Communities and Local Government

Update of response time loss relationships for the Fire Service Emergency Cover toolkit

Fire Research Report 3/2010

www.communities.gov.uk
community, opportunity, prosperity

Communities
and Local Government

Update of response time loss relationships for the Fire Service Emergency Cover toolkit

Fire Research Report 3/2010

December 2010

Greenstreet Berman Ltd
Department for Communities and Local Government

The findings and recommendations in this report are those of the authors and do not necessarily represent the views of the Department for Communities and Local Government.

This document/publication is also available on our website at www.communities.gov.uk

If you require this publication in an alternative format please email:
alternativeformats@communities.gsi.gov.uk

Any enquiries regarding this document/publication should be sent to us at:

Department for Communities and Local Government
Eland House
Bressenden Place
London
SW1E 5DU
Telephone: 030 3444 0000

December 2010

ISBN: 978-1-4098-2437-4

Contents

Acknowledgements

*Martin Stone of Mott MacDonald Ltd. The Other Building loss analysis (Section 2.3 was completed by Mott MacDonald Ltd).

1 Introduction

The Fire Service Emergency Cover (FSEC) toolkit[1] uses formulae that relate response times to the loss of life and property in fires and special service incidents. These relationships were developed, mostly, using fire and incident data.

This draft report provides a summary of analysis completed to review and up-date response time – loss relationships used in the FSEC toolkit, specifically the response time fatality rate relationships used for:

- **Special Services** – last updated in an analysis reported in 2003 using 1999 data
- **Other Buildings** – which uses relationships developed in 1998 using data from the 1990's
- **Other Buildings** – which also uses relationships developed in 1999 using 1998 data.

The aims of the work reported here were to use more recent data in order to develop up-to-date relationships for use in FSEC.

In addition, doubts have been expressed regarding the accuracy of the Other Building fatality predictions, specifically the response time-fatality rate relationship. Therefore, this re-analysis provided an opportunity to also explore whether another and more accurate approach could be adopted for Other Building fatalities.

[1] See http://www.communities.gov.uk/fire/runningfire/fireserviceemergency/ for a summary of the toolkit.

2 Results

2.1 Special services

2.1.1 Introduction

The FSEC toolkit was provided with response time-fatality rate relationships for Road Traffic Collisions, Extrications, Other Special Services, Lift rescues, Lock in/out, HAZCHEM incidents, Water rescues, Line rescues and Ladder rescues. The relationships give a predicted fatality rate per incident with one or more death, casualty or rescue. The predicted fatality rate increases with the response time of the FRS. This was originally expressed using three time bands, namely 0 to 5 minutes, 6 to 10 minutes and over 10 minutes.

The special service response time-fatality rate relationships have developed in three stages:

- An initial set of relationships were developed in 1999 using data from 6 FRSs, namely Buckinghamshire, Cumbria, Lothian and Borders, Strathclyde, Tyne and Wear and Devon.
- The 2002 validation (unpublished) of the pathfinder results led to the modification of the RTA, extrication and Other Special Service relationships. The rates were amended to align the predicted deaths more closely to the reported deaths.
- In 2003[2] a larger dataset from 21 FRSs was used (of incidents in 1999) to produce a new set of relationships. These rates were subsequently expressed as regression formula, to replace the three time bands.

Communities and Local Government required in 2008 that these relationships be updated using more recent data. The aim was to ensure that the relationships remain valid and current. It was also hoped that more recent data may be of a higher standard. Special service incidents (to date) have not been reported through a standard national system. Consequently the extent of reporting and content of reporting varies greatly between FRSs. The forthcoming Incident Reporting System will encompass special service incidents and provide a far higher and more consistent set of reporting.

2.1.2 Data used

CLG provided a copy of the incident data provided by FRSs for use in the FSEC toolkit. The data covered the period 2002–2005. This data covered all FRSs in Great Britain.

The data included the time that the incident was reported, the FRS arrival time, the incident type and whether there was a death, non-fatal injury or rescue.

[2] Potential further developments of FSEC. March 2006. http://www.communities.gov.uk/publications/fire/potentialfurtherdevelopments

2.1.3 Initial data processing

As a first step, the data was sorted into the nine special categories and years. Then a count was produced for each incident category, response time band and FRS of the:

- number of deaths
- number of casualties
- number of rescues
- number of incidents where there was a death, non-fatal injury or rescue.

It should be noted that many FRSs lacked data on one or more type of incident. Indeed, in some cases only a minority of FRSs had any incident data. It is assumed by the researchers that this is due to inconsistencies in how FRS record special service incidents. The FRSs contributing to each dataset are given below.

Figure 1A: FRS included in analysis per incident category

Incident type	FRSs included in data set
RTA	2, 4, 5, 7, 8, 10, 13, 14, 19, 20, 22, 25, 26, 33, 35, 38, 39, 42, 43, 44, 62
Extrications	5, 7, 8, 9, 10, 11, 12, 13, 14, 232, 24, 25, 26, 30, 42, 44
OSS	4, 6, 7, 9, 10, 11, 18, 19, 22, 23, 24, 26, 30, 33, 35, 38, 39, 42, 43, 44, 45, 47, 60, 62
Lift	4, 5, 6, 7, 8, 11, 12, 13, 14, 17, 19, 20, 22, 23, 24, 25, 27, 30, 31, 35, 37, 38, 39, 42, 43, 44, 45, 60, 62
Lock in/out	4, 7, 8, 10, 11, 14, 19, 20, 22, 23, 30, 35, 37, 38, 39, 50, 62
Ladder	5, 7, 8, 9, 10, 22, 24, 25, 30, 31, 33, 35, 39, 43, 44, 61, 62
Line	7, 8, 10, 14, 22, 25, 30, 33, 35, 39, 43, 62
HAZCHEM	4, 5, 7, 9, 10, 11, 12, 14, 18, 19, 20, 22, 23, 24, 26, 30, 31, 33, 35, 37, 38, 39, 42, 43, 50
Water	3, 4, 5, 7, 8, 10, 18, 19, 22, 23, 25, 26, 30, 33, 35, 39, 42, 44, 60

Figure 1B : FRS code numbers

50	London	30	Nottinghamshire	14	East Sussex
47	West Yorks	29	Northumberland	13	Durham
46	West Midlands	28	Northants	12	Dorset
45	Tyne & Wear	27	North Yorks	11	Devon
44	South Yorks	26	Norfolk	10	Derbyshire
43	Merseyside	25	Lincolnshire	9	Cumbria
42	Manchester	24	Leicestershire	8	Cornwall
39	Wiltshire	23	Lancashire	7	Cleveland
38	West Sussex	22	Kent	6	Cheshire
37	Warwickshire	21	Isle of Wight	5	Cambridgeshire
36	Surrey	20	Humberside	4	Buckinghamshire
35	Suffolk	19	Hertfordshire	3	Berkshire
34	Staffordshire	18	Hereford &Worcester	2	Bedfordshire
33	Somerset	17	Hampshire	1	Avon
32	Shropshire	16	Gloucestershire		
31	Oxfordshire	15	Essex		

2.1.4 Screening of data

As a second step, the consistency of data was screened for each incident category. As reporting practices varied, some FRSs may report rescues whilst others do not for example. In the case of RTAs, extrications, Other Special Services and lock in/out, the average rate of death per incident was calculated (for all FRS with data, all years and all response times). The average rate of death for each FRS (for the same incident type) was then calculated and compared with the average for all FRSs. If the FRSs rate differed by more than a factor of 2 (double or half), it was excluded. This had the effect of reducing the size of the dataset but also limiting it to those FRSs with more consistent reporting practices. The researchers assumed that FRSs differ in what they report at special services, such as:

- some FRSs report all non-fatal casualties at an incident whilst other might only report casualties they handled or were still present when they arrived
- some FRSs may report non fatal and fatal casualties whilst others may only report fatalities or not make any distinction between fatal and non fatal casualties.

