in technology if driverless electric vehicles actually have the built in solution to the problem that some would argue, their propulsion system creates. It may be some time before car manufacturers develop a workable system that can be overridden in an emergency by the FRS or a building manager under the direction of the FRS. This would be a valuable area of research.

2) *"new propulsion system technologies, such as hydrogen cells are particularly concerning."*

3) *"induction charging which includes charging pads may present different risks to cars being charged by cable."*

4) *"places of special fire hazard need to be redefined to include transformer rooms serving car parks."*

5) *"Compartmentation in car parks could be useful. This would break up a large area to restrict the spread of fire."*

Evidence – Multiple, see the background reasons cited in the sections cross referred to.

There should be consideration of vehicles with different propulsion systems. Assuming a fire begins to involve a hydrogen fuel cell (FC) vehicle, potential exists for a hydrogen leak or hydrogen tank rupture. In the latter case, there may be the potential for a Boiling Liquid Expanding Vapour Event (BLEVE). Whilst not considered here, hydrogen FC vehicles would be included in any consideration of 'other fuel cell propulsion technologies' along with compressed natural gas (CNG) or liquified petroleum gas (LPG). Gas FC vehicles may include coaches or lorries.

A project could be conducted to observe the range vehicles (based on the make model and year of each parked vehicle) to determine the range of fuel cells in a selection of inner-city car parks on a range of different days.

Research could consider various combinations of these different vehicles up to the point where 100% electric vehicles are used in various states (charging, 100% charged and still plugged in and discharging). Until research can be conducted, it is not possible to determine which state comes with the highest fire risk.

The location of EESS in dwellings needs very careful consideration. Considerable research would be needed before AD B could provide guidance on locating EESSs in understairs cupboards or entrance halls. In the interim, and as a precautionary measure, perhaps they could be located more than one fire door away from the entrance hall or located in a special external enclosure.

Implication for AD B – It is important for AD B to remain relevant and current.

The challenge arising from Theme 3 Issue 1 suggests AD B could look at:

1) The research described in this theme and in the underlying background evidence.

6.3.14 Theme 6: Alternative fuels and Part L

Background – The two most likely alternative fuels that might replace fossil fuels include hydrogen and nuclear power as well as a wide range of renewables including wind and solar. The important consideration is to keep under constant review all different fuel types, this should include reclaimed oils, vegetable oils and even photovoltaics. The observation with Part L is that the thermal insulation thicknesses in buildings is unrecognisable between AD B (2006 edition) and the AD B (2019 edition including 2024 amendments). To achieve the increased thermal efficiency has seen a shift toward use of thermoset and thermoplastic insulation. To achieve thermal insulation mineral and glass wool are not used a commonly as the foamed plastics.

Driver – Respondents voiced a range of opinions on alternative fuels and Part L:

1) *"the push towards carbon zero has led to buildings with larger cavities and greener types of insulation."*

2) *"larger cavities had been giving detailing issues."*

3) *"there are constant new entrants in the thermal insulation market, including organic insulants."*

See section 3.3.7 *Consideration of the Research Foundation publication Fire Safety Challenges of 'Green' Buildings and Attributes (2020),* regarding organic insulation types. See also Example 9 *Deep dive – Roof testing and classification reports, roof terraces and Solar mounting standards*, (above) and the discussion on smouldering combustion with some types of insulation.

1) *"MMC has led to a reduction in thermal heat losses which has led to shorter times to heat the building."*

2) *"insulation of party walls has become more prevalent over the last 10 years meaning more fuel load."*

3) *"increasingly, insulation is now located above rather than in between rafters and joists. This has created a 'hot roof' structure with the potential for fires in roofs to cause failures and fire spread between compartment lines."*

4) *"money had been put into R&D looking into efficiency but next to nothing being put into safety."*

5) *"Solar panels/ solar rays are causing a risk of fire spread across roofs."*

Evidence – Multiple, see the background reasons cited in the sections cross referred to.

When considering alternative fuels there may be unintended consequences of using the new fuel type. If hydrogen gas was to be passed through a network of steel pipes, the hydrogen can cause hydrogen embrittlement of the underground network of metal pipes. Such matters needed fire testing, particularly if the metal pipes run into buildings in galvanised iron and run in risers in the same piping.

