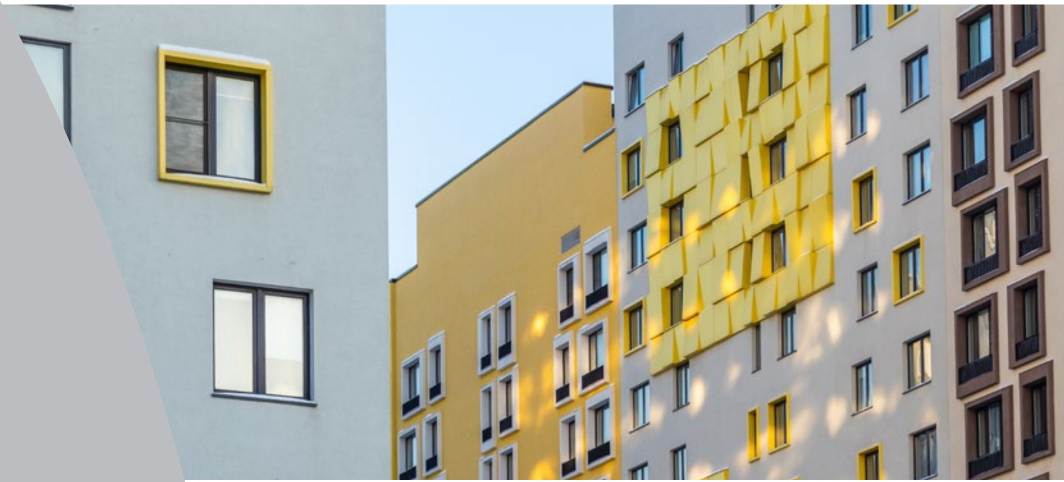
Advanced

Fire Safety in High-Rise Buildings

BS 8629 and Beyond



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Foreword

We are witnessing the biggest changes to fire safety for a generation. Accelerated by the Grenfell tragedy, the time has come to act.

Thankfully, our industry and its regulators are now addressing long-standing issues which have recurrently put lives at risk, property in peril and revealed low levels of care and competency in some areas of fire protection.

It is the publication of codes of practice, such as BS 8629, that prove we are starting to turn good intentions into tangible actions. However, real progress can only be made when we keep open minds, embrace change and invest time, effort and money in developing higher skill levels as well as new technologies that innovatively tackle the threat of fire.

The team at Advanced benefit from hundreds of years of combined experience in the development and delivery of automatic fire detection solutions for wide-ranging sites across the world. It therefore seems fitting for us to share our knowledge and spark discussion around pertinent issues at this pivotal time.

We hope that this e-book will add to the ongoing debate and give pause for thought about the best ways for us all to work together to improve fire safety – both now and in the future.

Ken Bullock
Business Development Manager

Executive summary

This document is intended as a source of background information, discussion and debate on the future of fire safety in high-rise buildings.

Its purpose is to:

- clarify the new regulatory regime overseeing fire safety in high-rise residential buildings containing flats.
- offer an overview of some of the solutions, whether included in the Fire Safety Act 2021, or not, which have relevance in high-rise fire protection.

More specifically, the following key topics are addressed:

BS 8629
What it means, how it works and how to specify a system that is fit for purpose, fully compatible with current legal requirements, and future-proof.

Fire systems
Why Part 6 is preferable to Part 1, how modern technology can help make high-rise buildings safe and why the system is one part of the wider solution.

Compartmentation
The vital importance of monitoring and maintaining compartmentation, how it works and why it must never be compromised.

Sprinklers
What benefits a sprinkler system can offer, why it is not the perfect solution some claim, and how it could work in a high-rise residential setting.

Cladding – What can go wrong, what are the short-, medium- and long-term solutions, how big is the problem, and how can we put it right.

Smoke control – Why smoke control hasn't caught on in the UK, why that may be about to change and why it must be done right if it's going to save lives.

Introduction

On the morning of 14th June 2017, the fire industry changed forever. Even now, years after the last flames were extinguished, the repercussions of the Grenfell Tower fire continue to be felt.

In fact, with the Grenfell Inquiry, the Fire Safety Act 2021 and the ongoing debate over who should pay for the replacement of defective cladding, the topic is rarely off the mainstream news agenda.

As an industry, we have faced several years of uncertainty following the Grenfell fire, with many short-term recommendations and changes to best practice raising more questions than they've answered.

Manufacturers like Advanced have worked more closely than ever with installers and end clients, particularly in high-rise residential blocks, to deliver short- and medium-term solutions, while never being completely certain what the eventual regulatory regime would look like.

Now, with the passing of the Fire Safety Act 2021, we finally have some clarity and, while the story it not over – the Grenfell Inquiry has yet to report – we can begin the process of moving forward and making high-rise residential buildings fit for the future. This makes it an ideal time to sit back, take a look at the new rules, and examine all of the factors involved in ensuring that Grenfell can never be repeated.

BS 8629: the new standard for high-rise residential evacuation in the UK

One of the key flaws that led to the tragic number of fatalities at Grenfell was the failure of the evacuation plan or, the almost total lack of one.

Despite lessons that should have been learnt from previous fires in high-rise residential blocks, the traditional ‘stay put’ policy was adopted despite the building’s compartmentation being compromised by unsuitable cladding – and there was no Plan B. With no fire drills, limited instruction and no effective communication between rescue services and residents, the devasting outcome was all but inevitable.

High-rise residential buildings present unique challenges that need to be considered when undertaking fire risk assessments.

> The number of storeys and quantity of flats on each floor, the presence of occupants requiring assistance and layouts involving long, complex escape routes are just some of the challenges to fire safety.

In the unfortunate event that a fire incident does occur, stay put is still required and proper evacuation strategies need to be in place to ensure that residents are alerted and evacuated in a timely manner, and that fire and rescue services can achieve rapid containment and suppression of the fire. At Grenfell, none of this occurred, and now we must live with the consequences.

The new BS 8629 British Standard Code of Practice recommendations attempt to help building owners, managers and fire brigades ensure that there can never be a repeat of the 2017 disaster.

The document specifies a dedicated building-wide evacuation alert control system for the first time. It also addresses other safety measures, such as the need to expand fire systems into flats themselves (not just communal areas), the requirement to educate residents on what to do in the event of a fire emergency, as well as the importance of regular drills and updates of the evacuation plan in line with evolving best practice.

The new standard applies to all high-rise residential structures in England and Wales, as well as those over 18 metres in Scotland, where it is mandatory. It lays out a series of design features and other criteria required to achieve an effective evacuation, controlled by the fire brigade.

The standard is applicable to both new and existing buildings, and it includes specifications for a new type of evacuation alert system comprising the **evacuation alert control and indicating equipment** (EACIE) with audio and visual alarm devices, to ensure simple, consistent and intuitive operation.

BS 8629 was introduced in November 2019 as guidance in England and Wales and is already in the Building Regulations (Scotland) domestic technical handbook (as amended in 2019). With the post-Grenfell call for enhanced rules and regulations showing no sign of abating, it seems very likely that it will become mandatory in England and Wales too.

Evacuation control

The concept of a dedicated evacuation control system is nothing new, having been used in the United States for decades, and the tallest UK skyscrapers have had them in some form for many years, but the concept of such a system in high-rise residential blocks of the type found right across the UK – i.e. the ones like Grenfell Tower – is a relatively new one.

The system recommended by BS 8629, for which Advanced and other companies have developed a bespoke solution, is relatively basic compared to those found in other countries. Put simply, it allows the fire services to control evacuation floor by floor according to the severity and location of the fire.

The guidance states that the evacuation alert control system should be installed where a 'stay put' policy is in force, so that it can be used to facilitate a timely and ordered evacuation for all residents. It must be standalone, with its only function being to assist fire and rescue services in the evacuation of the building.

To ensure total dependability and system integrity, it must also be completely independent of the fire system, as well as from other building management systems and apparatus such as lifts, gas valves, air conditioning and smoke control systems.

The new standard also recommends that local fire and rescue services should play an active role in the design and specification of every new system. This helps to guarantee it is fit for purpose, as well as ensuring that personnel are familiar with it in readiness for an emergency situation.

Key features

BS 8629 states that the evacuation system must include evacuation alert control and indicating equipment that can be operated by the fire and rescue services, along with audio and visual alarm devices in each apartment, providing clear evacuation signals to building occupants.

Most importantly, any compliant system must be simple and intuitive so that it can provide straightforward support to fire brigade personnel coordinating the evacuation of a high-rise residential building.

To the casual observer, these new UK-spec systems may appear somewhat low-tech. There is no graphics-rich touchscreen or LCD display, the evacuation alert control system instead employs a series of vertically-mounted manual switches, mirroring each floor of the building. Each switch uses LED technology to indicate whether the evacuation zone is active and to notify a fault.

While existing fire system devices are fully compatible with evacuation alert systems, the new BS 8629-compliant control panels are highly specialised items. Advanced is currently one of a handful of manufacturers to offer an EACIE system housed within a box specially-designed by Gerda Security to meet stringent anti-tamper standards.