Whilst we can only speculate as to why data sets vary so much, it is clear that the ratio of fatalities to the total count of fatalities, non fatal casualties and rescues varies greatly and we assume this is due to inconsistencies in what is reported.

In the other incident categories the fatality rate was very low, often zero for most FRSs. Therefore, all FRSs were used (where they had provided data).

2.1.5 Calculation of relationships

This entailed calculation of the rate of deaths per incident involving one or more death, non-fatal casualty or rescue for each response time period (0 to 5, 6 to 10 and >10 minutes).

The fatality rate was also calculated for 11 to 15, 16 to 20 and over 20 minutes, as a test of this option. However, due to the small number of incidents attended in these times, the datasets were very small and statistically volatile.

Categories with very low fatality rates

As with previous analysis, in some categories (lift, ladder and line rescues) the rarity of deaths requires a two-step approach to devising fatality rate relationships. That is, the first step estimates the rate of injury by response time. The second step applies a fatality rate per casualty.

2.1.6 Comparing rates

The new response time fatality rate relationships were compared with the original and 2003 rates, in Table 1. The table shows the:

- number of fatalities and incidents by incident type and response time for the 2003 and the current analysis
- calculated fatality rates per response time band
- per cent difference in the fatality rates between the 2003 and 2008 results
- calculated fatality rates if you combine the 1999 and 2002–2005 data.

The 2003 and current fatality rates are also shown in Figure 2 to Figure 7. Figures are not shown for ladder, line or lift rescues due to the very low fatality rates.

It can be noted that the:

- sample sizes achieved with the 2002–2005 data were similar to, or less than the sample size for the 2003 analysis
- calculated fatality rates differ between the two analyses, but remain in the same order of magnitude.

It may be noted that the:

- slopes for Other Special Services, HAZCHEM and Extrications are similar for 2003 and 2008 analysis
- 2008 analysis provides a less ‘smooth’ slope for RTAs
- lock in – lock out relationship is not smooth (does not rise for each time period) the fatality rates are much higher in 2008 than the 2003 analysis
- 2008 analysis provides a less smooth slope for water rescues.

As discussed in Section 2.1.7, it is judged that the differences in fatality rates and slopes may simply reflect random differences in the data due to the inconsistencies in reporting practices. It is assumed that the differences in fatality rates do not reflect real changes in fatality rates.

Table 1: previous and new special service response time fatality rate relationships

			2003 data analysis (1999 data)			2008 data analysis (2002 to 2005 data)				Combined 1999 data and 2003/05 data		
Incident type	FRS Response time (minutes)	Original rates (1999)	Fatalities	Incidents with 1 or more casualty, death or rescue	Rate per incident	Fatalities	Incidents with 1 or more casualty, death or rescue	Rate per incident	% difference	Fatalities	Incidents with 1 or more casualty, death or rescue	Rate per incident
RTA	0 to 5	0.045	159	3109	0.051	58	1847	0.031	39%	217	4956	0.044
	5 to 10	0.12	422	4998	0.084	381	6008	0.063	25%	803	11006	0.073
	>10	0.163	577	4559	0.127	454	7014	0.065	49%	1031	11573	0.089
			1158	12666	0.091	893	14869	0.060	34%	2051	27535	0.074
Extrications	0 to 5	0.014	48	2123	0.023	5	352	0.014	37%	53	2475	0.021
	5 to 10	0.019	73	2121	0.034	22	1388	0.016	54%	95	3509	0.027
	>10	0.076	62	724	0.086	34	594	0.057	33%	96	1318	0.073
			183	4968	0.037	61	2334	0.026	29%	244	7302	0.033
OSS	0 to 5	0.04	78	1032	0.076	23	1041	0.022	71%	101	2073	0.049
	5 to 10	0.1	127	865	0.147	87	1639	0.053	64%	214	2504	0.085
	>10	0.17	87	392	0.222	102	756	0.135	39%	189	1148	0.165
			292	2289	0.128	212	3436	0.062	52%	504	5725	0.088
Lift	0 to 5	0.001	0	1333	0.000	0	159	0.000	N/A	0	1492	0.000
	5 to 10	0.002	1	951	0.001	4	214	0.019	–1678%	5	1165	0.004
	>10	0.003	0	128	0.000	0	33	0.000	N/A	0	161	0.000
			1	2412	0.000	4	406	0.0099	–2276%	5	2818	0.0018
Lock in out	0 to 5	0.13	21	3233	0.006	8	243	0.033	–407%	29	3476	0.008
	5 to 10	0.132	13	2570	0.005	16	592	0.027	–434%	29	3162	0.009

(*continued*)

Table 1: previous and new special service response time fatality rate relationships

			2003 data analysis (1999 data)			2008 data analysis (2002 to 2005 data)				Combined 1999 data and 2003/05 data		
Incident type	FRS Response time (minutes)	Original rates (1999)	Fatalities	Incidents with 1 or more casualty, death or rescue	Rate per incident	Fatalities	Incidents with 1 or more casualty, death or rescue	Rate per incident	% difference	Fatalities	Incidents with 1 or more casualty, death or rescue	Rate per incident
	>10	0.133	2	411	0.005	8	168	0.048	–879%	10	579	0.017
			36	6214	0.006	32	1003	0.032	–451%	68	7217	0.009
Ladder	0 to 5	0.015	0	52	0.000	0	73	0.000	N/A!	0	125	0.000
	5 to 10	0.02	0	51	0.000	1	172	0.006	N/A	1	223	0.004
	>10	0.028	0	8	0.000	0	59	0.000	N/A	0	67	0.000
			0	111	0.000	1	304	0.003	N/A	1	415	0.0024
Line	0 to 5	0	0	3	0.000	0	8	0.000	N/A!	0	11	0.000
	5 to 10	0	1	13	0.077	1	30	0.033	57%	2	43	0.047
	>10	1	0	7	0.000	2	37	0.054	N/A!	2	44	0.045
			1	23	0.043	3	75	0.0400	8%	4	60	0.067
HAZCHEM	0 to 5	0.04	2	94	0.021	0	33	0.000	100%	2	127	0.016
	5 to 10	0.06	7	143	0.049	2	137	0.015	70%	9	280	0.032
	>10	0.08	7	112	0.063	4	62	0.065	–3%	11	174	0.063
			16	349	0.046	6	232	0.026	44%	22	581	0.038
Water	0 to 5	0.1	2	41	0.049	4	31	0.129	–165%	6	72	0.083
	5 to 10	0.2	14	107	0.131	10	84	0.119	9%	24	191	0.126
	>10	0.3	21	89	0.236	29	65	0.446	–89%	50	154	0.325
			37	237	0.156	43	180	0.239	–53%	80	417	0.192

