Cost Benefit Analysis to Inform Decision Making Process for Limitations to Standard 2.15 Automatic Fire Suppression Systems – Alterations, Extensions and Conversions

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Scottish Government
Riaghaltas na h-Alba

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1. Introduction

1.1 Introduction

1.1.1 Standard 2.15 (automatic fire suppression systems) of the building regulations requires that buildings must be designed and constructed in such a way that, in the event of an outbreak of fire within the building, fire growth will be inhibited by the operation of an automatic fire suppression system. The standard applies to the following buildings:

- An enclosed shopping centre.
- A residential care building.
- The whole or part of a sheltered housing complex.
- A school building other than a building forming part of an existing school or an extension to a school building where it is not reasonably practicable to install an automatic fire suppression system in that building or extension.
- A building containing a flat or maisonette.
- A social housing dwelling.
- A shared multi-occupancy residential building (with more than six residents).

1.1.2 The last three categories of buildings were added to the regulations in 2020 as part of the Building (Scotland) Amendment Regulations 2020 which came into force on 1st March 2021. The change also applies to certain conversions listed in Schedule 2 of the Building (Scotland) Regulations 2004 including:

- Type 1 conversions apply to changes in the occupation or use of a building to create a dwelling or dwellings or part thereof e.g. conversion of a non-domestic building to flats.
- Type 3 conversions apply to changes in the occupation or use of a building which alters the number of dwellings e.g. conversion of a large house to social housing flats.
- Type 7 conversions apply to changes in the occupation or use of a building so that it becomes a residential building e.g. conversion of offices to shared multi-occupancy residential buildings with more than six residents.

1.1.3 Building owners/agents can apply to Scottish Ministers under S3(2)(a) of the Building (Scotland) Act 2003 for a relaxation/dispensation of Standard 2.15 in cases where the building is being extended, altered or converted. Since the introduction of the new categories into Standard 2.15 in March 2021, BSD has received a significant number of applications (primarily for flats and maisonettes) for relaxation of the Standard. Local authorities are of the view that dispensation of Standard 2.15 is merited, particularly where it is not considered to be reasonably practicable having regard to all the circumstances including the cost of undertaking the work. Hence, BSD is considering a review of the requirements of Standard 2.15 to allow verifiers some flexibility.

1.2 Aims and Objectives

1.2.1 BSD has commissioned a research project to consider the circumstances which would support the relaxation of the Standard to assist BSD in the proposal to amend the limitations of Standard 2.15. Relaxations would not apply to building conversions, alterations and extensions if automatic fire suppression systems are already installed.

1.2.2 This research project is considering all the building types listed in paragraph 1.1.1 except for schools as there already is a qualification to the application of the Standard to school buildings.

1.2.3 All other building types are included in Standard 2.15 as the benefits of installing an automatic fire suppression system outweigh the costs of the system. Any relaxation to the Standard should only be permitted if the costs of installing the automatic fire suppression system outweigh the benefits.

1.3 Report Content

1.3.1 This report is organised as follows:

- Section 2 provides an overview of the trends in the number of fires and casualties since 2009/10 in the building types covered by Standard 2.15.
- Section 3 provides a brief summary of the applications for relaxations (as at 20th February 2023).
- Section 4 considers the results of previous cost benefit studies which have been undertaken to assess the cost effectiveness of the installation of automatic fire suppression systems in new buildings.
- Section 5 sets out the estimates of benefits for inclusion in the cost benefit assessment.
- Section 6 sets out the estimates of costs for inclusion in the cost benefit assessment.
- Section 7 presents the results of the cost benefit analysis.

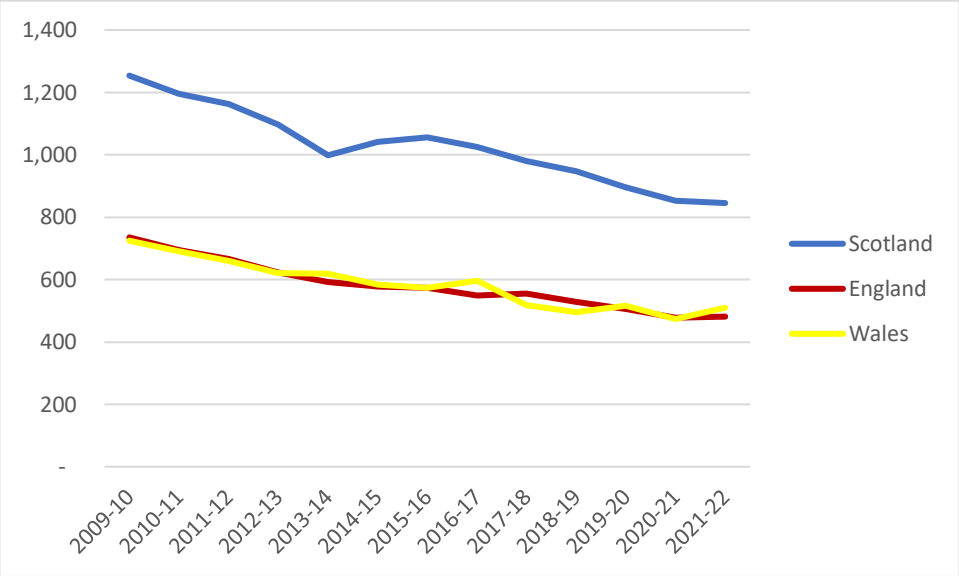
2. Analysis of Fire Statistics

2.1 Trends in the Number of Fires

2.1.1 This section sets the context for the analysis by providing a brief overview of the trends in the number fires and casualties in Scotland in recent years, drawing on the Scottish Fire and Rescue Service (SFRS) comprehensive incident dataset.

2.1.2 There has been a substantial reduction (-29%) in the number of dwelling fires in Scotland since 2009/10[1]. The number of fires per million population has fallen from 1,254 in 2009/10 to 845 in 2021/22. However, the number of fires per million population remains significantly higher than in England and Wales. Figure 2.1 provides details.

Figure 2.1: Number of Dwelling Fires per Million Population



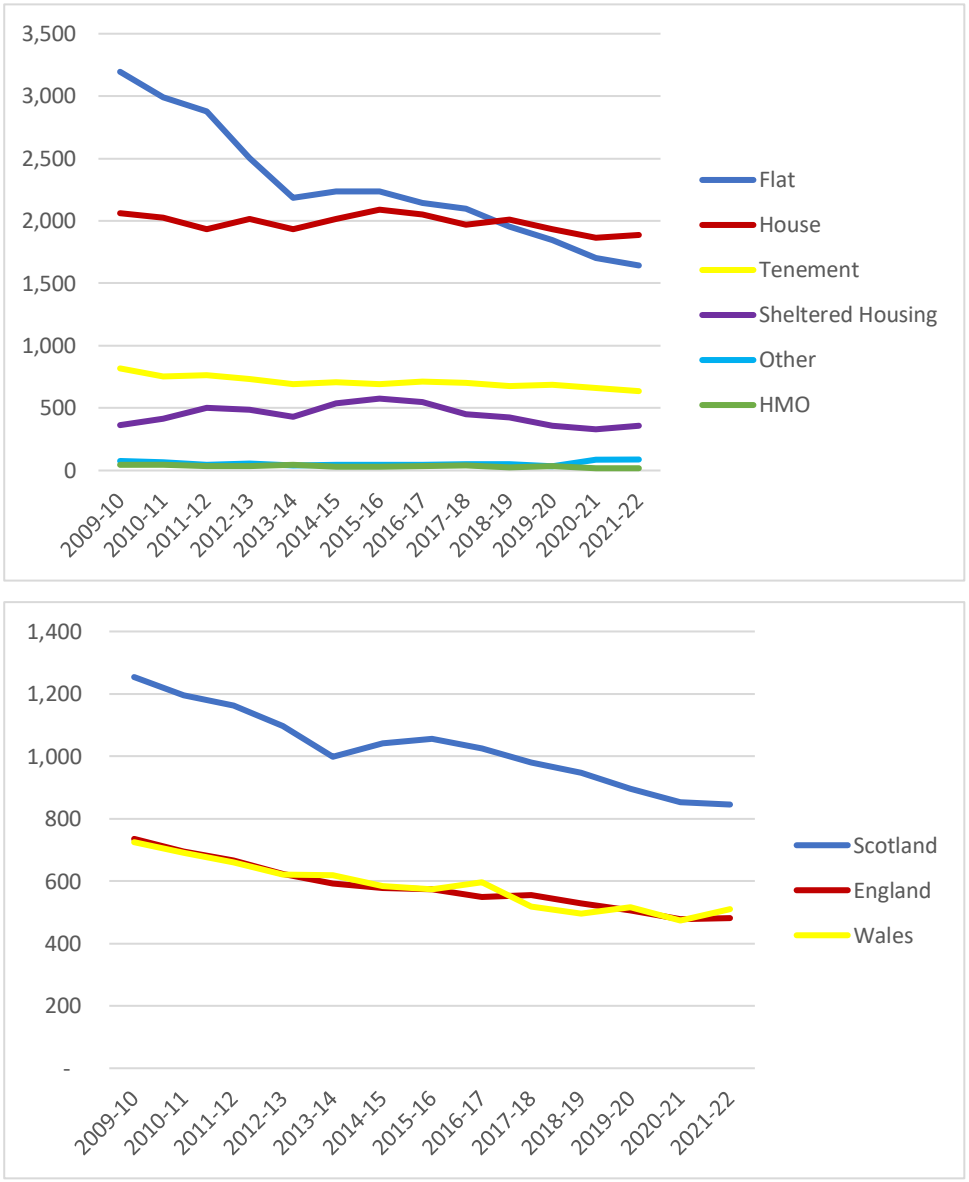
2.1.3 The SFRS data classify building fires into residential dwellings, residential 'other' and non-residential. The buildings covered by Standard 2.15 are primarily residential dwelling buildings, although there are some buildings within residential 'other' and non-residential categories which are relevant to the analysis.