Organic insulants tend to undergo smouldering combustion. Potentially, this smouldering combustion can be for several hours after a fire resistance or reaction to fire test. This is significant because in real buildings there is the prospect of flare-ups in cavities sometime after a fire may be thought to be extinguished and if this happens in combustible construction, this may lead to the loss of a building. It may need to be taken into consideration when considering if the building should have a stay put fire strategy or not.

Implication for AD B – It is important for AD B to remain relevant and current.

See Example 5 *Deep dive – Volumetric construction, Fire testing of combustible construction, Monitoring the cooling period after standard testing* (above) and considers:

The challenge arising from Theme 6 suggests AD B could look at:

1) Research into the different types of fuel:
    i) How the fuel supply network runs in urban and suburban environments
    ii) How the fuel is stored in buildings
    iii) How the fuel is used in buildings
    iv) How the fuel behaves in a fire situation when it is not necessarily the first material ignited.

2) The recommendations of section 6.1.2 Survey Issue 1b: *The approved documents (What is an approved document), property protection and combustible construction*, in relation to separate guidance for combustible and non-combustible construction and research into what we mean / desire by robust construction and how to identify whether construction is robust by using extended monitoring during the cooling phase after standard fire testing.

6.3.15 Theme 7: Part B5 review

Background – The Technical Steering Group agreed that the whole of B5 needs a fundamental review. It may be that as a result of this review, additional guidance covering new provisions may be identified.

Driver – The Technical Steering Group agreed the driver was simply the time that had lapsed between the AD B (2006 edition) and the AD B (2019 edition including 2024 amendments).

Evidence – It is worth considering the whole of Theme 1: Issue 2: *Tall buildings, single stairs. Physiological limitations of firefighters*, which draws on the work of the Building Disaster Assessment Group in their report for Government in 2004.

Implication for AD B – It is important for AD B to remain relevant and current if it continues to give guidance on access and facilities for the Fire and Rescue Service.

The challenge arising from Theme 6 suggests AD B could look at:

1) Conducting a complete review of B5.

6.3.16 Theme 8: Fire load review

Background – The perception that there is a shorter time to flashover in modern highly insulated buildings than was the case when AD B (2006 edition was being considered). There has been a noticeable trend towards open plan living in the past two decades. Open plan layouts are frequently desired in single family dwellings undergoing material alterations to create additional storeys, irrespective of height to the topmost habitable storey and the usual requirement to protect the stairs.

Driver – Ever-increasing levels of thermal insulation and airtight construction and the drive for sustainability and lowering carbon footprint of construction by building in timber more than before.

Evidence – If the precepts upon which the current guidance regime have moved since 2006, research should be conducted to determine if modern buildings reach flashover more quickly and whether fires in under ventilated compartments is a modern phenomenon.

<u>Trends in modern living</u>

Open plan living increases fuel distribution, and enclosure ventilation. Fires can spread to several storeys and are considerably larger and present a greater danger to means of escape. Homes have a greater polymeric material in them than two decades ago. There may be changes to the Furniture and Furnishing

Regulations (see below). Homes have more white goods in them than two decades ago and there are new sources of ignition from lithium-ion batteries e.g. laptop computers, mobile phones, e-cigarettes, e-bikes, hoverboards, electric scooters, mobility scooters, and cordless DIY tools etc.

Working patterns during the COVID-19 pandemic has resulted in a greater emphasis on working from home. Working from home, by necessity, results in a greater use of IT and electronic equipment and office furniture. This increase in fire load should form part of any consideration of fire load density in residential use buildings.

Lithium-ion batteries

In the early 2000s, petrol fuelled gardening tools would probably have been stored away from the dwelling in a garage/garden shed. In 2024, it would not be uncommon to find the batteries and charging points associated with this equipment and other DIY based products located within the dwellings.

An ageing population is more likely to use mobility scooters powered by lithium-ion batteries than 'old' technology batteries because of the longer battery life associated with lithium-ion technology.

Other goods such as 'children's toys', e-bikes hoverboards and electric scooters are also powered by lithium-ion batteries. The fire load in the modern home has changed since the early 2000s.

The Furniture and Furnishing Regulations

The Furniture and Furnishings (Fire) (Safety) Regulations 1988 (as amended) are now under review by the Office for Product Safety and Standards. A major driver for the review has been the health and environmental impact (by ingestion and bio-accumulation respectively) of fire-retardant chemicals.