Figure 2: RTA fatality rate (2003 and current results)

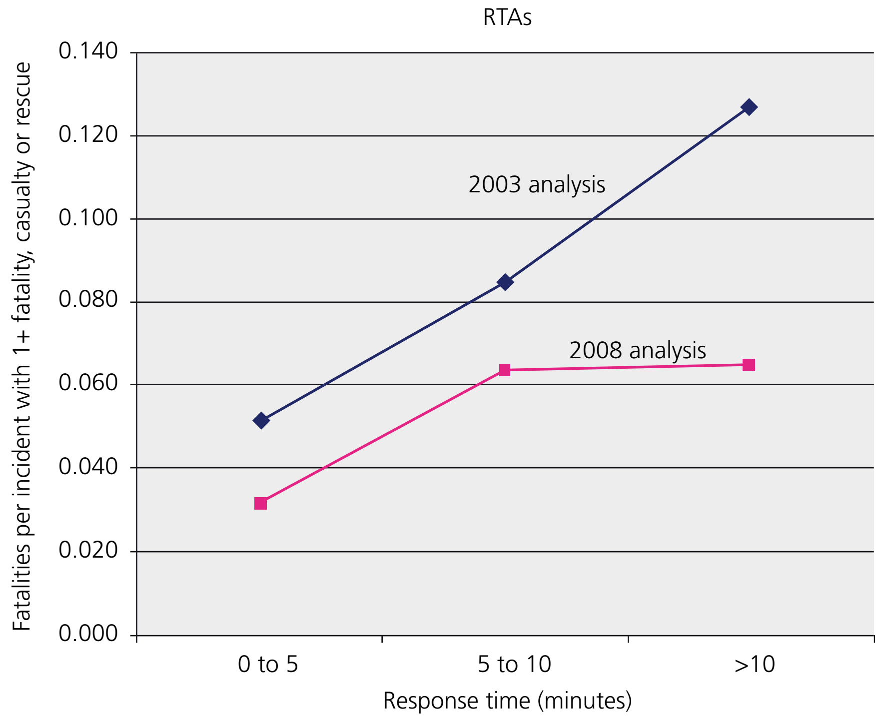


Figure 3: Extrications fatality rate (2003 and current results)

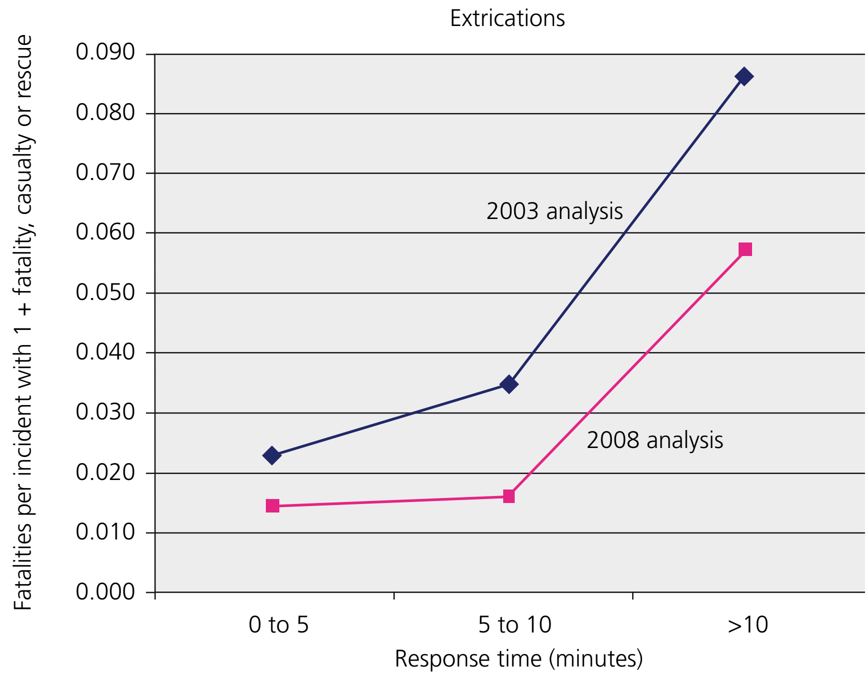


Figure 4: Other Special Service fatality rates (2003 and current results)

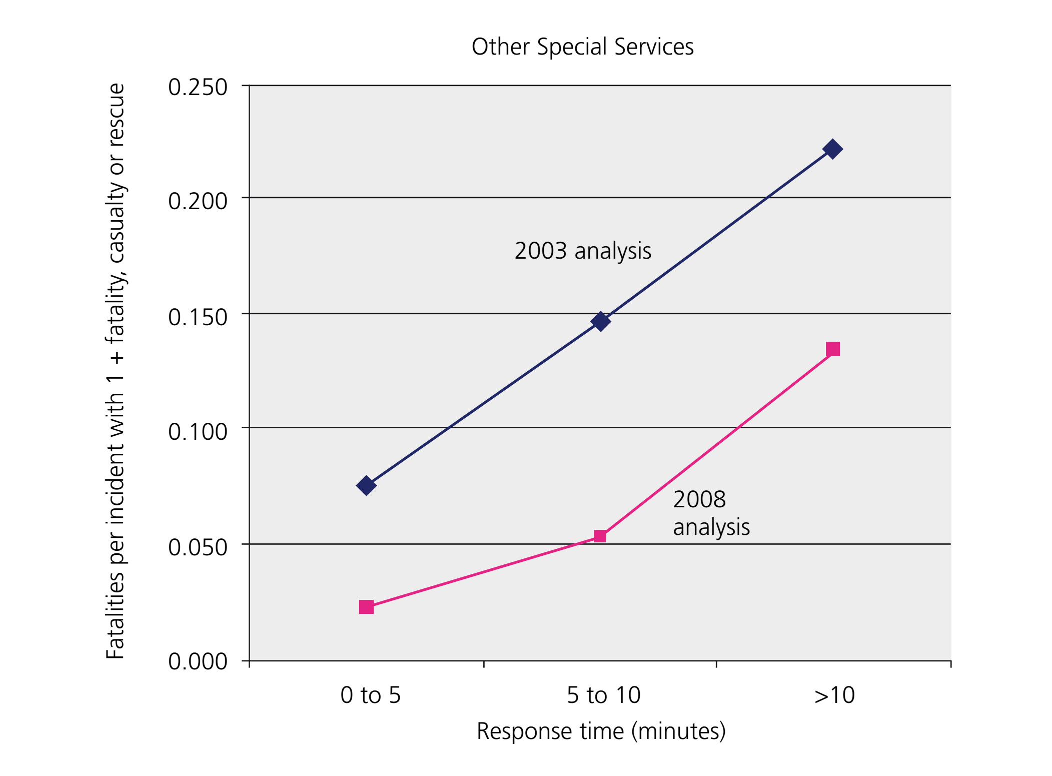


Figure 5: HAZCHEM fatality rates (2003 and current results)