2.1.4 While the number of residential dwelling fires has declined by almost 30% since 2009/10, the decrease has primarily been driven by the decline in fires in flats. Figure 2.2 provides details of the number of residential dwelling fires by building type. Note that the sheltered housing data shown in the dwellings graph relate to self-contained sheltered housing.

[1] Scottish Fire and Rescue Incident Dataset 2021/22

2.1.5 Figure 2.2 also shows the trend in the number of fires in other building types which are relevant to the current analysis. The absolute number of fires in these building categories in 2021/22 is considerably less than the residential dwelling categories except for HMOs and 'other' residential buildings.

Figure 2.2: Fires in Residential Dwellings and Other Selected Building Types, 2009/10 to 2021/22



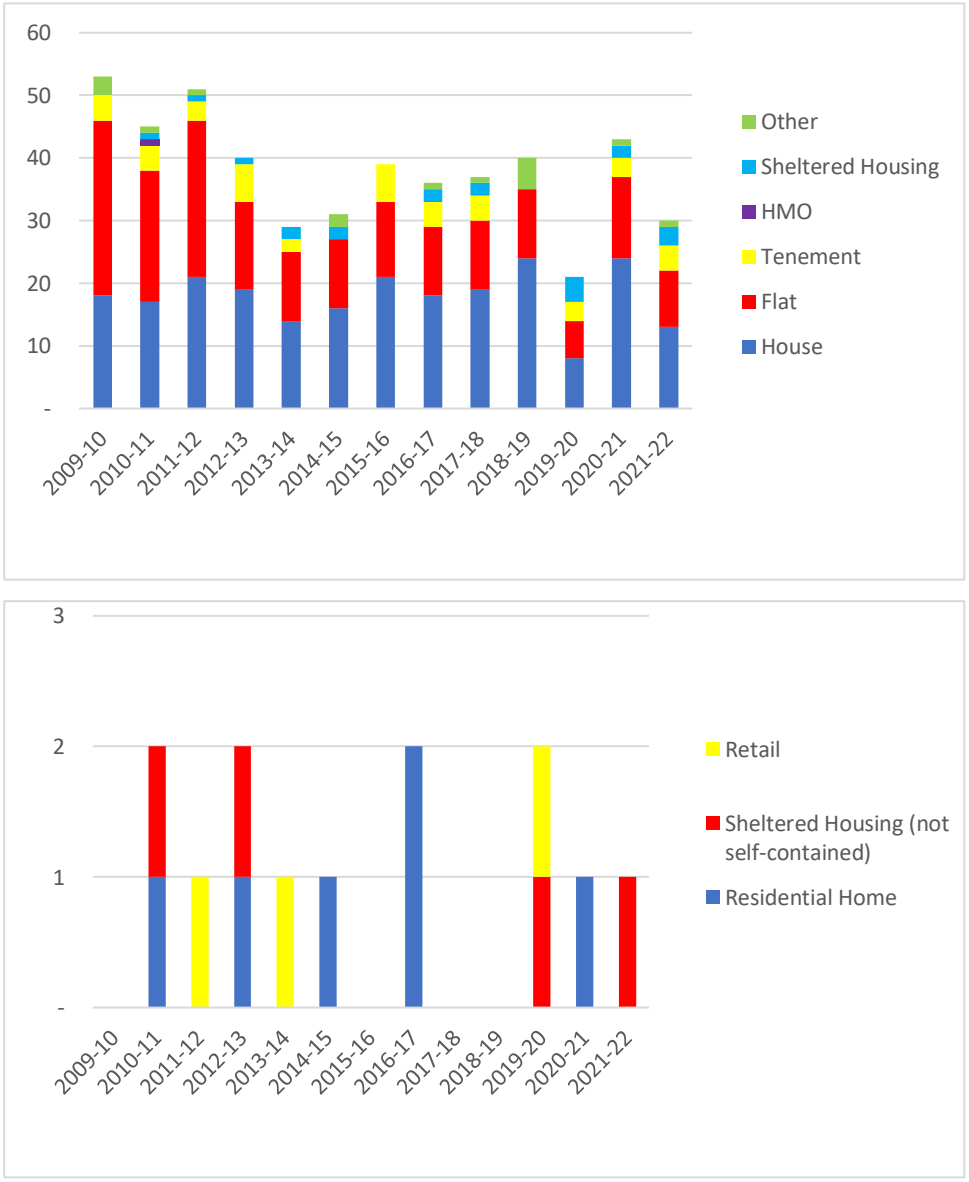
2.2 Trends in the Number of Casualties

2.2.1 Figure 2.3 shows the number of fatal casualties in residential dwelling fires between 2009/10 and 2021/22. Although the number of fatalities fluctuates from year to year, there has been a clear reduction in the number of deaths in residential dwelling fires over the period from 53 in 2009/10 to 30 in 2021/22.

2.2.2 In each year, the majority of fatalities arise in house and flat fires, but as shown in Figure 2.2, house and flat fires dominate in terms of the number of fires. Throughout the period there has only been one fatality in HMO properties with the number of tenement and sheltered housing fatalities usually less than 5 per annum.

2.2.3 Figure 2.3 also shows the trend in the number of fatalities in other relevant building types. There have been very few fatalities in these building types over the period.

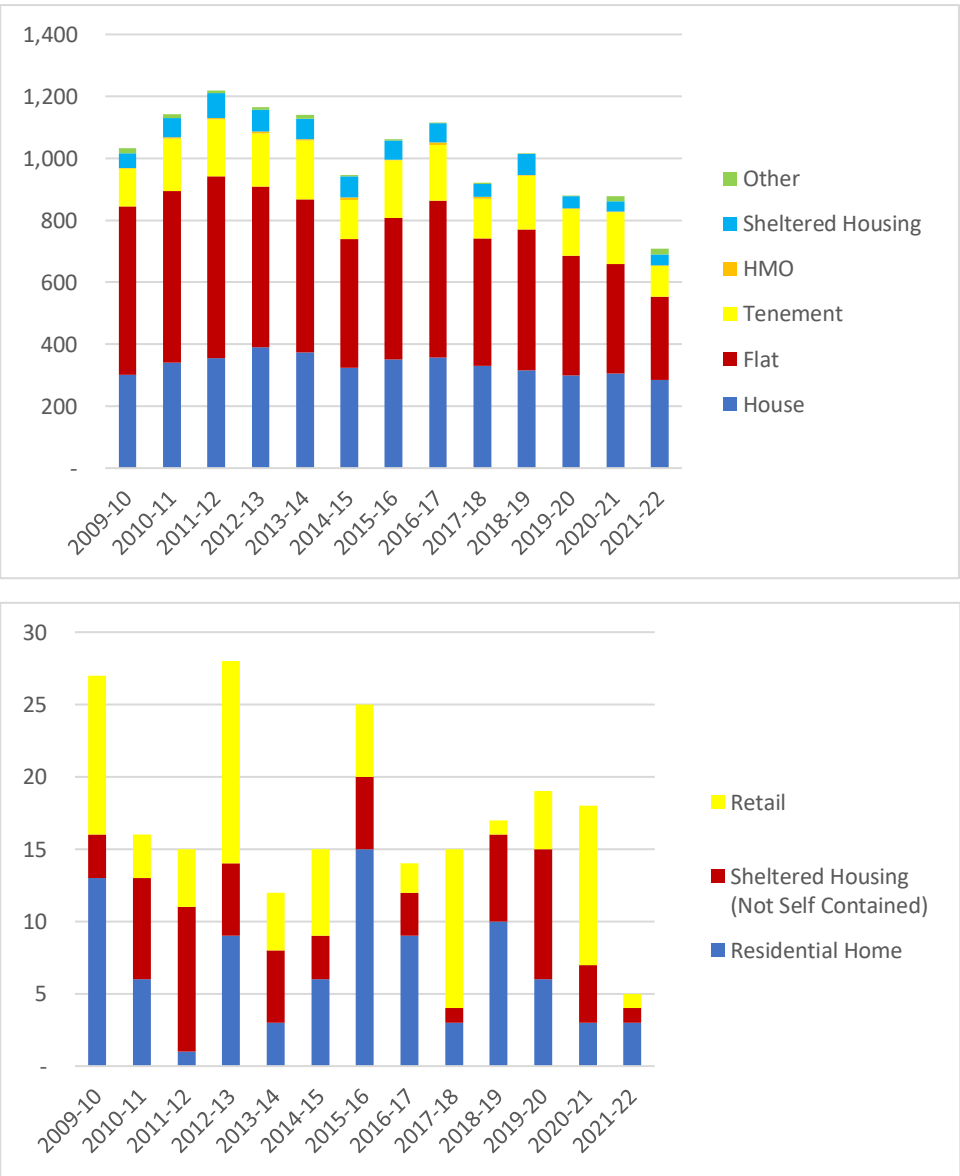
Figure 2.3: Fatalities in Residential Dwellings and Other Selected Building Types, 2009/10 to 2021/20