Integrity

The integrity of any BS 8629-compliant evacuation system is a key factor in its design and specification as it must be assumed that the fire will already be advanced by the time it comes into action. This means that cable infrastructure must be protected, and circuit isolators need to be installed at the entry and exit points to each zone, as well as prior to cable entry into each flat.

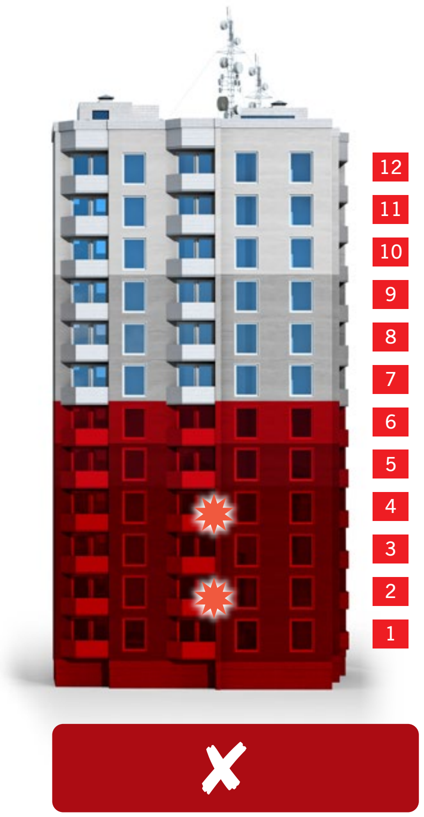
The precise rules differ according to the height of the structure.

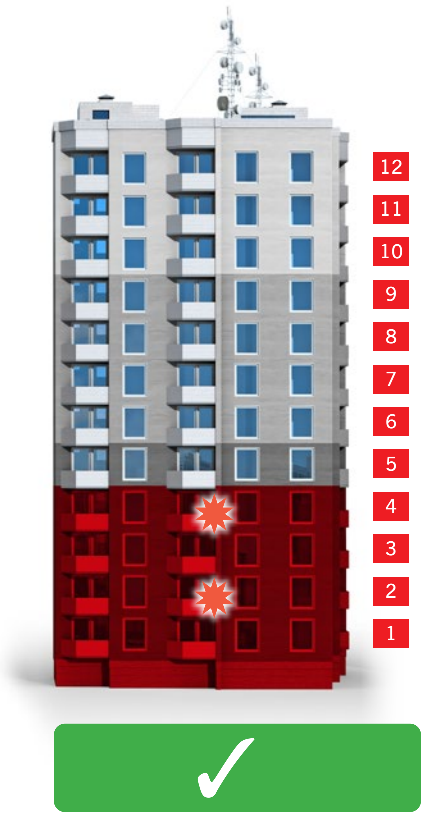
In buildings with fewer than ten storeys, two simultaneous faults on a single circuit should not disable the evacuation devices on more than half the number of storeys with flats.

In buildings with ten storeys or more, two simultaneous faults on an evacuation circuit should not disable the evacuation devices on more than a third the number of storeys with flats.

Any fault on a single flat's evacuation device should not be permitted to affect any other device elsewhere on the system.

Regular maintenance and testing are vital to ensure the readiness and reliability of the system. Full inspections should be undertaken every six months by a qualified engineer, and a yearly test must be completed on each sounder to verify its ability to function autonomously from the rest of the system. Systems will require a team of two engineers during the annual maintenance visit, one at the EACIE and one within the test zone, to verify the functioning of the sounders.



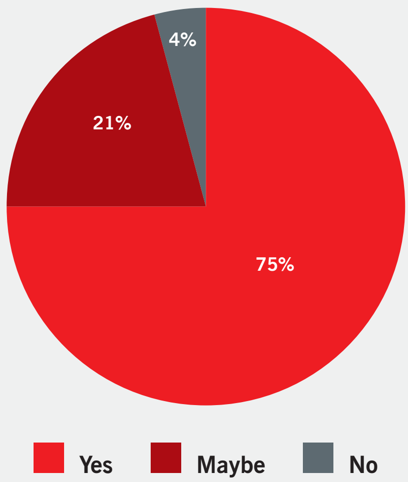


Saving lives

While some may see BS 8629 as overkill, the vast majority see it as overdue and, regardless of when it becomes law in England and Wales, we are already seeing rapid adoption of the system in association with other measures, such as upgraded fire systems, compartmentation improvements and sprinklers.

BS 8629 is no holy grail as a standalone system, but working in conjunction with enhancements to technology alongside human intervention, it can help to ensure that the lessons of Grenfell are learnt, and the mistakes are never repeated.

Would you consider installing an evacuation alert system into a high-rise residential building?



Source: *Advanced survey – Fire safety in high rise residential buildings*

Fire compartmentation: where compromise is not an option

Introduction

Fire compartmentation forms a vital part of the design of any modern building and, especially in the aftermath of Grenfell, we are learning even more about the importance of effectively dividing up large spaces to limit the spread of fire.

Compartmentation is just one tool in the strategic fire safety arsenal, and it can be combined with other passive and active safety measures to ensure the effective protection and evacuation of building occupants, if it's done right.

According to the Fire Protection Association (FPA), fire compartmentation gives a building's occupants additional time to evacuate before escape routes are potentially compromised by the spread of smoke and fire. It also decreases the danger to which fire and rescue services are exposed.

Compartmentation is also used to support specific fire evacuation strategies, such as defend in place strategies in blocks of flats – where each flat is designed as its own fire compartment, limiting the need for a full evacuation of a building in the event of a fire in one flat.

In residential buildings, the fire compartments are usually comprised of individual residential units, separated from each other by walls and floors made from fire-resistant materials, which create a barrier to the spread of fire and smoke for a specified time period. The challenge for modern fire engineers is not only to ensure that these are effective when initially constructed, but also that they are not compromised by subsequent refurbishment and 'improvements' to the building.

History

Fire compartmentation is not a modern concept. Many of the earliest industrial buildings sought to limit the risk of fires through the use of concrete or stone floors, thick walls and steel doors.

The earliest examples of attempts to segment and compartmentalise buildings to prevent the spread of fire actually date back to the aftermath of the Great Fire of London, when the *Act for Rebuilding the City of London 1667* contained the following clauses:[1]

- Walls of all new buildings were to be of brick and stone;
- Main streets were to be wide enough to prevent fire spread;
- The number of existing narrow alleys was to be reduced.

Fire safety, as a discipline and a specific career path, is a relatively recent phenomenon. Although many engineers in the late-Georgian and Victorian periods were aware of basic measures needed to limit the spread and extent of fire incidents, these were initially focused on industrial buildings. It was only as residential blocks grew larger and taller in cities like Victorian London, that increased attention was paid to effective measures in residential buildings as well.

The modern practice of actively designing PFP (Passive Fire Protection) into a building owes much to the lessons of World War 2 (WW2), when incendiary bombs demonstrated the shortcomings of existing buildings, especially larger apartment blocks in major cities. The overall aim of PFP is to slow the spread of fires by using fire-resistant materials in walls, floors and doors.

After WW2, *Post War Building Studies No. 20 Fire Grading of Buildings Part 1 – General Principles and Structural Precautions* introduced the basic concepts that have driven fire compartmentation ever since. These included a definition of fire safety requirements, how buildings should be subdivided, and the type of materials that should be used in building construction.

It was these guidelines that led to the development of modern fire standards, which in turn led to the practice of designing fire compartmentation into many of the high-rise blocks of the 1950s and 60s, including Grenfell.

Despite the modern reputation of these buildings as badly constructed, unpleasant places to live, the vast majority were actually built with fire safety in mind. The problem, however, is that, over subsequent decades, these measures have often been compromised by refurbishments, rendered ineffective by bad fire planning, or both.

1 IFP Magazine, Fire Compartmentation (Peter Stephenson), 27/11/2019

Effectiveness and compromise

When it comes to fire compartmentation, the word 'compromise' has two meanings. Firstly, that it is important not to compromise in the effective design of your building, and secondly that the compartmentation must not be compromised once it is in place. We will cover both of these distinct, yet inextricably linked, factors.

There are two basic elements that dictate the effectiveness of fire compartmentation. These are the efficacy of the compartmentation itself, both its original design and modern-day value, and how it fits into the overall fire strategy for the building, as dictated by the fire system, evacuation strategy and other systems, such as sprinklers.

The standards that dictated the original design of the building will depend upon when it was built. Until 2007, compartmentation was largely down to best practice and the viewpoint of the architect and specifiers. It was then incorporated into the ***Building Regulations (April 2007)*** and, since 2019, it has been governed by ***Approved Document B (fire safety) volume 1: Dwellings, 2019 edition***, with subsequent amendments in 2019.

One major change since Grenfell has been an enhanced recognition of the role that compartmentation has to play within an effective fire strategy, coupled with growing awareness that many buildings that were presumed to be fireproof are, in fact, nothing of the sort.

At Grenfell, the compromise was caused by the defective cladding allowing the flames to bridge the gap from apartment to apartment, but the compromise is just as often caused by internal issues, such as holes drilled through walls to allow the installation of central heating in buildings that originally had ducted electric heating.

To be effective, compartmentation needs to work for long enough to make a 'stay put' policy effective, and also to allow controlled evacuation.