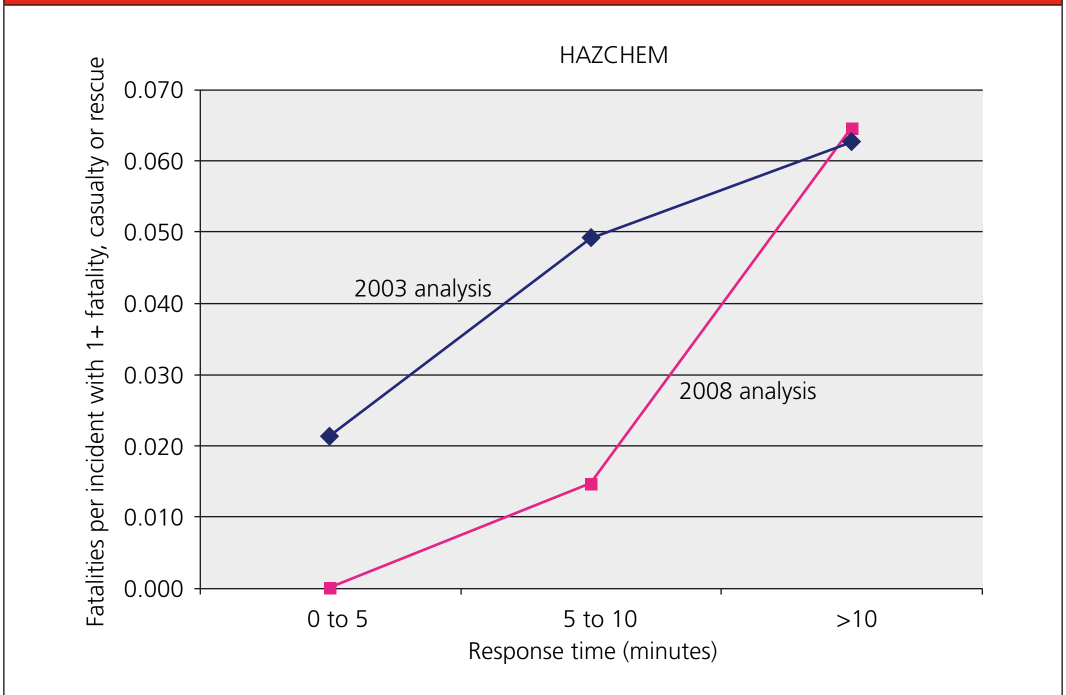


Figure 6: Water rescues fatality rates (2003 and current results)

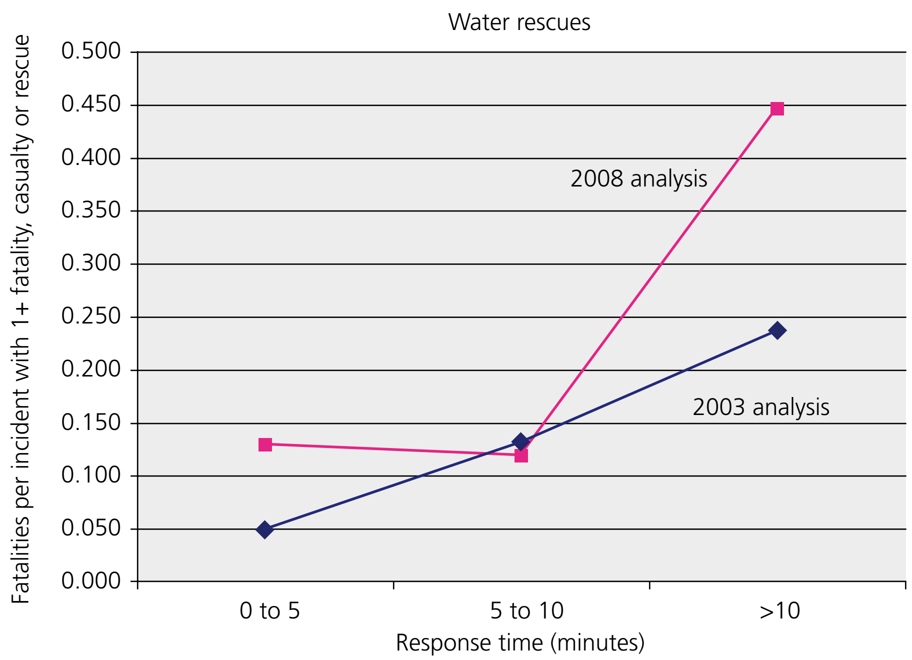
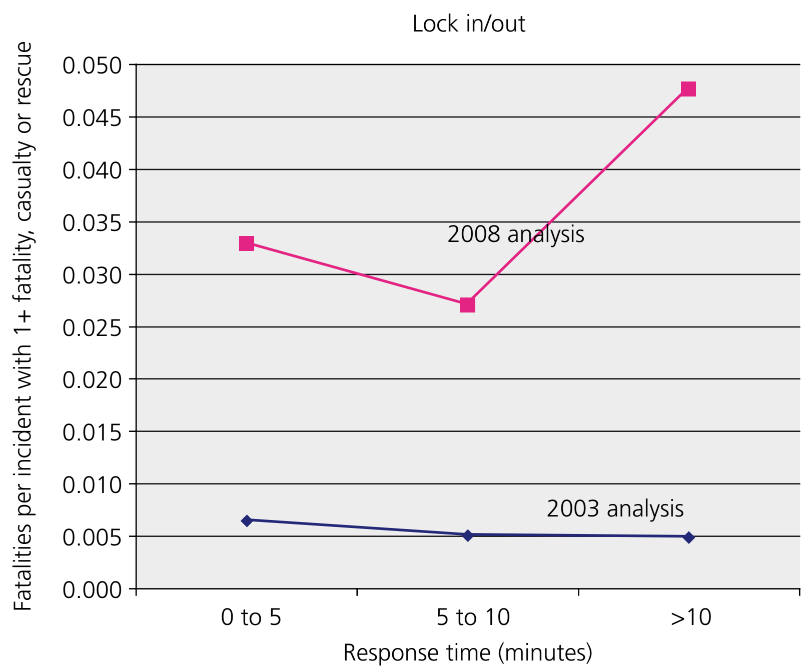


Figure 7: Lock in /out fatality rates (2003 and current results)



Ladder, line and lift rescues

In these cases the low frequency of fatalities prevented the calculation of fatality rate relationships, using fatality data alone. Therefore, a response time casualty rate relationship was produced and then multiplied by the fatality rate for all incidents.

For example, in the case of ladder rescues the response time casualty rate relationship was as stated in column B below. The fatality rate was 0.0033 for all incidents. Thus, for a 0 to 5 minute response time there are 0.452 casualties per incident x 0.0033 deaths per incident = 0.0015 deaths per incident.

(A) Response time (minutes)	Casualty rate per incident (B)	Fatality rate (C)
0 to 5	0.452	0.0015
6 to 10	0.5	0.0016
>10	1.017	0.0033

The same was applied to lift rescues to give the following fatality rates.