2.2.4 Figure 2.4 shows the trend in the number of non-fatal casualties in residential dwelling fires between 2009/10 and 2021/22. As with fires and fatalities, there has been a general reduction in the number of non-fatal casualties. Non-fatal casualties are dominated by casualties in flats and houses.

2.2.5 The number of non-fatal casualties in other building types is also shown in the Figure although the total number of non-fatal casualties is very low. Within each building type there are typically less than 10 non-fatal casualties per annum.

Figure 2.4: Non-Fatal Casualties in Residential Dwellings and Other Selected Building Types, 2009/10 to 2021/20



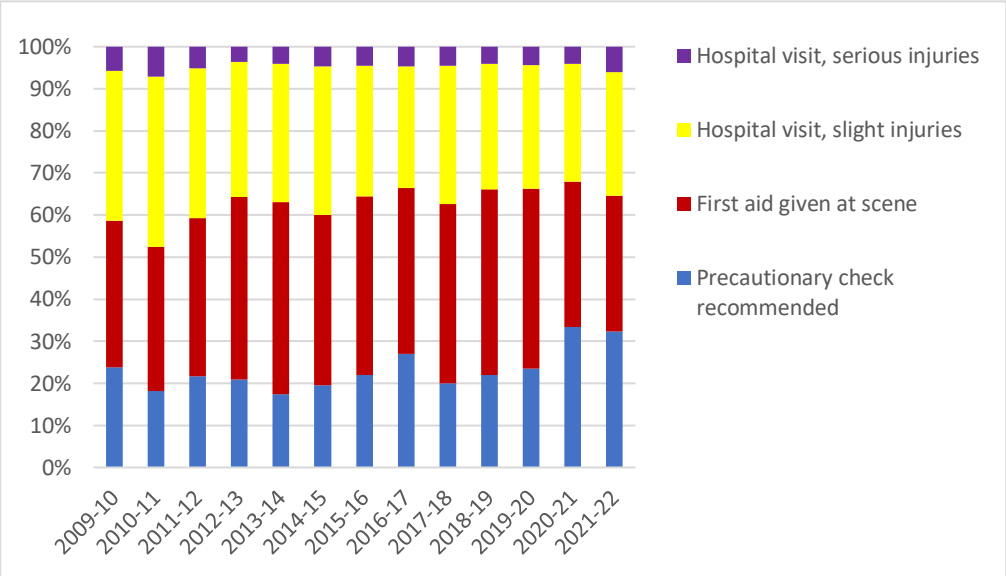
2.2.6 For all dwelling fires, the distribution of non-fatal casualties by severity of injury is shown in Figure 2.5. The injuries are classified using a scale where 'precautionary check recommended' is the lowest form of medical intervention through to hospital visit with serious injuries. The scale covers:

- Precautionary check recommended.

- First aid given at the scene.
- Hospital visit with slight injuries,
- Hospital visit with serious injuries.

2.2.7 While the proportion of non-fatal casualties requiring a hospital visit for serious injuries has remained steady at approximately 6%, there has been a move towards a higher proportion of non-fatal casualties requiring the lowest form of medical intervention (precautionary check recommended).

Figure 2.5: Non-Fatal Casualties in Residential Dwellings and Other Selected Building Types, 2009/10 to 2021/20



2.2.8 There is a strong relationship between age and rates of fatal casualties. The rate of fatalities increases significantly with age, particularly for those aged over 70. After age 79 the rate is considerably higher, with those aged 80-89 having a rate more than triple the Scotland average and those over 90 years of age having a rate over six times higher. The 10-year average rate of fatal and non-fatal casualties per million population is shown in Table 2.1.

2.2.9 The relationship between age and rate of casualties is not as strong for non-fatal casualties as it is for fatal casualties. The rate for non-fatalities aged 80-89 is 1.6 times the Scotland average and those over 90 have a rate over three times the average.

Table 2.1: Rate of Fatalities and Non-Fatalities by Age Group		
	Fatal Casualties	**Non-Fatal Casualties**
0-4	0.6	146.6
5-16	0.7	54.9
17-29	2.7	267.3
30-39	4.4	230.3
40-49	8.8	236.1
50-59	11.3	218.1
60-69	12.4	177.3
70-79	15.1	205.8
80-89	25.9	364.6
90+	53.7	662.8
Total	**7.9**	**213.6**

2.2.10 Analysis of SFRS data[2] also shows that:

- Deprivation is strongly associated with the rate of dwelling fires with the 20% most deprived areas of Scotland having a rate of dwelling fires 4.3 times higher than the 20% least deprived areas and approximately twice the Scottish average rate.
- When the characteristics of geographical areas are considered, remote small towns and large urban areas have higher rates of dwelling fires per million population - 1.2 and 1.15 times the Scottish average respectively.

2.3 Summary

2.3.1 The last 13 years have seen a substantial reduction in the number of dwelling fires in Scotland, although the rate per million population remains considerably higher than in England and Wales. The number of fatalities and non-fatal casualties has also decreased, particularly for residential dwelling fires.

2.3.2 There has also been a move towards a higher proportion of non-fatal casualties requiring the lowest form of medical intervention. There is a strong relationship between age and the rate of fatal casualties and deprivation is strongly associated with the rate of dwelling fires.

[2] "Fire and Rescue Incident Statistics (Scotland), 2021-22" Scottish Fire and Rescue Service (October 2022)

3. Relaxation Applications: Standard 2.15

3.1 Applications for Relaxation of Standard 2.15

3.1.1 Since the addition of a building containing a flat or maisonette, a social housing dwelling and a shared multi-occupancy residential building (with more than six residents) to Standard 2.15 in March 2021, BSD has processed 19[3] applications for the relaxation of the Standard. Two of these applications have been refused and 17 have been granted. Table 3.1 provides a summary of the applications and their status.

Table 3.1: Summary of Applications for Relaxation of Standard 2.15

Type	Description	Decision
Conversion	Existing office to 4 ground floor flats	Refused
Conversion	Conversion providing rear extension to disused ground floor flat/outbuilding	Refused
Conversion	Form maisonette from 2 flats within 3 storey & basement, A-listed building	Granted
Conversion	Form maisonette with attic storage from attic space within 2 storey building	Granted
Conversion	Form maisonette from 2 flats, B-listed building	Granted
Conversion	Conversion to form maisonette from attic space within 2 storey building	Granted
Conversion	Form maisonette from ground and basement flats within 5 storey, A-listed building	Granted
Conversion	Form maisonette from ground floor storage area and flat within 4 storey building	Granted
Conversion	Form maisonette from attic space within 2 storey building	Granted
Conversion	Form 3 apartment ground floor flat from a children's nursery within a 3 storey building	Granted
Conversion	Form maisonette from attic space within 2 storey building	Granted
Conversion	Form maisonette from attic space within 2 storey building	Granted
Conversion	Form 3 storey flat from an office within 5 storey building	Granted
Conversion	Form maisonette from attic space within 2 storey building	Granted
Conversion	Form maisonette from attic space within 2 storey building	Granted
Extension	Rear extension to ground floor flat (14m2)	Granted
Extension	Rear extension to ground floor flat (35m2)	Granted
Extension	Extension to ground floor flat (18.9m2)	Granted
Extension	Rear extension to ground floor flat (26m2)	Granted

[3] As at 20th February 2023

3.1.2 All applications (to date) relate to the Standard 2.15 category “a building containing a flat or maisonette”. The majority of applications (79%) are for conversions with the remainder being extension projects. Of the 15 conversion projects, eleven relate to the formation of a maisonette from either two flats or from the conversion of attic space. All eleven applications to form maisonettes have been granted.

3.1.3 There have been three applications for conversion of commercial (e.g. office space, children’s nursery) to residential accommodation with two applications approved and one refused. There has also been one conversion application to provide an extension to a ground floor flat and outbuilding which was refused.