Coupled with new guidance on effective fire alarms, which must now be extended to cover residential units, and the new BS 8629-compliant evacuation systems, compartmentation can play a vital role in saving lives in a fire situation.

The key point, however, is that one will not work without the other. Effective compartmentation buys the fire service the time they need to make people safe, but if it has been compromised, the active fire and evacuation systems will be rendered ineffectual.

According to Dr Stephen Hunter, "In the event of fire, a pencil-sized hole (6mm x 6mm x 3mm) between compartments would take just four minutes before a person would not be able to see their hand due to smoke."[2] This clearly shows the risk that can be posed by ineffective or compromised cladding. The challenge of maintaining it is all the greater when you consider that these issues will often be hidden within voids, behind kitchen units or under baths. The good news is that, once identified, these breaches of the compartmentation can often be overcome relatively simply with the use of approved seals, fire resisting ducts, fire resisting dampers and service ducts.

Complying with regulations

While compartmentation can be used for life safety or property protection purposes, the former will always be the overriding concern in any high-rise residential building. In addition to protecting the residential units themselves, the purpose of compartmentation will likely cover protecting or sub-dividing escape routes – including corridors, stair enclosures, refuge areas, lobbies and lift shafts.

Approved Document B, Volume 2 (2019) defines a fire compartment as:

"A building or part of a building comprising one or more rooms, spaces or storeys constructed to prevent the spread of fire to or from another part of the same building or an adjoining building."

This can be achieved by the installation of fire-resistant walls and floors offering between 30 and 120 minutes fire resistance. According to guidance issued by the Fire Protection Association (FPA):

"The wall or floor must remain functional for the duration of the designed fire resistance period. The compartment wall or floor should not crack or develop holes that allow flames, smoke or hot gases to pass through it, and if appropriate, it should maintain a suitable degree of insulation."[3]

2 IFP Magazine, Post-Grenfell realisations about compartmentation for fire safety (Dr Carl Hunter), 24/08/2017
3 Fire Protection Association, What is Fire Compartmentation, 16/11/2020

Approved Document B Tables B3 and B4 provide detailed information regarding the minimum periods of fire resistance required in buildings for different purpose groups and maximum permitted compartment sizes.

How to achieve fire compartmentation

Source: *The FPA*

Fire resisting construction and cavity barriers, with any fire stopping if necessary.

Approved Document B refers to a cavity as any concealed space and states that cavity barriers should be provided in the following situations:

- To divide cavities at junctions and cavity closures
- To close the edges of cavities at junctions and cavity closures
- To protect escape routes and cavities affecting alternative escape routes
- Fire doors together with its frame and furniture, intended when closed to resist the spread of fire and/or toxic gases and meet the requirements of BS 476-22 and or BS EN 1634-1.
  (Please refer to Approved Document B, Volume 2 (2019), Table C1 and B5 regarding incorporating glazing in the design of the door.)
- In blocks with old-style ducted air heating systems, fire dampers in air handling ductwork are generally actuated by automatic smoke detection or thermally actuated devices and are sited where ductwork penetrates the fire resisting construction.

Summary

In the post-Grenfell period, effective compartmentation is more important than ever. It is vital that it is delivered in new buildings, and that existing buildings are thoroughly checked to ensure that their compartmentation remains fit for purpose and has not been compromised.

Legal regulations should be treated as a minimum level of compartmentation and we should look to increase its effectiveness where possible, either through enhancement of the protection afforded to each residential unit or to the building as whole.

It is also important to view effective compartmentation as one part of a wider fire prevention, limitation and evacuation strategy in order to maximise the benefits that can be derived from it.

Active systems such as sprinklers, building-wide fire systems and BS 8629-compliant evacuation alert systems can help to augment the advantages of effective compartmentation.

Most importantly, never compromise on your investment in fire compartmentation, and never compromise the compartments themselves through later additions or improvements to the building.

Cladding and the lessons Grenfell has taught us

Introduction

If there is one word now guaranteed to alarm any fire industry professional, it is 'cladding'. Ever since the tragedy at Grenfell, there has been a steady flow of coverage detailing how defective cladding led to the deaths of 72 people back in 2017. We still don't have the official verdict on how unsuitable cladding came to be used, but we do know that it contributed directly to the spread of the fire and to rendering the building's compartmentation effectively obsolete.

The key point to make is that cladding in itself is not dangerous. When it comes to effective insulation of a non-traditional building there are only really two options, interior or exterior insulation. The former can take a big chunk of interior space, so external cladding can be a great asset, when used correctly. This means investing in the right materials, fitting them properly and ensuring that you do not compromise existing safety measures designed into the building – basically, many of the things that didn't happen at Grenfell.

With 30 years of malpractice and over 2,000 high-rise buildings still to make safe, the process of making good the mistakes of the past is really just beginning, but steps are at least being taken to make it happen.

History

While cladding of the type found at Grenfell is a relatively modern concept, the idea of cladding a building is nothing new. In fact, many medieval cathedrals are made from rough stone, or even rubble, that has been clad in dressing stone to create the overall effect of grandeur and symmetry.[4]

In terms of wood and similar materials, evidence has been found in the United Kingdom of wooden cladding being used as early as 500AD, and it was used extensively in Scandinavia from the 12th century onwards. Initially, wood cladding was used to protect more vulnerable materials, such as wattle and daub, which led to the development of interlocking wood cladding in the 16th century.

It was the development of wood and steel frames that spurred the development of modern cladding, allowing lightweight materials to be used as a form of insulation and decoration on any building, although the development of industrial brick manufacturing led to this being the prevalent form of construction in the UK for much of the 19th and 20th centuries.

In the years after the Second World War, the search for cheaper and more efficient building materials led to rapid developments in the manufacture and capabilities of cladding panels. They became a popular solution for steel-framed buildings and, as the flaws of 1960s housing developments were exposed, cladding was also seen as a cheap and effective way to improve these buildings, both environmentally and aesthetically.

Starting in the early-90s, cladding became the go-to solution for both modernising existing buildings and completing new ones. Across the UK, thousands of buildings were covered with multi-coloured panels with mixed degrees of aesthetic success – although that is a debate for another day.

The problems arose in the challenge of making cladding that was both fireproof and weatherproof. The only material that is both insulative and fireproof is asbestos, and when this fell out of use from the 1970s onwards, manufacturers were forced to develop alternatives.

Unlike internal insulation, there is a limit to the weight and thickness of cladding that can be applied to any building, while it also needs to be protected from the weather. Therefore, all modern cladding is the result of a compromise between weight, weather protection and insulation, which becomes even more complex when value for money is added to the equation.

4 Bushbury Cladding Ltd, The History of Cladding (23/09/2019)

The problem

As mentioned above, all external cladding is a compromise between numerous, non-complementary factors, all of which need to be balanced in order to deliver a product that is fit for purpose.

Acceptable forms of cladding should be certified, in theory at least, by a combination of laws relating to fire safety, building regulations and insulative qualities. Problems arise when cost becomes a primary factor and manufacturers seek to develop cheaper products that are within the letter, if not the spirit, of the law. This is what happened in the UK, culminating ultimately in the events of Grenfell.[5]

It is not the purpose of this paper to deliver an in-depth analysis of the issues that led to Grenfell, nor to allocate blame. However, it is quite clear, even before the final report is released, that there was a culture of cost saving in the industry and many professionals knew that defective cladding was being applied to buildings, with the potential for deadly consequences.[6]

The problem at Grenfell was that the flammable cladding acted like a telegraph system for the fire, allowing it to bridge the compartmentation measures designed into each flat by the 1960s architects. The cladding was legal in the UK for low-rise blocks, but not certified for high-rise residential as it only had an E fire rating, not the required B. The problem was further exacerbated by the use of a cassette fixing system, which had failed many fire tests that alternative riveted systems were able to pass.

In the end, it all came down to cost. The defective cladding at Grenfell was chosen in order to help reduce a £400,000 overspend on the wider refurbishment project.

Cladding and compartmentation

As mentioned, Grenfell was built with compartmentation of each residential unit to facilitate a ‘stay put’ strategy in the event of a fire incident.

Appearing on the BBC immediately after the fire, one of the building’s original architects blamed the cladding for the failure of these measures, and this appears to be borne out in a 2018 interim submission to the Grenfell Inquiry by fire safety expert, Dr Barbara Lane, in which she states that the internal compartmentation had done its jobs, while the flames moved across the external cladding of the building.[7]

The compartmentation in the Grenfell Tower extended beyond the external walls in a series of horizontal fire stops, which were covered in cladding as part of the refurbishment process. This not only allowed the flames to move across the surface of the building and around the concrete stops, but it also created 50mm gaps between the outer panelling and the insulation, which became vertical voids that carried the flames up the building, fuelled by the flammable insulation.[8]

As there is no evidence that the internal compartmentation was compromised by the refurbishment or breached by the fire, and as other measures such as fire doors appear to have done their job, it is reasonable to conclude that the cladding was the primary reason for the rapid spread and high death toll of the Grenfell fire. The report also shows that effective compartmentation remains a key tool to successful limitation of fire incidents and evacuation of high-rise buildings, but it is only as good as the associated infrastructure of the building and must never be comprised, internally or externally.