Lift rescues (0.012 fatalities per incident)		
Response time (minutes)	Casualty rate per incident	Fatality rate
0 to 5	0.157	0.002
6 to 10	0.336	0.0041
>10	0.667	0.0082

The same was applied to line rescues to give the following fatality rates.

Line rescues (0.04 fatalities per incident)		
Response time (minutes)	Casualty rate per incident	Fatality rate
0 to 5	0.63	0.025
6 to 10	0.77	0.031
>10	0.68	0.027

2.1.7 Discussion regarding special service fatality rates

Differences between 1999 and 2002–05 results

The current analysis did not achieve an increase in the sample size of incidents from the results published in 2003 using 1999 data. The researchers' assume that the consistency in reporting has not increased since the 2003 analysis. The new period of data has not provided a larger or more consistent data set.

Options

The researchers' also suggest that the differences between the 1999 data and current (2002–05) results may simply reflect 'random' differences in samples and inconsistencies in reporting practices. It is judged that the differences cannot be attributed to a 'true' change in fatality rates between these two periods.

Therefore, there are a number of options, including:

- retaining the 2003 results (from 1999 data)
- using the 2002–05 data results
- using results from combining the 1999 and 2002–05 datasets.

The researchers suggest that the third option is adopted as this uses the largest data set available, except for ladder, line and lift incidents (for which the 2002–05 casualty and fatality rate data is advocated).

Dropping minor incident categories

A further option is to drop the minor categories of special service incidents on the grounds that they make an insignificant contribution to the overall special service risk and their response time-fatality rates are prone to significant uncertainty. The proportion of fatalities per category are shown below. This would suggest that RTCs, Extrications and Other Special Services are the main categories, perhaps with Water Rescues and Lock in/out also retained. Line rescues, ladder rescues, HAZCHEM and Lift releases account for just 1.1 per cent of the reported deaths and could be dropped.

Category	% of deaths (2002–05 data)
RTCs	68
Other Special Services	17
Extrications	8.5
Water rescues	2.5
Lock in/out	2.3
Hazchem	0.7
Lift	0.3
Line	0.1
Ladder	0.03

Suggested fatality rates

Table 2 presents the suggested special service response time-fatality rates. These are based on the combination of the data used for the 2003 analysis and the current 2002–2005 datasets, as per the three right hand columns of Table 1. They are shown as 'rounded' fatality rates per time band and as regression formula. The regressions were derived by placing a best fit line to the three fatality rates using the auto fit function in MS-Excel. These are shown in Appendix A Section 4.

These rates are based on data from a selection of FRSs that have relatively consistent reporting practices. A significant number of FRSs were excluded from the analysis. Therefore, when these rates are applied to those FRSs excluded from the analysis the predicted fatalities are unlikely to match actual fatalities. This can be resolved by using consistent reporting practices across FRSs, such as using consistent definitions of what a casualty is, and repeating the analysis with new data.

Table 2: Suggested new response time fatality rates

Incident type	FRS Response time (minutes)	Rounded fatality rates	Regression formula y = fatality rate per FCR incident, x = response time in min's
RTA	0 to 5 5 to 10 >10	0.045 0.070 0.090	$y = 0.0045x + 0.0346$
Extrications	0 to 5 5 to 10 >10	0.020 0.030 0.075	$y = 0.0132e^{0.1322x}$
OSS	0 to 5 5 to 10 >10	0.045 0.090 0.170	$y = 0.0125x + 0.0079$
Lift	0 to 5 5 to 10 >10	0.002 0.004 0.008	$y = 0.0006x + 6E-05$
Lock in/out	0 to 5 5 to 10 >10	0.008 0.009 0.017	$y = 0.0064e^{0.0728x}$
Ladder	0 to 5 5 to 10 >10	0.0015 0.0016 0.0033	$y = 0.0002x + 0.0008$
Line	0 to 5 5 to 10 >10	0.025 0.031 0.027	$y = 0.0002x + 0.026$
HAZCHEM	0 to 5 5 to 10 >10	0.015 0.030 0.060	$y = 0.0106e^{0.1386x}$
Water	0 to 5 5 to 10 >10	0.080 0.120 0.300	$y = 0.0528e^{0.1322x}$

The new suggested fatality rates were applied along with the current FSEC rates for special services, assuming a constant rate of incidents and same response times. The differences in new and previous predictions are given in Table 3. The new rates would lead to a 23 per cent reduction in predicted deaths overall.

Table 3: Change in predicted fatalities if new fatality rates are applied

	New prediction	Previous prediction	Difference
RTCs	2035	2647	–612.4
Extrications	254	290	–36.0
OSS	514	779	–265.3
Lift	9	1	8.2
Lock in out	68	95	–26.6
Ladder	1	7	–5.8
Line	3	3	–0.5
HAZCHEM	21	27	–6.5
Water	75	65	10.0
Total	2979	3914	–935

2.2 Other Building fatality rates

2.2.1 Introduction

The Other Buildings module includes a response time – fatality relationship. The relationship was developed in 1998. It was based on a sample of fires in the UK and other developed countries. The sample was limited to those for which information on the number and timing of deaths and rescues was publicly available. The cumulative number of rescues was calculated for each time period, such as 38 per cent of rescues occur within 10 minutes, 80 per cent within 15 minutes. It was then assumed that in the absence of a fire service response these rescues would have been fatal. This approach was used because an exploratory analysis concluded that a response time – fatality rate relationship could not be derived for Other Buildings using a three to four year period due to the relative infrequency of deaths.

The current work aimed to update these relationships. It was also used as an opportunity to explore whether another method could be used to assess fatalities in Other Buildings. The original approach was subject to a number of limitations, including:

- limited to those fires for which publicly available information could be acquired
- a concern that publicly available fire reports could be skewed to 'worse cases'.

Therefore, in this analysis fire data was acquired for the period 1996 to 2006, covering England.

The analysis was completed for all Other Buildings together except houses in multiple occupation (HMOs) and purpose built flats. These were assessed separately to check if the relationships differed.

Currently FSEC only considers societal risk and property loss for other buildings. In the analysis reported here fires involving individual life risks were also considered so that this risk can be included in FSEC.

2.2.2 Analysis process

Data sorting

The FDR1 data for 1996 to 2006 was sorted as follows:

- the data was sorted with Other Buildings fires retained. In the first instance case the data was limited to all Other Buildings excluding HMOs, flats and houses converted to flats
- all late fires[3] were excluded. Fires with response times over 60 minutes were retained in the dataset
- all negative response times (which occur due to data entry errors) were excluded
- the data was supplied with the response time pre-calculated by CLG's statisticians
- the data was then sorted into each year.

This gave 13,964 fires.

Next, a count was made of the number of (1) fatalities, (2) non-fatal casualties and (3) rescues[4], for each response time period (0 to 5, 6 to 10, 11 to 15, 16 to 20 and >20 minutes).

Thus, there was a dataset sorted into response time bands per year, as shown in Table 4.

Table 4: Other Building data by response time band

Response time (minutes)	Deaths	Non-fatal casualties	Rescue	Total	% of total cases
>20	5	232	6	243	1%
15 to 20	7	455	27	489	2%
10 to 14	48	2040	98	2186	11%
5 to 9	239	11254	1248	12741	56%
<5	131	7303	820	8254	30%
Total	430	21284	2199	23913	100%

This process was repeated for fires in HMOs, flats and houses converted to flats. This gave 21,240 deaths, non fatal casualties and rescues (as in Table 5) in 27,857 fires.