3.1.4 All four extension applications have been granted and are for extensions to flats of between 14 and 35 sqm. No applications for alterations have been received.

3.1.5 There have been no applications for exemptions related to retail, care homes, sheltered housing, social housing or HMOs.

4. Previous Cost Benefit Studies

4.1 Introduction

4.1.1 Automatic fire suppression systems installed in domestic and residential premises are primarily designed for life safety purposes. Successful activation can provide occupants, including vulnerable occupants, with additional time to escape following an outbreak of fire. The added benefit of automatic fire suppression in domestic and residential buildings means that the damage and disruption caused by fire is greatly reduced.

4.1.2 A number of studies have examined the costs and benefits of installing automatic fire suppression systems in domestic and residential buildings and the results of these studies are summarised below. It should be noted that some of the studies are quite old.

4.2 Results from Previous Studies

4.2.1 A BRE[4] study in 2004 examined the benefit: cost ratio for the introduction of automatic fire suppression systems in range of different residential property types – houses, flats, various types of care homes and various types of HMOs. Additional analysis was also undertaken for different building heights.

4.2.2 The benefits examined included the prevention of deaths and injuries and the reduction in property damage. The average value of a prevented death and injury was based on UK Government data for the year 2000 and updated to 2002 prices. The average value of property loss was also taken for a UK Government study. The costs considered included the cost of installing the system, the provision of water supply and annual maintenance. These costs were provided by members of the UK sprinkler and water industries.

4.2.3 The main conclusions of the analysis were:

- Residential sprinklers are not cost effective for most dwellings. The benefit cost ratio was in the range 0.19 to 0.67 for the generic categories of houses and flats.
- Residential sprinklers are probably cost effective for residential care homes. The benefit cost ratio was in the range 1.2 to 4.9 for different types of care home e.g. older people, children, disabled people.
- Residential sprinklers are probably cost effective for tall blocks of flats (11+ storeys) where the benefit cost ratio was 2.12.

[4] BRE "The Effectiveness of Sprinklers in Residential Properties" 2004 for the Office of the Deputy Prime Minister (ODPM).

4.2.4 The 2004 BRE report was subject to some criticism from the Fire Sprinkler Association[5] (FSA) which criticised some of the assumptions, particularly the assumptions regarding the effectiveness of sprinklers in reducing deaths, injuries and damage. Reworking the calculations, the FSA found a net benefit for many more building types, particularly flats and some HMOs.

4.2.5 In 2009 BRE[6] undertook a study for the Scottish Government to undertake a cost benefit analysis for the installation of sprinkler systems in new build houses and update the analysis of the 2004 BRE report for flats and maisonettes where the topmost storey height is not more than 18m above ground level. For houses in the analysis, the sprinkler system was a low cost system based on a New Zealand model which was connected to domestic plumbing with water supplied by the town mains supply, no alarms to indicate sprinkler activation or call the fire service, no control valve and no ongoing maintenance requirements. For flats, the system was in accordance with British Standard BS 9251.

4.2.6 The analysis focused on the same costs and benefits as the previous 2004 BRE study and found that:

- The low cost system was cost effective for houses with a benefit cost ratio of 1.8. However, adding one man-hour of maintenance to this low cost system had a very detrimental effect and took the benefit cost ratio to 0.5.

- For flats, the benefit cost ratios were 1.2 (town mains water supply) and 1.1 (pump and tank water supply) although there was some uncertainly around the results.

4.2.7 A BRE[7] study in 2012 for the Chief Fire Officers Association sought to update the 2004 BRE study and to consider sprinkler protection in new build residential premises. The components of costs and benefits were the same as in the 2004 report, but updated/revised assumptions were used. The main conclusions of the analysis were:

- Residential sprinklers are cost effective for all residential care homes for elderly people, children and disabled people. The benefit cost ratio was in the range 1.9 to 11.6. The main reasons for the higher ratios include higher property damage values and increased effectiveness in preventing deaths, injuries and damage.

- Residential sprinklers are cost effective for most blocks of purpose-built flats and larger blocks of converted flats. The benefit cost ratio was in the range 1.4 to 2.3 with a reduction in installation costs and increased effectiveness in preventing deaths, injuries and damage, the main drivers of the improved ratio. The previous research had only found a positive ratio for tall (11+ storey) flats.

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[5] Fire Sprinklers Association “An Appraisal of the ODPM BRE Report ‘The Effectiveness of Sprinklers in Residential Properties’”

[6] BRE “Cost Benefit Analysis for Residential Sprinklers in Scotland” 2009

[7] BRE “Cost Benefit Analysis of Residential Sprinklers” for the Chief Fire Officers Association, 2012

- Residential sprinklers are cost effective for traditional bedsit type HMOs where there are at least six bedsit units per building and the costs are shared. The benefit cost ratio was 1.9 for this type of HMO, but it was noted that should there be less than six units or costs cannot be shared across units, the assumptions may not be valid.

- Residential sprinklers are not cost effective for houses.

4.2.8 To support the Domestic Fire Safety (Wales) Measure 2011 which requires the provision of automatic fire suppression systems in new and converted residential premises, the Welsh Government commissioned BRE to undertake a cost benefit analysis of the provision in the Measure[8]. The analysis was undertaken for a range of residential premises and the costs and benefits considered in the analysis were the same as those included in the BRE studies reviewed above. However, the Welsh Government also requested that the reduction in greenhouse gases associated with sprinkler fires be considered. There is an annual benefit from reduced greenhouse gases, but the monetised value was estimated to be very small compared with the other benefits.

4.2.9 The analysis was undertaken on the forecast number of new residential buildings to be built over the period 2013 to 2022. The key findings of the research were:

- Fitting sprinklers in all new residential properties in Wales is not cost effective.

- Sprinklers are cost effective in new care homes and halls/dormitories, primarily due to the reduction in financial losses from damage to the building, its contents and business interruption.

- Sprinklers may also be marginally cost effective in new blocks of flats, blocks of sheltered flats and traditional HMOs (with an average of six units per building). These premises benefitted from sharing the costs over a number of accommodation units.

- Sprinklers are not cost effective in new single occupancy houses, shared houses, hostels and sheltered houses.

4.2.10 The analysis was undertaken for new build premises and noted the cost of sprinkler installation may be higher in building conversions. The earlier BRE report noted that retro fitting costs could be 20% higher than new build costs.

4.2.11 In 2015 Optimal Economics undertook a research project for the Scottish Government[9] to update the cost effectiveness position regarding residential sprinklers in Scotland. The analysis was undertaken for houses, flats, HMOs and halls of residence and considered both new build and existing buildings and systems operating from mains water supply and those requiring storage tanks and pumps.

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[8] BRE “Report of Cost Benefit Analysis of Residential Sprinklers for Wales” 2012

[9] Optimal Economics “Cost Effectiveness of Sprinklers in Residential Properties” 2015

4.2.12 The main results showed:

- For houses, the results were consistent with the earlier studies. Automatic fire suppression was not cost effective in both new build houses and retro-fit properties using either mains or pump and tank systems. The benefit cost ratios were in the range 0.16 to 0.23 (central case).

- For flats, if sprinklers could be installed towards the lower end of the estimated costs, installation would be cost effective for mains water supply systems in both new build and retrofit properties (BCR range of 1.47 to 1.68). For pump and tank systems, the benefits were much more marginal with the BCR range 0.9 (retrofit) to 1.03 (new build).

- For HMOs, the study found that installing sprinklers in shared houses was not cost effective, but for HMOs in flats there could be a case for sprinklers at the lower end of the estimated costs. The BCR for large (10 beds) units was in the range 1.4 to 1.6 if costs towards the lower end of the range were used.

- The case for sprinklers in halls of residence was stronger, particularly at the lower end of the estimated cost range. The benefit cost ratio was 1.73 to 2.26.

- There is evidence that the risk of fire (and therefore the expected benefits of suppression systems) is higher in certain social, demographic and economic circumstances e.g. people living in deprived areas, single men, older people and people with problems related to drugs and alcohol. Where the risk of fire is increased (e.g. risk doubled in deprived areas) there is a very strong case for installing sprinklers in flats (new and existing).

4.3 Other Studies Reviewed

4.3.1 In addition the cost benefit studies, the analysis has also reviewed some research on the cost of fire. The UK Department for Communities and Local Government (DCLG) as was, commissioned a series of studies on the Economic Cost of Fire which sought to estimate the total cost of fire to the English economy. The last study[10] provided estimates for 2008.

4.3.2 Using a modeling approach, costs were broken down in to three categories – costs in anticipation, as a consequence and in response to fire. Costs as a consequence are most relevant to this research and include the cost of fatal and non-fatal casualties, lost business, property damage and costs to the police and criminal justice system. These latter costs arising as a result of arson.