The numbers

In total, Inside Housing has estimated that almost 600,000 people living in high-rise buildings in the UK have been affected by the cladding crisis, with 56,000 people in buildings with aluminium composite material (ACM) cladding of the type found at Grenfell.[9]

In June 2020, there were estimated to be 300 towers still awaiting work to make them safe, compared to more than 400 in June 2017, although this does not account for buildings with timber, high-pressure laminate and polystyrene cladding and insulation systems. These are big numbers, and the government has pledged £3.5 billion for making good the affected high-rise blocks, yet this does not take into account thousands of other low-rise buildings with defective cladding.[10]

The total cost of the Grenfell disaster has not been calculated, but it includes more than £75 million on rehousing, £32 million to make safe and demolish the shell of the tower, and £24 million (and counting) on the Grenfell Inquiry itself. The cost to replace cladding on hundreds of residential buildings across the UK is expected to breach £5 billion.

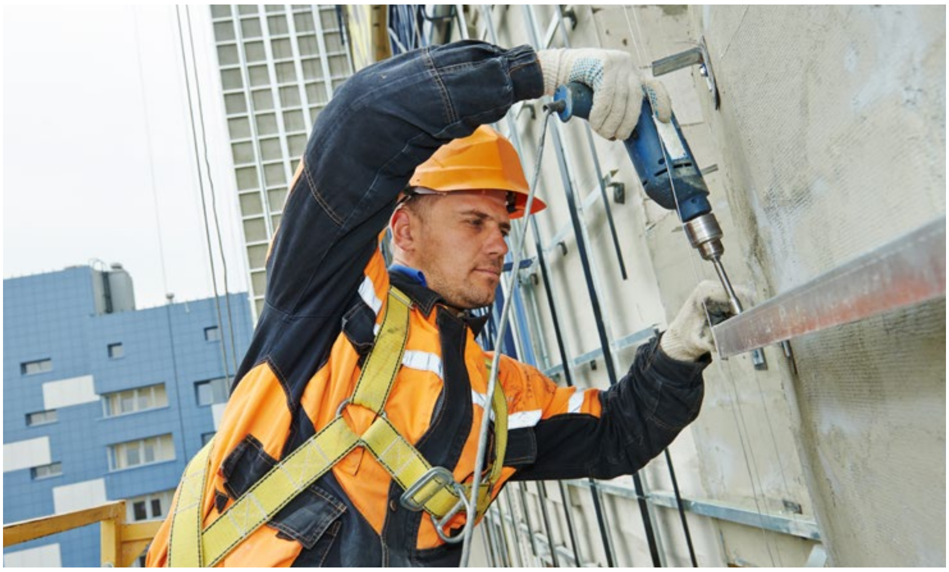
5 IFSEC Global, The road to Grenfell: A disaster they knew would happen, Mike Fox (07/04/2021)
6 BBC News, Grenfell Tower inquiry: 9 things we now know about the cladding, Tom Symonds (23/03/2021)
7 Grenfell Tower- fire safety investigation, Dr Barbara Lane (05/03/2018)
8 Architects for Social Housing: The Truth about Grenfell Tower (21/06/2017)
9 Inside Housing, Fact check: how many people in buildings with dangerous cladding?, Peter Apps (30/06/2020)
10 Daily Mail, Boris Johnson pledges to help victims of the cladding scandal, Miles Dilworth (04/02/2021)

Regulation

The official guidance on fire resistance for cladding in UK residential buildings is known as Class 0 (Zero). It was written into official guidance in Part B of the Building Regulations 2000 (Modern Regulations 2000) and it states that 'the external walls of the building shall adequately resist the spread of fire over the walls and from one building to another, having regard to the height, use and position of the building'.[11]

Because the Grenfell cladding was on sale legally, given that it was permitted for use on low-rise buildings, the government argues that the regulations were not at fault. Rather, the fault lay with the specifiers and designers of the Grenfell refurbishment, as well as with the suppliers and manufacturers who failed to point out that it was not fit for purpose. It therefore seems clear that government regulations and guidance were not aligned with industry practice at the time of the Grenfell refurbishment.

Dame Judith Hackett recognised this issue in her report on building regulations and fire safety in 2018, stating: 'It is not realistic to expect guidance to stay ahead of changing practice if it is owned by government, especially in an industry which is as fragmented and diverse as the built environment sector'. She further recommended that the UK government draft Building Regulations and set the outcomes to be achieved, then ask the construction industry to produce the detailed guidance required to meet these outcomes.[12]



There is no simple answer to this, but there was clearly an issue with a system that allowed defective, flammable cladding to be in place on the Grenfell Tower when it was not legally approved for high-rise use. Not only that, the manufacturers knew it was flammable, and none of the additional tests required to permit its use were actually carried out.

Summary

The issue at Grenfell Tower was not the lack of a suitable cladding. Alternative cladding and fixing systems were readily available that together would have mitigated all of the issues that rendered the compartmentation obsolete and led to the rapid spread of the fire. The problem was a culture of ignorance, cost cutting and disregard for the facts, built up over almost three decades.

Cladding is, in fact, an excellent product that can insulate buildings, cut bills and help the UK to reach carbon reduction targets, without comprising compartmentation or fire protection, but only when it is specified and installed correctly. The right products are out there, which will mean that all defective cladding can be removed and replaced with a product that is fit for purpose, but it's going to take time and it's going to cost billions.

The sad fact is that it took Grenfell to understand the issues with defective cladding, and the human cost goes beyond the victims of the fire itself, with many homeowners left in limbo, unable to sell their apartments and facing huge bills for cladding remediation. Even with the extra government help, many people will end up out of pocket or even homeless.

The challenge for the fire industry and for government is to learn the lessons of Grenfell and transform the culture of this sector, transferring the focus from cost cutting to public safety above all other considerations.

11 Oxford Law, 'Class 0' and Government Guidance on Building Regulations, Jonathan Carrington (13/01/2019)
12 HMSO, Building a Safer Future, Dame Judith Hackett (May 2018)

Fire systems: Grenfell and its implications

Introduction

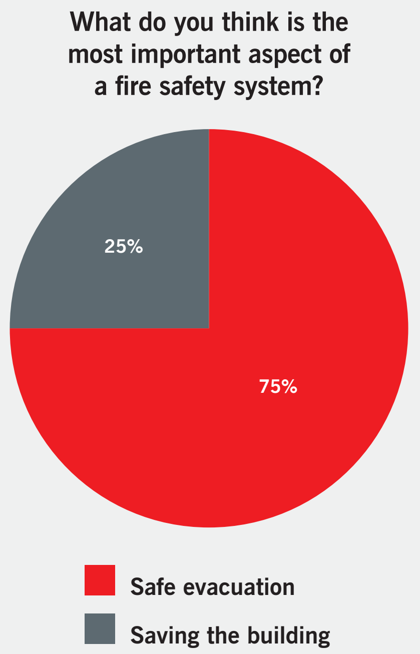
Fire systems lie at the heart of fire detection, evacuation and control in any high-rise residential building. They need to be installed properly, tested regularly and operated correctly in order to perform as they should, and they are only as good as the passive measures in the buildings they protect, as we saw at Grenfell. Following the sad events of 2017, there has been widespread uncertainty over fire system requirements and best practice in high-rise residential buildings, which it is now important to clarify.

The key factor to consider in any high-rise residential building is whether it has been compromised in any way by defective cladding, breaks in compartmentation or any other factor that is likely to render a traditional 'stay put' policy ineffective. Where this occurs, you are going to require at least a temporary Class 1 installation or Waking Watch until the problems have been dealt with. Where there are no issues with the building fabric, 'stay put' remains the preferred strategy in a fire situation. In this case, a Class 6 fire system with a BS 8629-compliant evacuation system is the basic requirement.

There has clearly been much confusion over what is required, with multiple changes in legal standards, best practice and government guidelines generating mixed messages for our industry.

Many professionals have simply assumed that a Class 1 system is now a basic requirement, whereas in fact there are 20-30 fires in high-rise flats in the UK every week, more than 90% of which never spread beyond a single unit.

This means that, in the vast majority of cases, alerting and evacuating the whole building is likely to be both unnecessary and counter-productive, which is why 'stay put' is still the best policy, provided that a BS 8629-compliant system has been installed.



Source: *Advanced survey – Fire safety in high rise residential buildings*

History of fire alarms

Fire alarms have been around for centuries in the shape of whistles and church bells. This evolved into manual bells in buildings, perhaps accompanied by a fire position with sand buckets and early types of fire extinguisher, but the modern concept of a fire system emerged around the 1850s when two Americans, Moses Farmer and William F Channing designed what can most simply be described as a telegraphic key. When someone detected a fire, they would crank the handle, which would then send the box number to a central alarm station. As soon as the telegrapher received the message, they would notify the fire department team of the box location.[13]

The first automatic electric fire alarm was patented by another American called Francis Robbins Upton, an associate of Thomas Edison, in 1890. While he is widely recognised for creating it, however, it clearly didn't catch on and details of how it worked are sketchy.[14]

In 1902 George Andrew Darby, an English electrical engineer, patented the electrical Heat-Indicator and Fire Alarm. The device was actually a heat detector that sensed an increase in temperature in the space where it was installed.[15] Darby's device never really caught on, however, and the more commonly recognised inventor of the modern smoke detector was Swiss scientist Walter Jaeger, who created it almost by accident while attempting to develop a poison gas detector. It was his research that led to the eventual invention of the first ionising smoke detector, which went on sale in the USA in 1951.[16]

You may notice a trend here towards the USA leading the way, and that of course is no accident given the preponderance of high-rise buildings in that country. The first domestic fire detectors went on sale in 1955, followed by low-cost battery

13 Protect & Detect, The History of Fire Alarms and Smoke Detectors
14 Google Patents, FR Upton & FJ Dibble: Portable Electric Fire Alarm, 23/09/1890
15 New World Encyclopaedia, Smoke Detector
16 United States Nuclear Regulatory Commission, Background on Smoke Detectors, 07/01/2021

detectors in 1965, and the first optical smoke detector in 1972. This coincided with rapid developments in compartmentation, smoke control, sprinklers and evacuation systems, culminating in the highly complex fire prevention, alert, smoke control, and evacuation systems we find in US high-rise buildings today.