3 Late fire calls are where the FRS is called to a fire when it is reported after it has extinguished.
4 Rescues, as recorded in the FDR1 database, only include those rescued that were not casualties.

Table 5: HMO and purpose built flat data by response time band					
Response times (minutes)	Deaths	Non-fatal casualties	Rescues	Total	% of total cases
10+	31	1215	119	1365	6%
5 to 10	144	6738	913	7795	37%
0 to 4.99	194	10618	1268	12080	57%
All	369	18571	2300	21240	100%

Analysis

The number of fatalities was divided by the sum of fatalities, non-fatal casualties and rescues, for each time band. This was repeated for each year and for all years together.

This provided a set of fatality rates (rate of fatalities per casualty – where casualties include fatalities, non-fatal casualties and rescues) for the response time bands. These are shown in Figure 8 along with rates of casualty and rates of rescues. These indicate that the:

- proportion of rescues decline as the response time increases
- proportion that are casualties increase as the response time increases.

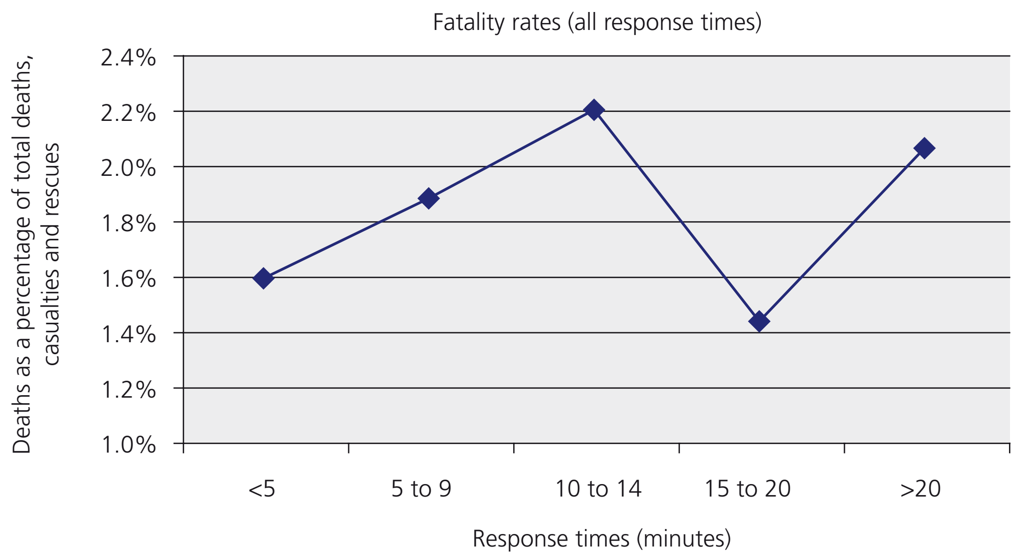
The fatality rates are shown in Figure 8.

Table 6: Fatality, non-fatal casualty and rescue rates by time period for Other Buildings excluding HMOs and flats (% of all)			
Response time	Deaths to total	Non-fatal to total	Rescues to total
<5	1.6	88	10
5 to 10	1.9	88	10
10.1 to 15	2.2	93	4
15.1 to 20	1.4	93	6
>20	2.1	95	2

The same approach was applied to purpose built flats, houses in multiple occupation and houses converted to flats, with the exception of using three time bands only. The fatality rates are shown in Table 6, where the number of fatalities is divided by the sum of fatalities, non fatal casualties and rescues (FCRs). They do not differ markedly from those for Other Buildings as a whole.

Table 7: HMOs and flats – deaths per FCR (% of all per response time band)	
Response time (minutes)	Deaths to all FCRs (%)
0 to 4.99	1.61
5 to 9.99	1.85
10+	2.27
All	1.74

Figure 8: Fatalities as a % of all fatalities, casualties and rescues in Other Buildings (1996 to 2006, excluding HMO and flats)



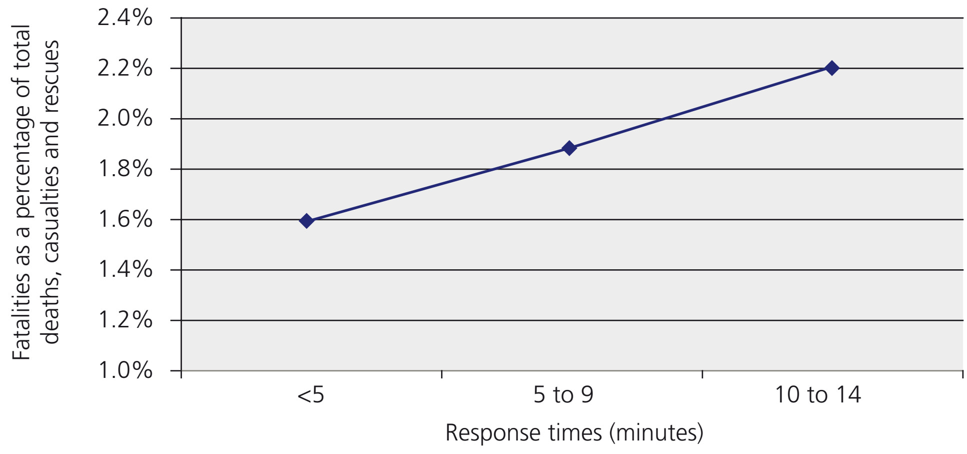
Interpretation of results

These rates were then reviewed. It was noted that the number of incidents attended in over 15 minutes was relatively small, namely 2.8 per cent of the total (732 out of 23,913). It was judged that this caused volatile results for responses over 15 minutes. Accordingly, it was decided to disregard these response time categories for the sake of producing fatality rates. This gave the following fatality rates:

Table 8: Other Building (excl HMOs and flats) fatality rates after disregarding responses over 15 minutes	
Response time (minutes)	Fatalities as a % of total fatalities, non-fatal casualties and rescues
<5	1.6
5 to 9	1.9
10 to 14	2.2

These rates are shown in Figure 9.

Figure 9: Fatality rates for Other Buildings excl HMOs and flats by response time (minutes) – disregarding response over 15 minutes



If you merge the response time categories for 11 to 15, 16 to 20 and over 20 the fatality rate is 2.1 per cent instead of 2.2 per cent.