4.3.3 In 2008, the costs as a consequence of fire were estimated to be almost £3.3 billion with the costs of casualties (£1.4 billion) and property damage (£1.5 billion) accounting for the majority (88%) of the total. The estimate of the cost of casualties (fatal and non-fatal) were derived from the DfT estimates of the value of a death and injury. This is consistent with the previous cost benefit studies.

[10] Department for Communities and Local Government (2011) “The Economic Cost of Fire: 2008”

4.3.4 Average property damage per fire is estimated to be £2,634 per fire, but this is calculated across all fires including buildings, non-buildings and false alarms. If the property damage cost was restricted to building fires, the average per building would be £24,200 and lost business per building fire would be £730.

4.3.5 This estimate of average property damage costs is higher than the estimates used in the cost benefit studies where damage costs for domestic properties were between £7,000 and £9,000 and between £23,000 and £30,000 for commercial properties.

4.4 Cost Estimates from Previous Studies

4.4.1 The studies reviewed in Section 4.2 contained considerable information on the costs of installing and maintaining sprinkler systems. Table 4.1 provides a summary of the costs used in the analysis and to allow comparison, all costs are presented in 2021 prices.

4.4.2 The Table shows:

- Retro-fitting a system is approximately £500 to £1,000 more expensive for flats/houses.
- Annual maintenance costs are higher in the more recent studies.
- Pump and tank water supply systems are approximately £800 to £1,600 more expensive than mains systems.

4.4.3 While Table 4.1 provides a summary of the main assumptions underpinning the various cost benefit studies, the Optimal Economics report included cost estimates from a range of contractors and a local authority from which the following points are relevant:

- Costs from seven local authority social housing sites found that the cost of installing automatic sprinkler systems was approximately 1.2% to 2.1% of total project costs if using mains fed water. If a pumped system was required, sprinkler systems were approximately 4.3% to 4.8% of project costs. On average, the pump and tank systems added 3,400 (2021 prices) to the cost of installation.
- A contractor suggested that the cost of a water mist system would generally be 20% higher, although there could be savings as a result of reduced water damage and lower installation costs because of the reduced need for space for water storage.
- Contractors did not provide a clear indication of the scale of the projects for which costs were provided, but a number suggested that a pump and tank system would add £1,700 to £2,200 (2021 prices) to the project cost.
- Some contractors suggested that there could be additional costs for a more distant location.
- Retro-fit costs would be higher with concealed pipework more expensive than surface mounted pipework.

Table 4.1: Summary of Installation Costs (2021 prices)					
	BRE 2004	BRE 2009	BRE 2012 (CFO)	BRE 2012 (Wales)	Optimal Economics 2015
House (new)	3,200	700	3,100 (mains) 3,800 (tank)	3,800 (tank)	2,800 (mains) 3,600 (tank)
House (retro-fit)					3,700 (mains) 4,500 (mains)
Flat (purpose built)	1,500	1,600 (mains) 1,900 (tank)	800 (mains) 900 (tank)		
Flat (converted)	1,800		1,100 (mains) 1,200 (tank)		
Flat (all types)				1,100 (tank)	
Flat (new)					1,700 (mains) 3,100 (tank)
Flat (retro-fit)					2,200 (mains) 3,900 (tank)
Care Home (elderly)	7,900		14,600 (mains) 17,800 (tank)		
Care Home (all types)				24,800 (tank)	
HMO (bedsit)	1,400 (per unit)		800 (mains) (per unit) 1,000 (tank) (per unit)	2,200 (tank) (per unit)	8,100 (mains) 10,000 (tank)
HMO (shared house)	3,200		3,000 (mains) 3,800 (tank)	3,800 (tank)	3,600 (mains) 6,100 (tank)
Sheltered House				3,800 (tank)	
Sheltered Flat				1,100 (tank)	
Annual Maintenance	75	82	120 (house)	120 (house)	150 (average)

4.4.4 In January 2014, the Welsh Assembly Government announced it would be funding a pilot programme for the design and installation of fire sprinklers in social housing in Wales for housing associations and registered social landlords. BRE[11] were appointed to undertake research to monitor and record the learning and experience in relation to the design and installation of sprinkler systems including the water supply.

4.4.5 The study examined twelve schemes (eleven new builds and one conversion) covering bungalows, 2-storey houses, walk up flats with separate entrances and flats with communal entrances. The following points emerged from the analysis[12]:

- The design and installation costs were in the ranges:
  - £1,000 - £1,800 for a new build bungalow. The highest value was for a BS 9251: 2014 Category 3 system where the sprinkler system for terraced bungalows was part of the same system as an attached block of flats.
  - £1,500 - £2,000 for a new build 2-storey house (BS 9251: 2014 Category 1).
  - £700 - £2,200 for a new build flat (BS 9251: 2014 Categories 1, 2, 3 combined).
- Water company charges were £0 for standard charges (e.g. a new combined domestic water and sprinkler system per 32mm connection) or £400 per accommodation unit for bespoke cases (fixed design fees for a new dedicated/separate sprinkler supply or new combined sprinkler supply connections larger than 32mm).
- Where installed, the cost of booster pumps or pump and tank systems were in the range £100 - £1,700 per accommodation unit. The maximum cost was in cases where there was one booster pump for each accommodation unit. Costs were reduced where boosted pumps or pumps and tank could be shared over a number of accommodation units.
- Combining these elements yields design and installation and water company and supply costs of:
  - £2,300 - £2,800 per bungalow.
  - £1,800 - £3,300 per 2 -storey house.
  - £1,000 - £4,000 per flat.

[11] BRE “Welsh Government Sprinkler Pilot Study” 2016

[12] All costs in 2021 prices

4.4.6 Other costs, where quantified were in the range £50 - £1,200[13] per unit for builders and electrical work.

4.5 Conclusions from the Literature Review

4.5.1 The main conclusions from this review which are relevant to the current research include:

- The studies are consistent in the costs and benefits to be measured. The costs include installation costs, water supply costs and maintenance costs. The benefits are the prevention of deaths, injuries and a reduction in property damage.
- All studies adopt DfT estimates of the value of a fatal and non-fatal casualty.
- Most of the analysis has been undertaken on new build properties rather than alterations, conversions or extensions to existing buildings.
- The analysis tended to find that the benefit cost ratio was lower if pump and tank water systems were required. The extent to which this type of system would be required for alterations, extensions and conversions is a material consideration.
- The analysis found that retro fitting of systems tended to be more expensive than when required in new buildings.

[13] Excluding some avoidable costs related to scheduling and communications issues.

5. Analysis of Benefits

5.1 Introduction

5.1.1 This section considers the estimates of the value of benefits (avoided costs) from installing fire suppression systems. The benefits to be assessed are the prevention of deaths and injuries in fires and the reduction in property damage. While one study (reviewed in Section 4) included the benefit of reduced greenhouse gas emissions as a result of a sprinkler-controlled fire, the monetised benefit was found to be very small compared with other benefits. For this research, it is not proposed to consider greenhouse gases further.

5.1.2 The assessment of the benefits from sprinkler systems will require data and assumptions on the prevalence of fires, deaths and injuries per property type; the value of a statistical life, injury and fire damage; and the effectiveness of sprinklers in reducing deaths, injuries and damage. These are all considered in this section which concludes with estimates of the annual benefit of fire suppression systems by building category.

5.2 The Prevalence of Fire

5.2.1 As stated in paragraph 2.1.3, the SFRS dataset classifies building fires into residential dwellings, residential 'other' and non-residential. The buildings covered by Standard 2.15 are primarily residential dwelling buildings, although there are some buildings within residential 'other' and non-residential which are relevant to the analysis.

5.2.2 Comparison of the categories of buildings under Standard 2.15 and the overview of fire statistics shows that the categories of buildings do not correspond exactly. Table 5.1 sets out the proposed allocation of fire data categories to the building categories in Standard 2.15.

5.2.3 The published fire data does not provide a detailed breakdown of the retail category. Compared to the residential dwelling categories, retail has relatively few fires, deaths and injuries. Hence, it is proposed to use the statistics for retail in the analysis as a proxy for 'enclosed shopping centres'.

5.2.4 Social housing is a category in Standard 2.15. but it is not a building type. It is a characteristic of the ownership of the building and the occupier. Paragraph 2.2.10 highlighted that deprivation is strongly associated with the rate of dwelling fires. If it is assumed that social housing is more prevalent in areas of deprivation, it could be expected that the prevalence of fires in social housing would be higher than in mainstream housing. Therefore, to enable the analysis of social housing the fire statistics categories of 'flats' and 'houses' form the basis of the calculation, but prevalence of fires, deaths and injuries is doubled to reflect the higher incidence of fires in deprived areas.