In the UK, fire systems developed more slowly, and largely independently of the US and Europe, which is how we became more focused on the 'stay put' policy and less on technological advances. Although modern fire panel and detector technology was adopted, there was less focus on evacuation systems and smoke control, and a single staircase was considered adequate in buildings with compartmentation measures built in.

'Stay put' and fire alarms

The development of fire alarms in high-rise residential buildings in the UK is tied inextricably to the 'stay put' policy, and has been for almost 60 years. One has signposted the evolution of the other and, even after Grenfell, this link has not been severed. So, how did this come about?

The 'stay put' policy, has been much maligned in the aftermath of Grenfell, but it remains fundamentally sound in buildings where passive safety measures have not been compromised. It was first introduced as CP3 chapter IV part 1[17] of the British Standard Code of Practice 1962, the first national standard for high-rise residential buildings. It required all blocks taller than 80ft (24.4m) to provide one hour's fire resistance to allow controlled evacuation and allow firefighters to enter the building.[18]

The code stipulated that each flat should act as an individual compartment, which is exactly what Grenfell Tower was designed to do. For 'Stay Put' to work, however, the passive fire protection could not be compromised in any way, and there had to be clearly signed routes for the fire brigade to enter. If the compartmentation ultimately failed, firefighters were then required to knock on doors to facilitate the evacuation, floor by floor, as dictated by the spread and seriousness of the fire.

Of course, in 1962, fire systems remained in their infancy and evacuation control systems were unheard of. In fact, the writers of the code considered fire alarms to be undesirable, fearing that they could fear-trigger a general evacuation of the building, impede firefighter access to extinguish the fire and even cause a crush situation in the most extreme circumstances. In other words, given the technology of the time, 'stay put' was a compromise, but nevertheless the safest solution in most fire situations.

In 2018-19, the first full year after Grenfell, there were 802 fires in high-rise blocks over 10 storeys in the UK, of which only six resulted in fatalities. While six deaths are six too many, these statistics do serve to underscore the inherent sense of the 'stay put' policy, which ensures that whole building alerts and evacuations are only necessary in the most extreme incidents, probably less than five percent in total. The problem arises when the compartmentation measures are compromised, which then results in rapid fire spread to multiple flats over several floors, which is exactly what happened at Grenfell.[19]

17 Local Government Group, Fire systems in purpose-built locks of flats, 2011
18 Inside Housing, Where did the stay put policy come from and where do we go now, 31/10/2019
19 The Home Office, Fire & Rescue Incident Statistics 2018-19

Where we are now

The type of fire alarm in any high-rise residential building in the UK is currently determined by the existence, or otherwise, of uncompromised compartmentation and flammable cladding. If the building is fault-free with no defective cladding, a Class 6 fire system is required, ideally combined with a BS 8629-compliant evacuation system, which is currently highly recommended in England, but only mandated in Scotland. If the building has cladding or compartmentation issues, a Class 1 system is required, or alternatively a 24/7 Waking Watch to ensure all floors of the building are regularly patrolled and checked for fire.

So, for the long-term, 'stay put' remains the preferred policy of the UK government and most fire safety experts, despite the clear failures that led to the high loss of life at Grenfell. The truth is that 'stay put' in itself did not fail. The biggest failure was, of course, the flammable cladding, which led in turn to the failure of the compartmentation designed into the fabric of the building. There were also issues with the fire alarms, which allegedly could not be heard in certain apartments, ironically due to the fire doors, but in any case, the rapid spread of the fire made a traditional door knock evacuation impossible.

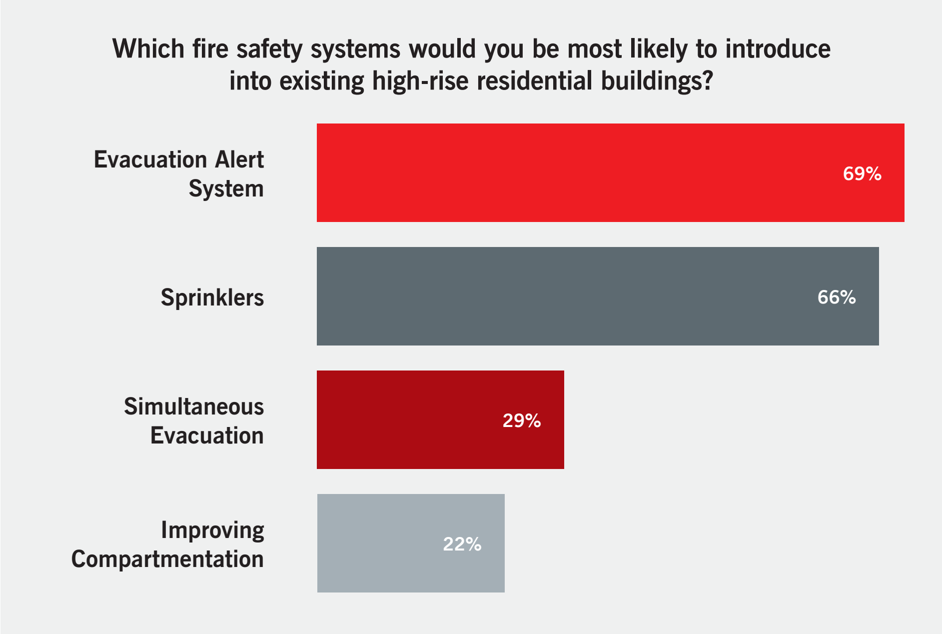
For now, the focus will very much remain on keeping the occupants of compromised buildings safe until their issues can be rectified, while also ensuring that other buildings are upgraded to offer the highest levels of protection and reassurance for residents. With no sign of a rapid resolution to the cladding problem, mainly due to the debate over who should pay for it, the primary focus is on replacing expensive Waking Watch with Class 1 systems. The good news is that these can often be installed in such a way that allows conversion to a BS 8629-compliant system in the future e.g. using 120-minute fireproof cable on the fire system installation that would be needed for the subsequent evacuation system.

Moving forward

Looking to the future, the good news is that BS 8629-compliant evacuation systems allied to Class 6 fire systems, covering communal areas, staircases, lift shafts and service areas, clearly offer the best combination to ensure that fires in high-rise buildings are rapidly contained, with no need for building-wide alerts and evacuations.

> Door knock evacuations were always the weak link in any 'stay put' strategy and BS 8629 effectively provides the missing piece in the jigsaw by allowing firefighters to control evacuations floor by floor from a single location, should the need arise.

Eventually, we will be in a situation where all of the defective cladding is removed, and all compartmentation will have been checked for breaches. When that happens, and our industry finally adjusts to a new normal, we need to remember that fire systems and effective evacuation strategies are only as good as the people who manage them. Grenfell has not only shown us that fire does not compromise, it has also shown us that we can't either.



Source: *Advanced survey – Fire safety in high-rise residential buildings*

Sprinkler systems: the magical solution?

Introduction

In the immediate aftermath of the Grenfell tragedy, there was a tendency among the UK public, driven by some sections of the media, to view sprinklers as the panacea that could have prevented the whole thing, or at least reduced the dreadful loss of life. However, as we often discover in our industry, while sprinklers certainly have a role to play, they are not the magical formula they are sometimes made out to be, especially in a residential environment.

Of course, the debate over sprinklers is nothing new. For at least the last decade, there have been calls for compulsory fitting of sprinklers in all new high-rise residential blocks, and a staged timetable for retrofitting in existing buildings. With just 16% of UK fires being in residential units, yet accounting for 79% of total deaths, the calls for action would appear to be justified, but the question we need to ask is whether sprinklers are a complete, or only partial, answer.

Successive reports by the Building Research Establishment (BRE) concluded the following:[20]

- Fitting sprinklers in all new residential buildings is not cost-effective.
- Sprinklers are cost-effective in new care homes and halls of residence.
- Sprinklers may be marginally cost-effective (i.e. the proof is not statistically significant) in new blocks of flats, blocks of sheltered accommodation and 'traditional' HMOs

The disadvantages of sprinklers include the fact that they are often not activated until the fire is well-established, which can lead to delays in waking building occupants, during which time they could be affected by smoke inhalation. It is also possible that the steam produced by rapid extinguishing of a fire by sprinklers could, at best, hinder the ability of residents to escape and, at worst, cause just as much harm as smoke inhalation.