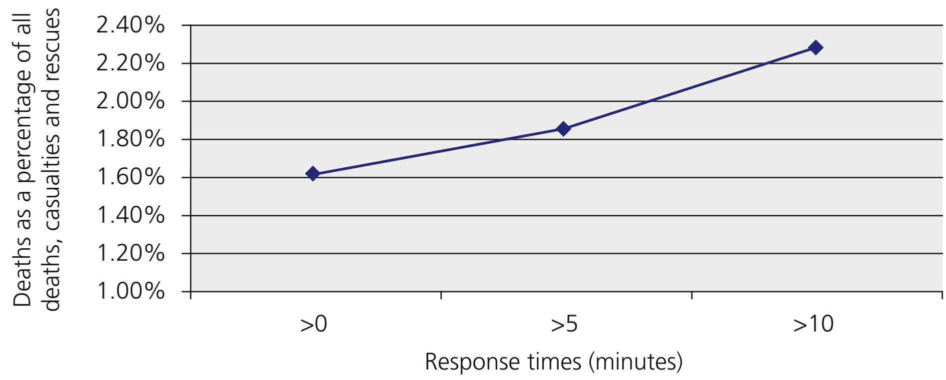
The fatality rates for each year were also reviewed. It was clear that the results for any one year were very volatile due to the relatively small number of incidents per year. If the dataset is limited to 2003 to 2006, the relationship again becomes volatile.

It was concluded that the whole dataset (1996 to 2006) provided a reasonable basis for fatality rates.

HMOs and purpose built flats

The fatality rates of reach time band are shown in Figure 10 for three response time bands. As with the Other Buildings, the use of three time bands provides a 'smooth' relationship.

Figure 10: HMOs and purpose built flat fatality rates



2.2.3 Other Building rates of individual risk fires

The response time – fatality rates developed using the FDR1 data apply to all fires in Other Buildings where there is one or more fatality, casualty or rescue, not just those with five or more fatalities or rescues. Therefore, a new set of Individual Risk rates of fire needed to be developed. These were produced by:

- summing the number of fires in Other Buildings where there is one or more fatality, casualty or rescue for the period 2003 to 2006, and dividing this by four years
- dividing the latter by the number of Other Buildings (taken from the Mott MacDonald report[5])
- deducting the rate of Societal Risk fires (again taken from the Mott MacDonald report) from the count of fires with one or more fatality, casualty or rescue.

This gave an annual rate of fire with one or more fatality, casualty or rescue per building per year (see column C for a rate per building and column D for a rate per 10000 buildings). This calculation was completed separately for each category of Other Building, to give a rate per category.

The fatality rate is per incident. The average number of fatalities, non-fatal casualties and rescues was 1.7. Thus, the rates of Other Building fire are actually a rate of fire with an average of 1.7 fatalities, non-fatal casualties and rescues per building per year, to which the new response time fatality rates can be applied.

The Individual Risk fire rates are given below for all Other Building other than HMOs and purpose built flats. Individual risk in HMOs, houses converted to flats and purpose built flats is addressed in the dwellings module. Therefore, they are excluded from this analysis.

2.2.4 Fatality rates for fire with five or more deaths or rescues

The FSEC toolkit uses a rate of fire with five or more deaths or rescues for producing Societal Risk rates of fire to Other Buildings (excluding HMOs and purpose built flats). Therefore, as a check, the 1996 to 2006 data was reduced to those with five or more deaths or rescues. The fatality rates were calculated per response time band as per the previous method.

The dataset was reduced to just 92 fires with 1,252 fatalities, non-fatal casualties and rescues.

There were no deaths in those fires attended in over 15 minutes (from 52 non-fatal casualties and rescues).

5 FSEC toolkit. Calculation of Other Building Fire Frequencies. Mott MacDonald report for Communities and Local Government, July 2006.

Table 9: Rates of Individual risk Other Building Fires

Code	Property	No. of fires with fatalities, injuries or rescues				Average 03–06	Societal risk fires	A	B	C = A ÷ B	D = C × 10,000
		2003	2004	2005	2006			Average less societal risk fires	Building Count	Rate per building	Rate per 10,000 buildings
A	Hospital	85	94	107	76	90.5	1.39	89.11	2355	0.03784	378.4
B	Care Home	86	78	74	72	77.5	1.72	75.78	24151	0.00314	31.4
F	Hotel	67	52	40	48	51.75	1.51	50.24	19674	0.00255	25.5
H	Other Sleeping Accommodation	186	187	213	222	202	0.86	201.14	24981	0.00805	80.5
J	Further Education	7	8	5	5	6.25	0.04	6.21	3934	0.00158	15.8
K	Public Building	1	3	1	1	1.5	0.42	1.08	37385	0.00003	0.3
L	Licensed Premises	189	156	144	140	157.25	1.22	156.03	116925	0.00133	13.3
M	School	24	26	28	15	23.25	0.42	22.83	31442	0.00073	7.3
N	Shop	103	95	98	104	100	1.39	98.61	582683	0.00017	1.7
P	Other premises open to the public	41	27	27	24	29.75	0.75	29.00	67451	0.00043	4.3
R	Factory or warehouse	174	165	142	138	154.75	0.18015	154.57	397268	0.00039	3.9
S	Office	22	18	17	19	19	0.20	18.80	362750	0.00005	0.5
T	Other work place	26	28	24	23	25.25	0.60	24.65	145801	0.00017	1.7
E	Hostel	12	6	4	6	7	0.53	6.47	19674	0.00033	3.3

Table 10: Fatality rates in Other Building fires (excluding HMOs and flats) with five or more deaths or rescues

Response time (minutes)	Fatalities as a % of total fatalities, non-fatal casualties and rescues
<5	2.3
5 to 9	1.3
10 to 14	3.0
15 to 20	0.0
>20	0.0%

The rate of fatality for all time bands was 1.84 per cent. This was very close to the rate of 1.8 per cent for fires with one or more fatality, non-fatal casualty or rescue. Therefore, it was concluded that the fatality rates as a percentage of total fatalities, non-fatal casualties and rescues were very similar for fire with five or more deaths or rescues as for fires with one or more fatality, non-fatal casualty or rescue.

2.2.5 Review of large fires

As another test a sample of fires with a large loss of life were reviewed. The sample of 15 fires was taken from the UK and other developed countries over the period. The number of persons present, injured and fatalities were identified (as possible) from publicly available reports. The per cent of people who die was then calculated.

The average fatality rate was far greater at 10 per cent of people than that found for the fires reported in FDR1.

It was judged by the researchers and through discussion with CLG that the sample of large fires may not be representative because it:

- is skewed to those publicly reported
- is a very small sample (15 versus 13,964 FDR1 fires).

Therefore, it was judged that the higher fatality rate in these fires does not invalidate the rate found in the FDR1 fires. However, it did suggest that the process of adjusting Maximum Probable Loss (MPL) and adjusting Societal Risk rates of fire should be retained, to allow an element of modelling fires with potential for a large loss of life.