Table 5.1: Allocation of Fire Categories to Standard 2.15 Categories	
Standard 2.15 Categories	**Fire Statistics Categories**
Enclosed shopping centre	Retail
Residential care building	Residential home
Sheltered housing complex	Sheltered housing (self-contained) Sheltered housing (not self-contained)
Building containing flat or maisonette	Flats Tenements
Social housing dwelling	Flats Houses
Shared multi-occupancy residential building	HMO

5.2.5 Using the Standard 2.15 categories in Table 5.1 above, Table 5.2 shows the average number of building fires by category over the last five years (2016/17 to 2021/22) and the earlier five year period 2012/13 to 2016/17. The data show a clear reduction in the average number of fires in each category. Similar data are shown for the number of deaths and casualties (non-fatal) from these building fires.

5.2.6 The Table shows that there were no deaths in HMOs in either of the two periods and that the average number of deaths per annum in enclosed shopping centres, residential care buildings and sheltered housing complexes is very low compared to the number of deaths in buildings containing flats/maisonettes and social housing dwellings. A similar trend is also shown for casualties from fires with HMOs, enclosed shopping centres and residential care buildings having low numbers of casualties.

Table 5.2: Average Annual Number of Fires, Deaths and Casualties by Building Type, 2012/13 to 2016/17 and 2017/18 to 2021/22		
	2012/13 to 2016/17	**2017/18/ to 2021/22**
Fires		
Enclosed shopping centres	236.4	181.6
Residential care building	149.0	123.8
Sheltered housing complex	551.8	433.6
Building containing flat/maisonette	2,967.8	2,521.6
Social housing dwelling	4,989.2	4,454.6
Share multi-occ. residential building	34.6	26.6
Deaths		
Enclosed shopping centres	0.2	0.2
Residential care building	0.8	0.2
Sheltered housing complex	1.6	2.6
Building containing flat/maisonette	15.4	12.8
Social housing dwelling	33.0	30.4
Share multi-occ. residential building	0.0	0.0
Casualties		
Enclosed shopping centres	6	6
Residential care building	8	5
Sheltered housing complex	70	48
Building containing flat/maisonette	649	519
Social housing dwelling	1,008	826
Share multi-occ. residential building	6	3

5.2.7 The average annual data for 2017/18 to 2021/22 in Table 5.2 has been used to calculate the prevalence of fires, deaths and casualties in each of the building categories. Prevalence is calculated as the number of fires, deaths and casualties per 10,000 properties in each building category and is shown in Table 5.3. The total stock of buildings in each category is also shown in the Table.

5.2.8 When account is taken of the number of buildings of each type in Scotland, the prevalence of fires is relatively high in residential care buildings and to a lesser extent sheltered housing. The rate of fires per 10,000 buildings is under 30 for buildings containing and maisonette or flat, a social housing dwelling and a HMO.

5.2.9 The rate of deaths and casualties per 10,000 buildings is also much higher for residential care buildings and sheltered housing.

Table 5.3: Average Annual Prevalence of Fires, Deaths and Casualties by Building Type, 2017/18 to 2021/22				
		Per 10,000 Properties of Each Type:		
	Building Stock	**Fires**	**Deaths**	**Casualties**
Enclosed shopping centres	22,400[1]	81.0	0.1	2.5
Residential care building	1,100[2]	1,158.1	1.9	46.8
Sheltered housing complex	20,500[3]	211.8	1.3	23.3
Building with flat/maisonette	864,200[4]	29.2	0.2	6.0
Social housing dwelling	2,645,300[5]	33.8[7]	0.2[7]	6.2[7]
Share multi-occ. residential building	9,900[6]	26.2	0.0	2.6

Notes: All data are rounded

1: Scottish Annual Business Statistics, Scottish Government, Data for 2020

2: Care Home Census for Adults in Scotland, Public Health Scotland, Data for 2021

3: Housing Statistics, Scottish Government, Data for 2021 includes very sheltered, sheltered and medium dependency housing for older people

4: 2011 Census - flat, maisonette or apartment. Data for 2011

5: Housing Statistics, Scottish Government, Data for 2020. Total dwellings (houses and flats)

6: Housing Statistics, Scottish Government, Data for 2021. Licenses for landlords and lodgers, bedsits and flats/houses to let.

7: Number of fires, deaths and casualties has been doubled to reflect the effect of deprivation.

5.3 The Value of a Statistical Life

5.3.1 The previous studies consistently used UK Government data on the value of a life. The latest available data (uprated to 2023 prices) are:

- The average value of preventing a fatal casualty is £2.3 million.
- The average value of preventing a serious casualty is £0.257 million.
- The average value of preventing a slight casualty is £0.020 million.

5.3.2 The data on casualties analysed in Figures 2.3 and 2.4 do not distinguish between serious and slight casualties. The severity of injury in Figure 2.5 shows that, on average over the last five years:

i. 25.8% of non-fatal casualties in dwelling fires were recommended to have a precautionary check.

ii. 39.7% of non-fatal casualties in dwelling fires received first aid at the scene.

iii. 29.9% of non-fatal casualties in dwelling fires were taken to hospital with slight injuries.

iv. 4.6% of non-fatal casualties in dwelling fires were taken to hospital with serious injuries.

5.3.3 Assuming casualties in categories (i) to (iii) above are classified as slight casualties and those taken to hospital with serious injuries (iv above) are classified as serious casualties, the weighted average value of preventing a casualty is £30,600. This value will be used in the cost benefit analysis.

5.4 The Value of Property Damage

5.4.1 The previous studies adopted a value of property damage per fire from a 2003 UK Government publication which was reported in the BRE 2004 report. The average property loss per fire was £7,100 for domestic properties and £22,600 for commercial properties (in 1999) prices. These figures were uprated to the relevant price base in the earlier studies.

5.4.2 The DCLG study found that average property damage was £2,600 per fire (2008 prices), but this included all fires including non-building and false alarms. Restricting property damage to building fires yields an estimate of £24,200 per building. This is substantially higher that the domestic estimates in the cost benefit studies.

5.4.3 The literature review did not identify any recent research on the cost of fire, although evidence from the Grenfell Tower fire estimates the cost to the council as over £400 million. This includes over £200 million of capital expenditure on new properties and £130 million on emergency housing, social care and well-being.

5.4.4 A fire in a high-rise block of flats in Glasgow in 2009 resulted in one fatality and two people needing hospital treatment. Of the 77 residents in the flats, only 18 were able to return to their homes in the immediate aftermath of the fire with some tenants out of their homes for many months. The cost of rehousing, refurbishment and loss of revenue was estimated at £2.6 million.

5.4.5 These projects illustrate the substantial costs associated with a major fire, but these large fires are relatively rare and as a result, their inclusion in the analysis would be inappropriate.

5.4.6 In the absence of any new research on the average value of property damage per fire, data from the literature review will be adopted and uprated for this study. The estimates (in 2023 prices) of property damage per building fire are:

- £12,300 for domestic properties (from cost benefit studies).
- £47,000 for commercial properties (from cost benefit studies).

- £35,700 for buildings (from Economic Cost of Fire study).

5.4.7 The result from the Economic Cost of Fire study does not distinguish between building type. Hence the estimates for domestic and commercial properties are assumed for this analysis as the building categories in Standard 2.15 cover both domestic and commercial properties.

5.5 The Effectiveness of Sprinklers

5.5.1 The assumptions about the effectiveness of sprinklers in reducing deaths, injuries and damage in the previous studies are shown in Table 5.4.

Table 5.4: Assumptions about Effectiveness of Sprinklers, %

	Deaths	Injuries	Damage
BRE 2004	70%	30%	50%
FSA Critique of BRE 2004	100%	85%	90%
BRE 2009	90%	61%	75%
BRE 2012 (Chief Fire Officers)	90% 62% - Elderly 30% - disabled	51% - 73%	87% - 93%
BRE 2012 (Welsh Assembly Government	90% - 100%	62% - 64%	88% - 93%
Optimal Economics 2015	95%	60%	85%

5.5.2 A report on the effectiveness of sprinklers by Optimal Economics[14] on behalf of the National Fire Chiefs Council and the National Fire Sprinkler Network found that sprinklers are highly reliable and effective. They work as intended in 94% of cases and control or extinguish fires in 99% of cases. The study also found that fires in residential buildings where sprinklers operated had an average area of fire damage of under 4 sqm. This compared to an average area of fire damage of 18 to 21 sqm for all dwelling fires in England between 2011/12 and 2015/16.

[14] Optimal Economics "Efficiency and Effectiveness of Sprinkler Systems in the UK: An Analysis from Fire Service Data", 2017

5.5.3 Following this research, supplementary analysis[15] was undertaken to assess the impact of sprinklers on fire fatalities and injuries. The analysis found that, on average, there is a fatal casualty every 142.5[16] dwelling fires. Where sprinklers were present in fires, only five fatalities were reported.

5.5.4 Further study of these five fatalities found that the circumstances of the fire were outside the life-saving operating parameters of the system. Typically, the casualty was directly involved in the fire with either their clothing or bedding ignited. The casualties were often unable to move away from the fire or remove clothing due to mobility issues and were often vulnerable due to age or infirmity.