None of this means that sprinklers are a bad idea, far from it. What it does mean is that we should not regard them as the answer to all our problems. As Andrew Lynch, editor of Fire Magazine, wrote in 2019,

> "Investment in research and innovation is required to develop a panoply of fire safety measures".[21]

History

According to Dakota Murphey, writing in IFSEC Global, the sprinkler system actually has its roots in the inventions of Leonardo da Vinci, who designed a system to put out fires in an automated kitchen he was building. It met with mixed success as, although it put out small fires, it also tended to ruin all the food in the kitchen as well.

In 1723, a basic system was devised by Ambrose Godfrey, better known today as the inventor of the fire extinguisher. This involved a series of trigger fuses, which would be lit by the fire and ignite small charges of gunpowder, thereby releasing water onto the source of the fire. Its success, or otherwise, is not recorded.

The first modern system, which can generally be viewed as the precursor of what we have today, was installed at the Theatre Royal Haymarket in 1812. Designed by William Congreve, this comprised a 100-tonne water tank leading to a network of pipes throughout the building with holes drilled into them.

The first (gunpowder-free) automatic sprinkler was invented by Henry S Parmalee of New Haven, Connecticut, in 1874. This comprised a proper sprinkler head with an internal bulb that was shattered by the heat from a fire, thereby releasing the flow of water. Development then continued almost incrementally until the invention of the modern Pattern Sprinkler head in 1953, vastly improving the range and effectiveness of sprinklers.

Since then, the design of the sprinkler head itself has hardly changed, although the systems that control and regulate sprinklers have improved massively, giving far more control over how and when they operate, while also allowing far better targeting of fire at the source, without the need to soak whole areas.

In 2011, the Welsh government said that all new homes built from 2016 should have sprinkler systems installed, while Scotland mandated their installation in all new flats from 2017. They are also now set to become mandatory in all residential buildings over 11 metres in England.[22]

20 Cundall, Residential Sprinklers, Steve Cooper (2012)
21 Fire, Searching for a panacea, Andrew Lynch (March 2019)
22 IFSEC Global, A history of fire sprinklers, Dakota Murphey (01/05/2019)

Effectiveness

Sprinklers do save lives. According to studies by the BRE, they can reduce the death rate for residential fires, especially in high-rise buildings, by constraining the size of the fire and by controlling the flames for long enough to facilitate an orderly evacuation. Compared to an overall death rate of 7 deaths per 1,000 fires with no sprinkler or alarm, there were around 3.89 deaths with sprinklers installed, which was further reduced to 1.46 with both a sprinkler and a fire alarm.[23]

The same report by the BRE included the following executive summary, quoted here in detail because of its effective summation:

- For the majority of scenarios experimentally studied, the addition of residential sprinkler protection proved effective in potentially reducing casualties in the room of fire origin and connected spaces
- Sprinkler protection was not found to be a complete panacea, slow-growing and shielded fires can be a problem
- Smoke alarms, fitted in the room of fire origin, responded typically in half the time required by sprinklers and well before the conditions had become life threatening
- Closing the door to the room of fire origin, was found to be effective in keeping tenable conditions in connecting spaces
- Residential sprinklers are probably cost-effective for residential care homes (old persons, children and disabled persons' care homes)
- Residential sprinklers are probably cost-effective for tall blocks of flats (eleven storeys and above)
- Residential sprinklers are not cost-effective for other dwellings
- In order for sprinklers to become cost-effective, high-risk buildings may be targeted, and justified on a case-by-case basis using the cost-benefit approach
- In order to be cost-effective in a broader range of dwellings, installation and maintenance costs must be minimal, and/or trade-offs may be provided to reduce costs by indirect means
- In general, the cost/benefit conclusions from other countries' experiences also showed that sprinklers were not cost-effective, unless systems were low cost or trade-offs could reduce costs.

In the aftermath of Grenfell, it is probably fair to assume that the focus on costs and value for money will be less of a consideration, but these must be factored in nevertheless, especially in buildings where all costs are borne collectively by the residents. As a mechanical system, sprinklers need regular maintenance and testing, so long-term costs need to be taken into account as well. Sprinkler installation is also likely to cause major upheaval as pipes are run throughout the building, including inside each residential unit.

The first priority for all building designers and specifiers is to prevent a fire from happening in the first place. Passive prevention is the holy grail as it effectively negates the need for detect, alert and extinguish. Yes, you still need the right systems for all four, but if you get prevention right, the other systems will never be needed.

The next stage is detection, which relies on sensors and a smart panel, using cause and effect to determine the validity, scale and nature of the fire event. These systems move very quickly to alert, with sprinkler systems sitting in their own zone somewhere between alert and extinguish. They aim to achieve the latter, but they rely very heavily on the fire systems to tell them where the fire is, and where the water needs to go. Get this wrong, and the costs can be high, fire or no fire.

So, from a purely emotional, non-regulatory point of view, sprinklers can be highly effective in high-rise buildings, but they are only as good as the fire detection and alert systems they are working with. There are some risks associated with them, such as the potential to deploy after smoke has already got to building occupants, but if the alerts are working as they should, that will be less of an issue. Sprinklers also have the potential to put out the fire before it spreads beyond a small area, but to do this they are wholly reliant on the performance of the wider fire system.

23 British Research Establishment (BRE), Effectiveness of sprinklers in residential premises (February 2004)

Public perception

Among some members of the public, probably due to misleading information in the tabloid press, sprinklers are the answer.

> There is a widely-held assumption that if you have sprinklers installed, you don't need an evacuation system, waking watch or anything else, and you can even leave your defective cladding where it is. None of this is true.

As we've already seen, sprinklers are just one cog in a much larger machine, and this is probably one of the reasons why many countries, including England, have been slow to legislate for their compulsory installation in new or existing residential blocks.

Following the Grenfell fire, the British Sprinkler Alliance (BSA) put out a statement saying:

> "Regrettably, Grenfell Tower did not have a sprinkler system and if there had been one installed, it would have undoubtedly saved lives and the outcome of this tragic event would have been far different."[24]

Subsequently, other people came out and said the same, including one contractor who claimed they could have given a "99% chance of survival"[25], but the truth is not necessarily so clear cut.

Grenfell only had fire sounders and detectors in communal areas, stairways and landings, so it is unlikely that the fire, which is believed to have started in a kitchen, would have been extinguished by sprinklers before it reached the infamous cladding, which acted as a catalyst to spread the flames around the building. With no sounders in the flats, many residents might already have been overcome by smoke by the time the sprinklers were activated and, in the absence of an effective evacuation plan, there can be no certainty that 99% of people would have escaped.

Would fewer people have died in Grenfell if there had been sprinklers? Possibly. Would the installation of sprinklers have necessitated the installation of a more effective fire system? Almost certainly. Would sprinklers have saved everyone, given the lack of an effective evacuation plan and regular drills? Almost certainly not.

Sprinklers are an amazing invention, and as we have seen in the aftermath of Grenfell and before it, they do save lives.[26] What they are not is a standalone answer to the prayers of all high-rise dwellers, and that is why the regulatory picture remains murky.

Regulatory regime

As we have already mentioned, Wales and Scotland have already acted. In England, sprinklers are now required in all new high-rise residential buildings.[27]

> "New statutory guidance published today also means that all new residential buildings over 11 metres tall will be fitted with sprinkler systems. This is another critical part of our commitment to delivering the biggest changes to building safety for a generation."

Robert Jenrick, *Secretary of State for Housing and Local Government*

The changes form part of a wider update of Approved Document B that was ordered in the aftermath of Grenfell, and they include improvements to signage and building design, effectively acknowledging that sprinklers are not a standalone solution to the issues presented by high-rise residential buildings in the post-Grenfell era.

The installation of new sprinkler systems in any building continues to be guided by BS 9251: 2014 Fire sprinkler systems for domestic and residential occupancies. Code of practice – or BS EN 12845: 2015 + A1: 2019 Fixed firefighting systems. Automatic sprinkler systems. Design, installation and maintenance 'for residential blocks of flats outside of the scope' of BS 9251.

Summary

For all this is a complex issue, the conclusions are not complicated. To put it simply, sprinkler systems are a great thing, and they can save lives, but they are only as good as the systems they are connected to and the evacuation procedures that are in place.

New regulations such as the requirement to extend fire systems into each residential unit and the introduction of the BS 8629 evacuation alert system all have a contribution to make. The risk is that we become too focused on sprinklers at the expense of other vital measures.

The Grenfell disaster has served as a stark reminder that by doing lots of small things differently, we can drastically reduce the risks of a fire incident occurring in high-rise residential buildings and prevent further needless loss of life.

24 British Sprinkler Alliance, Grenfell Tower Fire: Statement (2017)
25 BBC News, Grenfell contractor: Sprinklers would have saved tower, 27/09/2017
26 Doncaster Free Press, Sprinkler system installed in wake of Grenfell disaster saved two people (06/03/2020)
27 The FPA, Sprinklers to be required in 11m residential buildings (27/05/2020)

Smoke control: the forgotten element in high-rise fire management

Introduction

In all of the many debates that have followed the events at Grenfell, the one topic that has rarely raised its head is smoke control. However, that's not because it's irrelevant to the conversation about the best way to safeguard residents in Britain's high-rise residential buildings. There was in fact a smoke control system in the Grenfell Tower, but it clearly didn't work or was not fit for purpose.