The precautionary principle suggests it would be advisable to determine fire loads in modern homes and carry out compartment fires using 'new technology' furniture versus 'old technology' furniture as primary or secondary ignition sources. It may be advisable to revisit any experimental work if and when the regulations are amended to see how interior designs change over time to accommodate new regimes. In addition to flammability and fire load, toxicity could be another 'metric'. See also the output considerations of Theme 2 *Ventilation smoke control in modern buildings*. This research may affect assumptions about AD B from B1 to B5.

Ancillary spaces

It is not uncommon for residential tower blocks to include ancillary spaces; it is the scale of provision that has changed over the last two decades. A typical 2000s residential block of flats would have included some ancillary accommodation (e.g. a bicycle store, bin store, toilets and or a mail room) accessed via protected lobbies off the entrance lobby. The following example of a 47-storey block of co-living flats is taken from a London Borough Council Planning website. Drawings of this scheme show the scale of provision of 'ancillary' accommodation at ground, mezzanine, first, second, penultimate floor and roof garden, in 2022. Schemes differ but there does seem to be a design intent to maximise 'ancillary' space. Another change that came into focus (in response to the need to isolate and work from home during the COVID-19 pandemic lockdowns) is society's use of parcel delivery services. This naturally leads to considerations like whether mail rooms in blocks of flats need to be larger to accommodate parcel deliveries and whether a building's cardboard waste compactor is too small and lastly how the cardboard waste will be managed.

Shops and commercial, Industrial and storage

The established model for replenishment centres is that they will remain vast in scale, be occupied by large workforces and spaces inside may be complex, with great reliance on use of mezzanine floors for storage and sorting. Alternatively, they may become automated with greater use of robots and less reliance on human intervention. The scale of the undertaking would tend to suggest these facilities will remain out of town.

An alternative model could be that there need to be many more, but smaller replenishment centres located in and around cities to satisfy the same day 'click and deliver' societal expectation. If this alternative model predominates this would suggest many more replenishment centres appear in and around in cities and these may introduce fire risk into mixed-use buildings.

Places of special fire risk

The use of products and equipment containing lithium-ion batteries is now well established and will continue to grow. In complying with Schedule 1 Requirement Part L *Conservation of fuel and power* and the wider need for sustainable construction, it is highly probable that more buildings will be constructed with energy storage centres. Rooms and spaces containing products and equipment containing lithium-ion batteries and units comprising energy storage centres may need to be reconsidered in terms of fire and explosion resistance.

See also Theme 5 *Batteries* subheading 'Energy storage centres'.

Implication for AD B – It is important for AD B to remain relevant.

The challenge arising from Theme 8 suggests AD B could look at:

1) Conducting a complete review of fire loads in buildings to see the precepts of fire safety have shifted.

6.3.17 Theme 9: New ways of building other

Background – Green walls and roofs are becoming increasingly popular, and this is in large part because Local Authority planning departments are keen to make a link between landscaping and green walls, with the latter being an extension of 'landscaped areas'.

Use of inverted roofs

Modern designs will invariably have green, brown or (underlying blue roof) technologies. Green roofs have live plants (varieties of sedum) in growing medium (soil) and will often form part of an accessible terrace / communal garden. Green roofs can integrate with decking, paving and garden furniture (benches). Brown roofs are more focussed on providing bio-diversity for insects and birds and may include rope, logs, ponds, etc. Brown roofs are less likely to be public spaces and are quiet, rugged, nature-friendly spaces for self-sustaining habitats. Brown roof plants that can endure long dry periods are often selected (brackens). Little or no irrigation is required. Blue roofs can be provided under either green or brown roofs. Blue roof technology replaces underground storm water attenuation tanks, which were formerly fitted with hydro-brake (vortex flow) controls and provides the irrigation for green roofs.

The common theme with all these roofs is the use of thick layers 300 mm to 500 mm of thermoset insulation. Blue roofs also incorporate inspection boxes which may be plastic and on account of their size, they could not be subjected to testing in accordance with BS 476-3: 2012.

See also Example 9 *Deep dive – Roof testing and classification reports, roof terraces and Solar mounting standards* (above).