5.5.5 The analysis also found that where sprinklers are present, the rate of injury is around half that experienced in dwellings where sprinklers are not present. In general, there is a non-fatal casualty every 5.3 fires, but when sprinklers are fitted, this reduces to one in every 10 to 11 fires. The analysis also found that where a person is injured in a fire where a sprinkler system has activated, the severity of the injury is less and the need to receive hospital treatment is reduced.

5.5.6 From the review of literature, it is proposed to adopt the following assumptions for the effectiveness of the sprinkler system in preventing:

- Deaths – 95%.
- Injuries – 60%.
- Damage – 85%.

5.6 Estimates of Benefits

5.6.1 To derive an estimate of the benefit of preventing a death, the number of deaths per 10,000 buildings is multiplied by the value of a statistical life. This figure is divided by 10,000 to give the average benefit per building of preventing a death. This figure is multiplied by the effectiveness of sprinklers in preventing death to yield the estimated benefit of a prevented death as a result of the sprinkler system. This process is repeated for injuries and property damage with the values of the benefits of preventing death, injuries and damage shown in Table 5.5.

[15] National Fire Chiefs Council and National Fire Sprinkler Network “Incidence of Deaths and Injuries in Sprinklered Buildings: A Supplementary Report”, 2019

[16] Data for 2013/14 to 2017/8

Table 5.5: Annual Value of Benefit (Avoided Cost), £			
	Deaths	**Injuries**	**Damage**
Retail	19.48	4.91	323.36
Residential Care	408.79	85.87	1,210.78
Sheltered Housing	277.45	43.04	221.40
Flat/Maisonette	32.36	11.03	30.51
Social Housing[1]	50.22	11.47	35.21
HMO	0	5.56	28.09
Notes: 1: Prevalence of fires, deaths and injuries per 10,000 buildings reflects an uplift to allow for the effect of deprivation as a proxy for social housing			

5.6.2 As there have been no deaths in HMO buildings over the last five years, there is no benefit associated with a reduction in fatalities for these buildings. The very low number of deaths per 10,000 buildings in retail, buildings containing a flat or maisonette and social housing results in a relatively low value of benefit for the prevention of a death. In contrast, the relatively high number of deaths per 10,000 buildings in residential care and in sheltered housing results in a higher value of benefit for the prevention of death. A similar pattern emerges for the value of the benefit associated with preventing injuries.

5.6.3 The benefits from reduced damage are based on retail buildings being classified as commercial and the other buildings classified as domestic. The relatively high prevalence of fire in residential care buildings yields the very large benefit figure in Table 5.4.

6. Analysis of Costs

6.1 Introduction

6.1.1 The costs reviewed in Section 4 tend to relate to new or retro-fit projects, rather than conversions, extensions or alterations to existing properties. As a result, discussions were held with a major supplier of fire suppression systems to gather costs to inform the analysis.

6.1.2 In considering the costs associated with installing a sprinkler system into conversions, alterations and extensions, it is assumed that these buildings do not have a sprinkler system already installed. Applications for a relaxation of Standard 2.15 are not anticipated for properties which already have a sprinkler system, as the cost of extending the system is unlikely to be prohibitive.

6.1.3 The previous studies identified the main costs of installing sprinkler systems as:

- Installation costs.
- Water supply costs.
- Annual maintenance costs/ongoing costs.

6.1.4 For non-sprinklered properties undergoing conversion, extension or alteration, there are a wide range of potential projects across the different building types. Section 3 highlighted that over 70% of conversion projects were to form a maisonette from either an attic space or two flats. A further 20% of conversion applications were to convert commercial property to form flats.

6.1.5 Given that previous studies have not examined conversion, extension or alteration projects, a few example projects were identified and cost estimates provided for the three components of cost listed above.

6.1.6 Four conversion projects relating to the provision of domestic residential accommodation and two extension projects for care homes were identified:

1. Conversion of two flats into a maisonette or an attic space above a flat to form a maisonette (e.g. 1-2 bed flat into 2 to 3 bed maisonette). Approx 70 sq. m. to 140 sq. m.

2. Conversion of a large flat or maisonette into two flats. This is the converse of 1 above to determine if the per unit cost would be less.

3. Conversion of commercial/public buildings (e.g. office/school) to residential flats on a small scale – less than 20 flats.

4. Conversion of commercial/public buildings (e.g. office/school) to residential flats on a large scale – more than 50 flats.

5. Extension of 4 rooms to a small 8-bed care home.

6. Extension of 10 rooms to a large 40 bed care home.

6.1.7 The following points should be noted about the cost information provided:

- All costs relate to BS 9251:2021 which came into effect on 30th June 2021. The latest version of the standard requires more monitoring and has wider implications for the coverage of the system than the previous version of the Standard. Hence, costs are higher than they would be for a system meeting the earlier version of the Standard (BS 9251:2014).

- BS 9251:2021 has four risk categories which have minimum design parameters which determine the number of heads that should be used to calculate the amount of water and pressure required to run the system. All costs in this analysis relate to Category 1 to Category 3 levels as appropriate:

  - Category 1: covers individual dwellings and small blocks of flats and requires a minimum run time of 10 minutes with 1 or 2 heads included the calculation.

  - Category 2: covers residential care homes with 10 or less residents. It requires a minimum run time of 30 minutes with 1 or 2 heads in the calculation.

  - Category 3: covers larger residential care homes with more than 10 residents. It requires a minimum run time of 30 minutes with 2 or 4 heads in the calculation.

- None of the analysis is applicable to Category 4 systems which cover buildings over 18 metres in height and have greater run times and water supply requirements.

- The analysis has not considered the costs of installing a mist suppression system. The Standard for mist systems is older and not comparable to BS 9251:2021.

6.2 Costs of Sprinkler Systems

6.2.1 For the six project examples, the costs of installing the sprinkler system were provided. These costs exclude any other building costs and VAT but include a 2.5% main contractors discount. Table 6.1 provides a summary of the installation costs.

Table 6.1: Installation Costs of Sprinkler Systems excluding Other Building Costs		
	Total Cost, £	**Cost per Unit, £**
Two flats or attic space into a maisonette	11,000	11,000
Maisonette into two flats	15,000	7,500
Commercial building into 20 flats	42,000	2,100
Commercial building into 50 flats	93,500	1,870
Small care home extension (4 rooms)	12,700	12,700
Large care home extension (10 rooms)	18,300	18,300
Note: these costs assume the work is based in the central belt and where more than one flat is created, the protection is provided to the apartments only and not to any communal areas. For the care homes, protection is provided to the 4 or 10 additional rooms plus associated common access. A main contractors discount is included but the costs exclude VAT.		

6.2.2 The installation costs associated with the formation of a maisonette are considerable at £11,000. The cost of converting a commercial building into flats is substantial, but when considered on a per unit basis, it falls considerably to around £2,000 per unit. The costs of installing a system into the care home extensions are also substantial.

6.2.3 Discussions with the system supplier suggested that there is a move towards pump and tank water supply to ensure that the required water pressure and flow for the system can be delivered. Table 6.2 provides summary of the costs associated with installing a pump and tank for each project type.

Table 6.2: Costs of Pump and Tank Water Supply Systems		
	Total Cost, £	**Cost per Unit, £**
Two flats or attic space into a maisonette	11,100	11,100
Maisonette into two flats	11,100	5,550
Commercial building into 20 flats	15,500	775
Commercial building into 50 flats	19,300	386
Small care home extension (4 rooms)	19,300	19,300
Large care home extension (10 rooms)	19,300	19,300
Note: for the projects converting commercial premises to flats, the pump and tank are assumed to be located the building. Due to the small care home extension taking the number of residents to more than ten, it is assumed that the project may become a Category 3 project under BS9251:2021 which requires a larger capacity tank. If the project remains at Category 2 level, the tank size and cost could be reduced. A main contractors discount is included, but VAT is excluded.		

6.2.4 If it is possible to use the mains water supply rather than a pump and tank system, the cost[17] would fall to zero as a spur would be taken from the existing supply.

6.2.5 The annual cost of maintenance is advised to be £200[18] per unit.

6.2.6 Table 6.3 provides a summary of the total cost of installing a system per unit for both mains fed and pump and tank systems. The key points to note are:

- The costs are substantially lower for mains fed systems, particularly where a maisonette or one or two flats are created or a care home is extended.
- The costs reduce considerably with the number of units in the building project. Where there are only one of two properties associated with the conversion or extension, the cost per unit is very high. Where a larger number of units can be created, the costs per unit falls considerably, reflecting economies of scale in the installation process.

[17] Advised by Scottish Water.

[18] Advised by system supplier.