Smoke control is simple in definition, yet highly complex in practice. It is the management of smoke, in any fire situation, to prevent it from entering residential units and to keep pre-designated escape routes clear. It can be done passively, using inert ventilation, or actively, with the use of pre-programmed fans and ducting.

In most cases, smoke control systems will be linked to the building management and fire systems, for optimum reaction to the source and spread of the fire. Given the unpredictability of any fire incident, designing and implementing an effective smoke control system requires careful planning. Done well, it can be an invaluable tool in minimising casualties and expediting a successful evacuation.

The reason why smoke control has never really caught on in the UK is mainly due to the comparative lack of tall buildings compared to, for example, the USA and Australia. Although some newer tall buildings in cities like London do have complex smoke control systems installed, any systems in older high-rise residential blocks have tended to low-tech or non approved solutions with the emphasis more on compartmentation and 'stay put' to minimise casualties in a fire emergency. Now, with the lessons of Grenfell still being learnt, we are realising that all options need to be examined, and effective smoke control is one tool we need to take a fresh look at.

History

To discover the history of smoke control, or smoke management as it's sometimes called, we need to cross the Atlantic and go back to the mid-1960s, when a series of high-rise building fires led the National Research Council of Canada to start investigating what could be done.

This, combined with further work by the Illinois Institute of Technology and the US General Services Administration, led to the conclusion in 1971 that the heating, ventilation, and air conditioning (HVAC) systems in many tall buildings were exacerbating the spread of smoke in fire situations, which led to many US cities adopting new legislation on the issue for the first time.[28]

Although the new laws varied by jurisdiction, they generally included measures to prevent smoke spreading between floors by using lift and stair shaft pressurisation, deactivation of HVAC systems on activation of the fire system and the exhaustion of smoke-filled air from affected floors. These basic principles have not changed over time, although systems have tended to become far smarter and are now often integrated with building management and other systems, including HVAC and the fire system itself. Although they may be operated by the same person and manually coordinated, evacuation management systems are usually kept totally separate in order to maintain their reliability and effectiveness.

28 AHSRAE Journal, Development of Smoke Management Systems, Willam A Webb (August 1985)
29 National Institute of Standards & Technology, Smoke Management, NIST Multizone Modelling, Smoke Management (Updated August 2020)

Types of smoke control

The most basic form of smoke control is compartmentation, the simple effort of preventing the flow of smoke from one part of the building to another through the use of physical, and usually fireproof, barriers.

For our purposes, however, we will focus on measures aimed specifically at the management of smoke in a fire situation, defined by the US National Institute of Standards and Technology as follows:[29]

- **Dilution:** Dilution of smoke typically refers to the removal of smoke from non-fire spaces to maintain acceptable levels of gas or particulates within the non-fire spaces. As the name implies, this method relies on the provision of fresh air to dilute the smoke or combustion gases that infiltrate a non-fire space as the air from that space is exhausted.
- **Pressurisation:** Pressurisation refers to the use of mechanical ventilation systems (fans) to induce pressure differences across barriers having a relatively high resistance to airflow (i.e. small gaps) to control the movement of smoke between compartments. Stairwell and elevator shaft pressurisation and zoned smoke control are typical implementations of the pressurisation method.

The other types of smoke control – airflow and buoyancy – do not feature in high-rise buildings, so we will confine ourselves to dilution and pressurisation, looking specifically at what is available to facilitate effective smoke control in UK high-rise residential buildings.

Smoke control in the UK

To identify the issues with smoke control in the UK, there are few better case studies than Grenfell itself. A basic system was installed during the 2012 refurb, designed to extract smoke from communal areas outside apartments. However, based on the assumption that a fire would be contained in a single flat by the building's existing compartmentation barriers, it was only designed to protect one floor, with no coverage of the single stairwell and lift shafts. It was therefore rendered ineffective when the cladding caused the fire to spread to multiple floors.[30]

In her report on the Grenfell fire, Dr Barbara Lane of Arup said that she did not believe the system was fit for purpose, saying she had 'considerable concern' about the fire safety provisions within the staircases and communal areas. She also said that the installed system did not follow guidance laid down in Fire Safety: Approved Document B (ADB) 2013 as it was not designed specifically for the building and it also failed due to automatically opening vents (AOVs) not closing as they should have.[31]

According to CIBSE, Dr Lane also said the system was not a passive smoke dispersal system or a pressurisation system. It was a totally bespoke setup with a combination of inert and mechanical components, which did not comply with the BS EN 12101-6:2005 standards covering smoke and heat control systems. The 2012 installation was in fact an upgrade of an original smoke-ventilation system, which was in itself non-compliant with CP3 1971, the relevant regulation when Grenfell Tower was built. Given the non-standard nature of the system, and the fact that it did not comply with statutory guidance, she also felt unable to confirm if it complied with Building Regulations B1 and B5.

The overall conclusion from the report, which will form a major part of the evidence considered by the Grenfell Inquiry, was that smoke control regulations in the UK make no provision for the specific requirements of high-rise buildings and are, in effect, unfit for purpose.

Parts of the newly-installed mechanised system at Grenfell did not function, but even if they had, the system was not designed to cope with a fire on multiple floors. There was also evidence that the environmental ventilation system, which was supposed to shut down and close all vents in the event of a fire incident, had not done so correctly.

Finally, the submission to the Grenfell Inquiry from PSB, the installer of the 2012 upgrade, is worth quoting as it is both damning and revealing in equal measure: "[The] design approach was appropriate, given the limitations posed by the nature of the refurbishment. […] The Building Regulations provide guidance as to how the requirements may be met, while confirming that there may well be other ways of achieving compliance with the requirements – and, thus, there is no obligation to adopt any particular solution contained in an Approved Document if you prefer to meet the relevant requirement in some other way."[32]

In other words, they blamed the inadequate performance of the system on the laxity of the regulations and, while this may not be the whole story, it certainly illustrates the need for an urgent review of smoke control guidance and legislation in the UK.

In her initial report on Grenfell, Dame Judith Hackitt summed it up as follows:

"The Approved Documents are not fit for purpose. So, as professional engineers, we must now use codes and standards that are fit for purpose and are internationally respected – for example, the International Building Codes (IBC) and NFPA codes and standards, which I have used for 30 years on projects in the USA, the Middle East and Asia."[33]

Looking to the future

So, we have established that smoke control knowledge, regulations and legislation in the UK are limited at best, and non-existent at worst. The Grenfell fire has shown that action is needed to remedy this situation, especially in high-rise residential buildings, and it makes no sense to start from scratch. So, the obvious solution is to look to America, where we can find 50 years of experience and knowledge to help us move forward.

In the USA, the National Fire Protection Standards (NFPA) require any building over 23 metres to be pressurised at 12.5pa. These regulations have been adopted across the Middle East and served as the basis for similar laws in Australia. The current UK code under BS 5588 prescribes a pressure of 50pa, which is almost impossible to achieve, and is one of the reasons why many UK fire engineers and specifiers look for alternatives.

30 CIBSE Journal, What went wrong with smoke ventilation at Grenfell Tower, Liza Young (June 2018)
31 Grenfell Tower Inquiry, Dr Barbara Lane's expert report, October 2020
32 Grenfell Tower Inquiry, PSB UK Limited opening statement, October 2020
33 HMSO, Building a Safer Future: Final Report, Dame Judith Hackitt (May 2018)

It is also common in the USA for smoke control systems to be designed in tandem with sprinkler systems to ensure that steam from extinguished flames, which can be toxic, is also extracted. Guidelines suggest that systems should be made up of motorised dampers, AOVs and controls, with as few potential failure points as possible to reduce the risk of malfunction. If the system knows the location of the fire, fans can be used to keep stairwells free from smoke, regardless of how many floors are affected.

Protection of the stairwell is even more vital in the UK, where a single staircase is the norm. In the US, a second stairwell is required in all towers over 23 metres, which is something the UK could look to introduce for future developments, but which is simply not possible in buildings like Grenfell Tower.

Speaking to the CIBSE Journal, Martin Kealy, chair of the CIBSE Guide E Fire safety engineering steering group, says that the UK needs to either launch a total revamp of its existing guidelines to make them fit for purpose, including bringing the minimum pressurisation down to an achievable level, or it needs to adopt the NFPA codes and standards wholesale. He added:

> "We should not just design to the bare bone and hope everything works. […] The single stair and stay-put policy, which date back to the post-war studies of 1946, are out of date too. No other developed country has a stay-put policy for an unlimited-height building where there is a single stair."

The solution

Many companies, including Advanced, already have fully developed smoke control systems available in the US market and other jurisdictions where the NFPA standards have been adopted. Due to the inherent uncertainties in the UK, created largely by the lack of clear and transparent standards and legislation, there has been no incentive to launch these products in the UK market, or to adapt them to comply with UK guidelines, especially the over-the-top pressurisation requirements.

To adapt the existing systems to a new set of UK standards would not take long, and we already have the skills available to design and specify effective smoke control systems, which could be passed on to a wider UK workforce via training initiatives and approved qualifications.