Building shape

Building shapes have become less ‘box-like’ and less ‘vertical’. Facades are now multi-faceted. Tall buildings particularly, tend to be the canvas for exploring modern building shape(s), façade composition(s) and integration with living gardens.

Building shape. Typical fire breakout from a post-flashover fire through an existing window, on a vertical façade, has been well studied and observed.

Fire breakout from a window/door in modern shaped facades is not so well studied because façade shapes are almost limitless. Façade shape may influence the Coanda effect. The Coanda effect is characterised by a flame front seemingly ‘adhering’ to a surface and this is a mechanism of fire spread. The effect of wind would complicate fire spread. Modern building facades can also step, stagger and twist as well as curve.

Façade composition

The effect of fire on multi-faceted facades i.e. facades which have spaces between elements or spaces between overlapping elements (‘articulated’ façades) and/or with air voids and air channels will behave differently to monolithic materials (brick or sheet panelling).

Interaction with living gardens. The greenification of buildings has resulted in a desire for architecture incorporating terraces, balconies (including inset balconies) and winter gardens with considerable plant life. At one extreme is the vertical forest concept [199]. The vertical forest concept, attributed to Stefano Boeri, is that the building becomes a large living breathing air filter. Reference [200] shows a landmark building in Milan (designed by Staefano Boeriarchitetti, completed in 2014) and Reference [340] shows the first known vertical forest in West Bromwich. Other vertical forest buildings have been built in Utrecht, Lausanne and Nanjing, and others are planned in Paris, Tirana and Shanghai.

See also section 3.4.7 *Investigation of real fires* (above) which considers green walls and living walls. Green walls and green floors/decking and grass (including artificial) all represent new fire risk considerations for tall modern building design.

Assembly buildings

The material of choice seems to be highly-insulated, metal-skinned external wall panel systems. Such wall systems are seen as an effective way of thermally insulating and getting a good 'look' for the building quickly. Also, panelised walls (offsite constructed walls) have become a popular choice.

Driver – The green agenda.

Evidence – See above.

Implication for AD B – It is important for AD B to remain relevant and current.

The challenge arising from Theme 9 suggests AD B could look at:

1) Adding clarity for the users of AD B for green wall and green roof guidance, to minimise risks of fire spread, either by the foliage or the carrier pots and or materials in combination.

2) The challenges described in Example 9 *Deep dive – Roof testing and classification reports, roof terraces and Solar mounting standards* (above).

3) The challenges described in section 6.1.9 *Provision of cavity barriers, construction and fixing of cavity barriers and openings in cavity barriers and Cavities in flats, Provision of cavity barriers, and Pathways around fire-separating elements*, (above) as they relate to conducting research, into the effect of building shape on fire spread.

4) Sandwich plate systems. This technology incorporates an organic filler core of unknown fire performance used as a structural floor in large buildings.

5) Man-made roof slates which have a resin binder to hold the dust together.

6) Composite imitation timber fencing and decking material. This is because the material could be used on buildings e.g. roof terraces or it could be located close to means of escape routes.

6.3.18 Theme 10: Co-living

Background – See Example 6 Considering the decarbonisation of the UK's transport sector (above) and Example 7 Considering the popular trend for co-living, (above). See also section 6.2.3 Survey Issue 2c: *Residential care homes – general provisions* (above).

Driver – See Examples 6 and 7.

Evidence – See Examples 6 and 7.

Implication for AD B – See Examples 6 and 7.

The challenge arising from Theme 10 suggests AD B could look at:

1) The outcomes of Example 6

2) The outcomes of Example 7

6.3.19 Theme 11: Multiple and different uses

Background – See Note 1 Table 3 *Priority ranking of themes* and Table *4 Priority ranking of themes (proposed priority adjustments)* (above). During the Technical Steering Group meetings, members were asked to consider the following:

> *"The note asked that Steering Group members consider change of use over the life of a building. When considering residential uses please change to any/all the following HMOs, Airbnb, holiday lets, apart-hotels and conventional flats. For other uses consider based on your own experience and if you have experienced new trends such as 'meanwhile' or 'pop-up' uses."*

Driver – Maximising the use of a plot.

Evidence – This theme was thought to exist whereby an architect might have designed a building for one purpose group e.g. general-purpose needs flats, but over the life of the building it undergoes a material change of use to say an HMO or Air BnB or an Apart hotel.