Table 6.3: Total Cost of Installation (installation and Water Supply) of Fire Suppression Systems in Different Conversion/Extension Projects, £ per unit		
	Total Cost (Mains)	**Total Cost (Pump & Tank)**
Two flats or attic space into a maisonette	11,000	22,100
Maisonette into two flats	7,500	13,050
Commercial building into 20 flats	2,100	2,875
Commercial building into 50 flats	1,870	2,256
Small care home extension (4 rooms)	12,700	32,000
Large care home extension (10 rooms)	18,300	37,600
Note: Costs exclude annual maintenance costs		

6.3 Application of Costs to Building Types in Standard 2.15

Flats/Maisonettes

6.3.1 Table 3.1 highlighted that the majority of applications for relaxations (to date) relate to conversions of either attic space or two flats to form a maisonette. Table 6.3 shows that regardless of the water system adopted, there are very considerable costs associated with the installation of a water suppression system into this type of conversion. The cost benefit analysis will be undertaken for the two maisonette conversions.

6.3.2 Table 3.1 also shows that there were four extension projects to ground floor flats, of between 14 and 35m^2. It is very difficult to provide example costs for extension projects as the configuration of the system will depend on the size of the extension, the configuration of partitions and the use of the space. However, total costs in Table 6.3 are relatively high for the formation of a maisonette or one or two flats, particularly if a pump and tank are required. It is therefore expected that the costs would also be relatively high for an extension to an existing building for domestic residential purposes as the effects of economies of scale on unit cost are not likely to exist for an extension project. No specific extension project will be analysed in the cost benefit assessment, but broad conclusions will be drawn from the conversion results.

HMOs

6.3.3 There have been no applications (to date) for a relaxation of the Standard for HMOs. It has not been possible to obtain costs for the conversion of a large property into a HMO, but the cost of installing a fire suppression system into this type of property is assumed to be similar to the costs of converting a maisonette into two flats. The cost benefit analysis will therefore adopt the maisonette to two flats costs when considering HMOs.

Social Housing

6.3.2 There have been no applications (to date) for a relaxation of the Standard for social housing. As stated previously, social housing is more a description of the ownership/occupiers of the dwelling than a building type per se. There is no reason to believe the costs of installing a fire suppression system into a building which would be used for social housing would be different to the costs of installing a system into a building to be used as mainstream housing. The cost benefit analysis will adopt the cost estimates in Table 6.3 for small and large commercial conversions to flats for the assessment of social housing.

Care Homes

6.3.4 There have been no applications (to date) for a relaxation of the Standard for care homes to date. The analysis will consider the costs of the two care home examples in Table 6.3.

Sheltered Housing

6.3.5 There have been no applications (to date) for a relaxation of the Standard for sheltered housing. No specific costs were provided for sheltered housing projects, but the analysis will adopt the costs for conversion of commercial buildings into flats.

Retail – Enclosed Shopping Centres

6.3.6 There have been no applications (to date) for a relaxation of the Standard for enclosed shopping centres. As a project relating to an enclosed shopping centre would be a commercial project the fire suppression system would have to meet BS 12845:2021. This is a more onerous standard and the cost information obtained from the system supplier is not applicable to projects required to meet this standard. No specific cost benefit assessment will be undertaken for retail.

7. Cost Benefit Results

7.1 Introduction

7.1.1 This section presents the results of the cost benefit analysis using the individual benefits and costs set out in Sections 5 and 6 respectively. The analysis shows the costs and benefits in present value terms which is the current value of a future stream of cash flows. The discounted costs and benefits take account of the fact that £1 today is worth more than £1 in future years. The benefit cost ratio (BCR) is also calculated which is the ratio of discounted benefits to discounted costs. A BCR ratio greater than one indicates that the benefits are greater than costs. The analysis has been undertaken over a 60 year period and is consistent with the Treasury Green Book[19].

7.2 Cost Benefit Analysis

7.2.1 The cost benefit calculations are undertaken for the following building scenarios:

Flats/Maisonettes:

1. Costs for two flats or attic space being converted to a maisonette and benefits for flats/maisonettes.
2. Costs for maisonette being converted to two flats and benefits for flats/maisonettes.

Social Housing

3. Costs for conversion of commercial building to 20 flats and benefits for social housing.
4. Costs for conversion of commercial building to 50 flats and benefits for social housing.

HMO

5. Costs for maisonette being converted to two flats and benefits for HMOs.

Care Homes

6. Costs for small care home extension and benefits for care homes.
7. Costs for large care home extension and benefits for care homes.

Sheltered Housing

8. Costs for conversion of commercial buildings to 20 flats and benefits for sheltered housing.
9. Costs for conversion of commercial buildings to 50 flats and benefits for sheltered housing.

[19] A discount rate of 3.5% has been used for Years 1-30 and 3% for Years 31-60.

7.2.2 Table 7.1 provides a summary of the present value of costs and benefits for each of the scenarios in paragraph 7.2.1 and the BCR for each project.

7.2.3 The Table shows that for scenarios 1 to 5, the costs of installing a fire suppression system substantially outweigh the benefits for flats/maisonettes, social housing and HMOs. A number of points emerge from the analysis:

- The low value of benefits in the scenarios reflect the relatively low prevalence of fires, deaths and injuries in buildings containing flats, social housing or HMOs (Table 5.5).

- The present value of costs includes the installation, water supply and annual maintenance costs. At £200 per annum for all systems for 60 years, the present value of the annual maintenance fee alone is over £5 million. The present value of this component of cost alone is higher than the present value of benefits for buildings containing flats/maisonettes, social housing and HMOs.

7.2.4 The Table shows that for scenarios 6 to 9, the benefits of installing a fire suppression system outweigh the costs for care homes and sheltered housing projects. The analysis shows:

- The high value of benefits in care homes reflects the relatively high prevalence of fires in care homes and the value of damage associated with the fires (Table 5.5).

- The present value of benefits associated with the sheltered housing scenarios outweigh the costs with the BCRs in the range 1.7 to 2.0, depending on the water supply costs.

7.3 Broad Suggestions for Relaxations

7.3.1 From the analysis in this report, the following broad conclusions can be drawn:

- The prevalence of fires, deaths and casualties in care homes and sheltered housing is much higher than in the other building types forming part of Standard 2.15. This leads to relatively high values of annual benefit from avoiding a fire, death or casualty. When compared to the costs of installing automatic fire suppression systems, the benefits outweigh the costs in both water supply scenarios (mains and pump and tank systems). Both care homes and sheltered housing have been covered by the Standard since 1 May 2005 and during this time there have been no applications for a relaxation of the Standard. This suggests that a potential exemption may not be required for these two categories of buildings.

- It has not been possible to obtain costs for the installation of an automatic fire suppression system into an extension/conversion/alteration of a commercial (retail) property. However, given the need for the system to meet the commercial standard, it is anticipated that the costs could be substantial. The present value of benefits for avoiding a fire, death and casualties in retail properties is estimated to be £8.8 million. Should the present value of the cost of the system in an

extension/conversion/alteration project exceed this, the cost could be prohibitive. As with care homes and sheltered housing, retail has been covered by the Standard since 1 May 2005 and there have been no applications for a relaxation of the Standard during this time. This suggests that a general exemption may not be required and that any applications should be reviewed on a case by case basis.

- The analysis shows that the example projects relating to flats/maisonettes, social housing and HMOs have BCRs which are well below one, suggesting that the costs outweigh the benefits. These results derive from relatively low prevalence of fires, deaths and casualties and relatively high installation costs associated with conversion/extension projects, particularly where a small (e.g. one or two) number of homes are involved. Given that all the applications, to date, for a relaxation of the Standard apply to buildings which are flats/maisonettes, consideration should be given to a potential exemption for conversions/extensions/alterations in this building category. The exemption should relate to an automatic fire suppression system meeting meeting BS 9251:2021.

7.3.2 A number of caveats could be applied to the exemption including:

- The height of the building if more than 18 metres.
- The use of a mist suppression system.

Table 7.1: Cost Benefit Results by Building Project, (£000s for Present Value of Costs and Benefits)							
		Mains Water			Pump and Tank Water System		
Scen-ario	**Description**	**PV Costs**	**PV Benefits**	**BCR**	**PV Costs**	**PV Benefits**	**BCR**
1	Flats to maisonette	16.1	1.9	0.12	27.2	1.9	0.07
2	Maisonette to flats	12.6	1.9	0.15	18.1	1.9	0.10
3	Commercial to flats (small)	7.2	2.5	0.34	8.0	2.5	0.31
4	Commercial to flats (large)	6.9	2.5	0.35	7.3	2.5	0.34
5	Maisonette for HMO	12.6	0.9	0.07	18.1	0.9	0.05
6	Care home extension (small)	17.3	43.4	2.49	36.0	43.4	1.2
7	Care home extension (large)	22.8	43.4	1.90	41.4	43.4	1.05
8	Commercial to sheltered housing (small)	7.2	13.8	1.92	8.0	13.8	1.73
9	Commercial to sheltered housing (large)	6.9	13.8	1.98	7.3	13.8	1.88

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