Once installed, systems can be tested in simulated fire situations with the use of theatrical smoke to ensure they there are functioning as intended. It is vital to ensure that all of the connected systems coordinate correctly, that all fans work in the correct sequence according to the location of the fire, and all evacuation routes are safeguarded as intended in the design of the system.

Summary

Some changes in the UK guidance on smoke control are inevitable. We already knew it was unfit for purpose, and Grenfell brought it to the public's attention.

Even though, of all the issues raised by Grenfell, this has probably been the least high-profile, a groundswell has been created among fire professionals and building managers, with pressure building on the government to act. We don't know exactly when it will happen, or the exact form it will take, but when it does, manufacturers like Advanced will be ready to ensure that the right systems are brought to market.

Upholding standards – the critical role of competence in fire safety

Supported by the
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Even with the clarification presented by the Fire Safety Act 2021, our industry remains in a state of flux. The government has made it clear that further legislation might be required to ensure that existing guidelines can be enforced, and also to ensure that the eventual recommendations of the Grenfell Inquiry are implemented.

Unlimited fines and up to two years in prison are the ultimate penalties for serious breaches of the Regulatory Reform (Fire Safety) Order 2005. The majority of failures to comply with the Order's regulations are dealt with through formal/informal enforcement. However, the possibility of prosecution and imprisonment are sobering reminders of the risks in failing to meet minimum fire safety standards.

It all starts with the fire risk assessment

The Regulatory Reform (Fire Safety) Order 2005 places responsibility for fire risk assessments in non-domestic buildings squarely on the shoulders of the responsible person. Their primary duties are to:

- Carry out a fire risk assessment* identifying the risks and hazards in a building, with special consideration for those who may be especially vulnerable, and to review it regularly
- Eliminate or reduce the risk from fire as far as is reasonably practical, paying particular attention to ensure fire safety in areas where flammable or explosive materials are stored
- Put in place, and maintain appropriate fire safety measures
- Create a plan to deal with emergency situations
- Provide staff with fire safety-related information, instruction and training
- Document findings and actions taken
- Review the findings on a regular basis.

*If you are unsure how to complete a fire risk assessment, assign a fire risk assessor[34] with quality evidence of their competency (e.g. UKAS Accredited Third Party Certification).

It's a role that shouldn't be undertaken lightly and, to be done thoroughly demands specialist knowledge and experience. Nevertheless, the Order does not prescribe the necessary competencies of those appointed as the responsible person.

Although this is to some extent logical – in that the nature and complexity of premises varies dramatically – it also leaves the door wide open to people with no knowledge of fire safety being left in charge of this crucial measure. The competence of the responsible person is therefore one of many 'grey areas' that can affect the levels of overall fire safety achieved.

BAFE is the independent registration body for third-party certified fire safety service providers across the UK. BAFE's core responsibility is to develop and maintain schemes, which support defined quality standards and industry best practice. These schemes exist for fire safety service providers (including electrotechnical contractors who work on fire safety systems) to achieve UKAS Accredited Third Party Certification which provides quality evidence of their competency.

Specifically, BAFE SP205 covers life safety fire risk assessment – delivering quality, independent evidence that providers (from sole traders through to larger organisations with appointed fire risk assessors) are competent to deliver quality fire risk assessment services.

It's worth noting however, that although fire risk assessments are a cornerstone of the Regulatory Reform Order, their real value – even when carried out by a fully competent fire risk assessor – depends on an organisation's actions in response to them. This demands a whole new set of competencies and expertise.

34. The Fire Sector Federation's Guide to Choosing a Competent Fire Risk Assessor https://www.firesectorfederation.co.uk/advice/choosing-a-fire-risk-assessor/

Ensuring fire alarm system quality and reliability

Effective fire detection and alarm systems are central to fire risk management in any public, commercial or multi-occupancy building. To adhere to fire regulations, a premises' appointed responsible person must be able to prove that the fire system is designed, installed, commissioned and maintained by a competent contractor in line with standards.

When looking at high-rise residential buildings, there are some additional new areas to consider and it's important to choose a fire risk assessor with experience in dealing with these types of premises.

Safe evacuation is a key concern and one subject to rapidly changing rules, such as the possible need to install evacuation alert systems for use by fire and rescue service to safely evacuate building residents. It is also recommended for tall residential blocks to be equipped with premises information boxes, again for access by the fire and rescue service. These should contain the layout of the building along with locations of essential services and should include any personal evacuation plan(s) pertaining to vulnerable people living at the address. All this is on top of the fire doors and smoke ventilation requirements that are required under the building code.

Fortunately, there are several steps that can be taken to ensure that this is done.

Confidence in your suppliers and contractors

Choosing only qualified installers, who are third-party certificated by reputable and well-established bodies, is a great way to get further peace of mind that your fire protection measures are fit for purpose. For example contractors that feature on the BAFE Fire Safety Register are assessed by UKAS Accredited Certification Bodies. UKAS[35] (United Kingdom Accreditation Service) evaluates these Certification Bodies to confirm their competence, impartiality and performance capability to assess organisations who provide specific fire protection services.

In regard to BAFE and their available Schemes, they have monitoring groups that meet regularly to ensure their Schemes continue to support quality standards and promote the highest levels of competency and best practice within the industry.

One example of these schemes is BAFE SP207, which covers the design, installation, commissioning and maintenance of evacuation alert systems. Launched in 2020, this scheme supports British Standard 8629 which covers evacuation alert systems for use by fire and rescue services in buildings containing flats. Advanced believes this is an essential step in establishing a higher level of quality among providers installing evacuation alert control and indicating equipment (EACIE).

It's also worth remembering that in your choice of both products and installers, the old adage 'buy cheap, buy twice' applies in spades. Fixating on price and not value can lead to poor choices that compromise installations and expose the responsible person to unnecessary risk.

35. What is UKAS? https://www.ukas.com/about-us/about-ukas/

Specify the best equipment for the job at the outset

Accurate specification is critical to ensuring fire safety. However, the ever-increasing range of new technologies coming to market can make it hard to choose the optimum solution. This is where third-party certification can be a huge help.

When looking at system specifications, it's important to understand and ask about the long-term maintenance costs for each system. An example of this would be when using a wireless system, which might be cheaper to install but requires the cost of periodic replacement of batteries in each device to be factored in. Failure to change installed and back-up batteries in line with the manufacturer's recommendations will result in a poorly performing system that can quickly fall below standards, so when it comes to fire safety, cutting corners is simply not a viable option.

Summary

In the UK, adherence to our standards BS 5839-1 / BS 5839-6 and BS 8629 is a fundamental way of ensuring that best practice is followed. Despite this, all codes of practice allow for variations, so ensure you understand what you're getting and why any deviation from the main recommendations are being proposed.

Always seek advice from a registered expert, particularly if you have any concerns and don't assume that one size fits all. Seek out experienced fire experts, as the number of badges on the bottom of a letterhead are not necessarily the assurance of competence that they might first seem.

BAFE's "Don't Just Specify, Verify" campaign[36] outlines the essential action of anyone responsible for fire safety to confirm their chosen contractors are appropriately third -party certificated for the work required.

36. Further information can be found at:
https://www.bafe.org.uk/bafe-fire-safety-guidance/dont-just-specify-verify-third-party-certification

Conclusion

Even with the clarification presented by the Fire Safety Act 2021, our industry remains in a state of flux. The government has made it clear that further legislation might be required to ensure that existing guidelines can be enforced, and also to ensure that the eventual recommendations of the Grenfell Inquiry are implemented.

Without a crystal ball, future developments are impossible to predict, but the following developments would seem highly likely:

- BS 8629 will become a legal requirement in all new high-rise residential buildings in England and Wales, as evacuation alert systems already are in Scotland.
- 'Stay put' will remain the preferred evacuation method for high-rise residential buildings in England and Wales, not because it is the ideal system, but because single staircase designs effectively rule out any viable alternatives.
- The Grenfell Inquiry is likely to call for even stricter regulations on the maintenance and monitoring of compartmentation, both internal and external, and the government is likely to legislate accordingly.
- Smoke control will become far more mainstream in the UK and dedicated systems will come to market, probably based on US designs. Even so, it is unlikely to become a legal requirement and will likely always be more prevalent in new buildings that can be designed around it.
- Sprinklers will become more widespread, but not universal, despite the ongoing efforts of the British Sprinkler Alliance (BSA), and they will not become mandatory in older buildings.
- UKAS Accredited Third Party Certification will become a more commonly stipulated requirement to provide evidence of a contractor's competency for particular fire safety works.

One thing we can be certain of, especially after the government refused to cover the cost of removing cladding in low- and medium-rise residential buildings, is that we won't be emerging from the post-Grenfell period of uncertainty any time soon. In fact, at the current rate, it could take well over a decade to rectify all of the faults with cladding and compartmentation, before returning all buildings to the new 'stay put' standard.

As an industry, we need to maintain our knowledge base, ensure that we are fully au fait with the latest government guidelines, and work with our installers and end clients to ensure that all high-rise residential buildings offer the highest possible standards of fire prevention and safety. It is only by taking on this collective responsibility that we will be effective in building a safer future.

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