These changes would attract applications as material changes of use.

Implication for AD B – Is the guidance currently robust and clear for material changes of use?

The challenge arising from Theme 10 suggests AD B could look at:

1) Adding clarity for the users of AD B by providing separate material change of use guidance.

6.3.20 Theme 12: Multi-functional uses: Alternative and flexible

Background – See Note 2 Table 3 *Priority ranking of themes* and Table 4 *Priority ranking of themes (proposed priority adjustments)* (above). During the Technical Steering Group meetings, members were asked to consider the following:

> *"The note asked that Steering Group members consider designing for change from the outset. We want you to consider how commonly designers are saying to other designers, contractors and regulators that they want the building to be compliant for two or more uses. Is multi-functional use in this sense a modern trend or not widespread?"*

Driver – Maximising return on investment by having a building which can be readily adapted to more than one purpose group use.

Evidence – This theme was thought to exist whereby an architect might have designed a building for one purpose group, but the design was so flexible that the building could flip to another purpose group without any building work taking place e.g. an office use to a commercial use or an educational use to shop use.

On considering the Building Regulations 2010 UK Statutory Instrument 2010 No. 2214, it was apparent that it would not be possible to gain building regulations approval for 'floating uses'. The correct order of things would be as follows:

<u>Office use to commercial use</u>

This is not a change of use and so the building work would be assessed against 3(1)(b) or (c) for provision or extension of a controlled service or the material alteration triggers in 3(3). It would also be considered against the triggers of 3(3) is the building was to accommodate greater numbers – for considerations like means of escape.

<u>Educational use to a Shop</u>

This would be a Regulation 5(j) change of use for which Regulations 6(1)(a) and 6(1)(i) must be complied with and potentially, depending on height, 6(1)(c). Additionally, there may be material alteration triggers under 3(1)(b) or (c) and potentially 3(3).

It is highly unlikely that a building could enjoy multifunctional uses without regulatory oversight (and some building work being needed), such a concept if widespread does not translate to a flexible approval from the AHJ. This is not a modern trend and not widespread. A fresh building control application would be needed for both examples above.

What is more common are complex mixed-use buildings. The whole of the main report touches on revising AD B guidance to include non-standard buildings and mixed-use building guidance would be welcome by users of AD B.

Implication for AD B – There are no issues for AD B.

The challenge arising from Theme 12 suggests AD B could look at:

1) Adding clarity for the users of AD B by providing separate guidance for mixed use buildings.

6.3.21 Theme 13: Competing regimes

Background – See all the above examples whereby one part of Government introduced a Regulation, or a concession and it has unintended consequences for those using AD B.

Driver – Trying to do the right thing but implementing change too quickly.

Evidence – Very much all of the foregoing report.

Implication for AD B – AD B plays catch up.

The challenge arising from Theme 13 suggests AD B could look at:

1) More reviews like this but having them conducted more frequently.

6.3.22 Theme 14: Checking compliance in different ways: Digital and Artificial intelligence

Background – AI is bound to play a part in helping designers and AHJs check that designs comply.

Driver – Speed, consistency and safety.

Evidence – So many other walks of life are going down the AI route that demonstrating compliance with Building Control is a likely next step.

Implication for AD B – AD B could be involved in setting up AI platform(s).

The challenge arising from Theme 14 suggests AD B could look at:

1) Ensuring AHJ Officers can trump the algorithm and not blindly follow it.

7 Conclusions and recommendations for further work

This report contains a compilation of the findings of the project and provides draft options and recommendations for potential future work to address the identified issues and the challenges to AD B.

The project was delivered in three overlapping parts:

a) Literature review and historic survey data

b) Undertaking and reviewing of stakeholder survey (Volume 2 of this report contains survey response data)

c) Workshops to identify hot spots and key topic areas for future AD B review and development

Full details of all responses are present in Appendix A to this report.

Section 3 of this report identified and reviewed modern construction technologies and trends in design and building use. This revealed an abundance of drivers and challenges. The diverse nature of challenges impacting AD B was further shown by 11 Examples. Each Example was described in terms of its driver, its evidence, the issues impacting AD B, the implications for AD B and finally the challenges to AD B arising. Three of the 11 Examples were deep dives into specific topic areas.

Section 6 of this report identified implications for AD B (Volumes 1 and 2) and future work and direction to inform future AD B editions for each of the issues arising from:

a) The survey hot spots, and

b) The 14 themes identified during the workshop sessions with stakeholders including Departmental representatives. This section mirrors the structure used in presenting the 11 Examples identified in section 3.

The survey hot spots gave rise to focus on 17 issues affecting AD B Volume 1 and 15 issues affecting AD B Volume 2. Each issue was described in terms of its background information, its driver, its evidence (whether just respondent-driven i.e. derived from 'practitioner viewpoint(s)' or otherwise), the implications for AD B and challenges arising for AD B, with suggestions as to what AD B might address in the future.

22 consideration areas arising from the 14 themes, which were developed from the results of the survey work and subsequent workshops were identified and discussed in section 6.3. These are presented using the same structure as that used for the Survey Issues and 11 Examples cited in section 3.

Given the breath of information provided from this project all sections in the report need to be considered in toto. For each topic suggestions for future guidance, recommendations and research have been identified. Given the number of topics covered they have not been summarised again here but should be read in the context of the relevant sections and topics.

This work has proved to be a fruitful undertaking as it has shone a light on many matters affecting and potentially affecting AD B. It is, however, only a snapshot at a point in time. A review such as this needs to be iterative. The intelligence derived from constant horizon scanning would provide the Department responsible for AD B with continuous evidence, to inform its decision making.

A danger of not making this an ongoing and iterative review can be very clearly demonstrated by looking at Example 9 *Deep dive – Roof testing and classification reports, roof terraces and solar mounting standards.* This Example looked at the first limb of Schedule 1 requirement B4(2): *“The roof of the building shall adequately resist the spread of fire over the roof…”* This Example made it clear that there was a need to maintain a test method e.g. BS 476-3 which would allow for continued appraisal of surface spread of flame on roofs.

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Meetings were held on 13th January 2021, 24th March 2021, 23rd July 2021, 24th November 2021 and 22nd February 2023:

- At the first meeting, the proposed research approach was presented and discussed with a focus on the proposed survey inputs, outputs and analysis.
- At the second meeting, the reach and initial findings of the tailored survey and the compilation of future challenges (materials, methods, design and building uses) to date were presented.
- At the third meeting, Technical Steering Group members participated in an interactive session of three exercises with the aim of categorising the risks and frequency of the identified challenges.
  - Headline drivers and challenges to AD B previously identified and described in the Objective A report were reviewed and missing drivers and challenges were added.
  - Objective A, survey responses and Technical Steering Group members' feedback received to date placed under the headings, 'Modern construction technologies', 'Modern design' and 'Modern building use(s)' were considered and additional issues for consideration were added.
  - All comments were reviewed and grouped into themes. Each theme was considered and placed on the risk matrix for prioritisation. The matrix axes were frequency of occurrence and potential of risk (if AD B guidance was considered unclear or unavailable).
- At the fourth meeting, the Objective A theme rankings on the risk matrix were re-presented and confirmed, unchanged. Their prioritisation for progression to detailed review in Objective B and Phase C was discussed. One theme was considered to be outside the project scope, several themes were identified as being dealt with by other Workstreams and three themes were grouped together. In addition, the Objective B review of AD B provisions and comments/observations were presented in advance of the forthcoming detailed review workshops.
- At the fifth meeting, an overview of the draft Final report and a focus on section 6 (Future direction and work/research to inform future editions of AD B, themes and issues arising from the survey hot spots and the workshop sessions of the 14 themes) were presented. Technical Steering Group members were asked to provide input and feedback on this section at the meeting, particularly in strengthening the evidence base on some of the issues.

The following organisations were represented on the Project Technical Steering Group:

- Department for Levelling Up, Housing and Communities
- BRE Global (Project team)

- BRAC Working Group representative
- London Fire Brigade Fire Engineering Group
- Association for Specialist Fire Protection
- Association of Consultant Approved Inspectors
- Chartered Association of Building Engineers
- Construction Products Association
- Fire Industry Association
- Institution of Fire Engineers
- Local Authority Building Control
- National Fire Chiefs Council
- National House-Building Council
- Royal Institute of British Architects.

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Report Ends