2.2.6 Comparison of new and old approach

New approach

The application of the Individual Risk rates of fire and fatality rates was tested by:

a) applying the average number of fires per year given in Table 9

Table 11: Large fire data

Location/name of incident	Type of building	Date	Country	Deaths	Injuries	Rescues	Total	Deaths to total
Dusseldorf airport fire	Airport	Apr-96	Germany	17	72	2000	2089	0.8%
Rosepark Nursing Home Uddington, Scotland	Nursing home	Jan-04	Scotland	10	6	20	36	27.8%
Bradford City Football Club	Football club	May-85	England	56	200		2000	2.8%
L'Innovation Department Store Fire, Brussels	Department Store	May-67	Belgium	325	80	180	585	55.6%
The Station Nightclub fire	Nightclub	Feb-03	Rhode Island, US	100	200		404 people in crowd	24.8%
Hilton Hotel, Las Vegas	Hotel	Feb-81	Las Vegas, US	8	198		206	3.9%
Switel Hotel	Hotel	1994		12	140		450	2.7%
Schiphol airport	Airport	2005	Amsterdam	11	15		350	3.1%
Hamlet Chicken processing plant	Factory	Sep-91	North Carolina, USA	25	54		79	31.6%
Volendam,	Café	2001	Amsterdam	14	250		264	5.3%
Goteborg Discotheque fire	Warehouse	1998	Sweden	63	213		276	22.8%
The Mason Hotel Fire	Hotel	2004	San Diego, US	1	17		18	5.6%
Paris Hotel Fire	Hotel	2005	France	22	50		79	27.8%
California Hotel Fire	Hotel	2002	USA	4	18	30	52	7.7%
Childers Hostel Fire	Hostel	2000	Australia	15			90	16.7%
			Totals and averages	**683**	**1513**	**2230**	**6574**	**10%**

b) calculating the per cent of fires attended in <5, 5 to 10 and >10 minutes over the period 1996 to 2006

c) applying the fatality rate (for each response time band) derived at a) to the proportion of incidents with each respective response times.

This gave:

- 41.89 (Individual risk) deaths per year for Other Buildings excluding HMOs, purpose built flats and houses converted to flats.

Next, the Other Building Societal Risk Rates of fire were applied to the count of Other Buildings, including HMOs, purpose built flats and houses converted to flats. The new fatality rates per response time were applied, again applying the per cent of fires attended in <5, 5 to 10 and >10 minutes over the period 1996 to 2006.

This gave:

- 2.94 (societal risk) deaths in Other Buildings excluding HMOs, purpose built flats and houses converted to flats, and
- 4.25 (societal risk) deaths in HMOs, purpose built flats and houses converted to flats.

Thus, the total calculated individual and societal deaths' using the new method was 49.1 per year. This prediction includes Societal risk deaths in HMOs, purpose built flats and houses converted to flats, and both Individual and Societal Risk deaths in other categories of Other Buildings. Individual risk deaths in HMOs, purpose built flats and houses converted to flats were excluded from this prediction because they are already assessed within the Dwelling FSEC module.

The predicted fatalities in Other Buildings excluding HMOs was 44.83 (41.89 plus 2.94) per year. This can be compared to a reported average annual rate of 39.1 for the period 1996 to 2006. The difference may be due to the prediction assuming a constant number of each type of building over this period (as we only used a single count of buildings from mid 2000's). Also the Societal Risk rates of fire are based on 1997–2004 data and its known that there are uncertainties in the count of Other Buildings.

There was a negligible difference in the HMO/flat predicted deaths if you used the Other Building or the HMO/flat response time- fatality rates.

Current approach

The current approach was applied using a consistent set of assumptions, including:

- the same count of buildings
- the same distribution of response times.

It also assumed the default MPL and applied the current fatality rates per response time (ignoring partial benefits).

This gave a total of 119 deaths:

- 48.6 for Other Buildings excluding HMOs, purpose built flats and houses converted to flats, and;
- 70.63 in HMOs, purpose built flats and houses converted to flats.

Comparison of results

The current and new predictions are shown in Table 12. The new approach gives a result 59 per cent lower than the current method, due to the reduction in predicted deaths for HMOs, purpose built flats and houses converted to flats.

The predictions for Other Buildings excluding HMOs, purpose built flats and houses converted to flats for the two methods are very similar.

The predictions for HMOs, purpose built flats and houses converted to flats are very different.

The reasons for these changes are judged to be:

- the current method was based on an unrepresentative sample of Societal Risk fires that gave an excessive number of deaths per fire – the proposed approach is based on all Societal Risk Fires which gives fewer deaths per fire and hence a lower predicted number of Societal Risk fire deaths for Other Buildings and HMOs
- the new approach includes deaths in Individual Risk fires for Other Buildings (excluding HMOs), whilst the current approach does not.

Thus, the main reasons for the differences in results are the use of more representative fatality data for Societal Risk fires and the incorporation of Individual Risk into Other Buildings.

Table 12: Comparison of results from current and new potential methods

	Building categories	Individual fatalities	Societal fatalities	Total	Average reported per year (1996–2006)
Current method	OBs, excluding HMOs etc	–	48.6	48.6	39.1
	HMOs etc	–	70.63	70.63	
	All OBs			**119.23**	
New method	OBs, excluding HMOs etc	41.89	2.94	44.83	39.1
	HMOs etc	–	4.25	4.25	
	All OBs			**49.08**	

2.2.7 Guidance on implementation in FSEC

The new method would involve applying two rates of fire to Other Buildings, namely the:

- current rates of Societal Risk fire
- new rates of Individual Risk fires (except HMOs, houses converted to flats and purpose built flats, for which you only apply Societal Risk rates here because the individual risk is modelled in the dwelling module).

Societal risk

The Societal Risk rates of fire are applied and adjusted by the site assessment as per the current FSEC module

The maximum probable loss and single versus multiple compartment factors are applied as per the current FSEC module.

A new fatality rate is applied using the following regression:

$$y = (0.0006x + 0.0145) \times \text{number of potential deaths}$$

The number of potential deaths is the assume number per MPL category as currently applied in FSEC, e.g. 8 for buildings with a MPL of 20 to 50.

If the Single Compartment option is selected, the fatality rate is doubled.

The arrival time would be based on partial benefit factors. These can be the same as currently in FSEC, one appliance can enact two rescues. Thus, noting that FSEC is limited to modelling four appliances for Other Building Societal Risk, the arrival time would be modelled for the first four appliances, with a percentage of the MPL attributed to each appliance.

There are two options on the percentage of MPL per appliance. One option is to use the percentaeg currently in FSEC of 37.5per cent for the first two appliances, 20 per cent for the third and 5 per cent for the fourth. These percentages were based on the observed percentage of rescues achieved by each appliance in a sample of fires. This is shown below:

$$y = (0.375 \times (0.0006a + 0.0145) \times \text{number of potential deaths}) + (0.375 \times (0.0006b + 0.0145) \times \text{number of potential deaths}) + (0.20 \times (0.0006c + 0.0145) \times \text{number of potential deaths}) + (0.05 \times (0.0006d + 0.0145) \times \text{number of potential deaths})$$

Where a, b, c and d are the arrival times of the first, second, third and fourth appliance.

However, the latter approach uses the previous sample of fires to derive a response time – fatality rate relationship for a given weight of response. This relationship is superseded by the current work. Therefore, an alternative is to apply a simple ‘rule’ that each appliance can rescue two persons, as reported in the 2003 Greenstreet Berman Ltd report for ODPM[6] (p76). This would give the following formula:

$$y = (0.25 \times (0.0006a + 0.0145) \times \text{number of potential deaths}) + (0.25 \times (0.0006b + 0.0145) \times \text{number of potential deaths}) + (0.25 \times (0.0006c + 0.0145) \times \text{number of potential deaths}) + (0.25 \times (0.0006d + 0.0145) \times \text{number of potential deaths})$$

The latter formula was recommended.

Individual risk

The new Individual Risk rates of fires (see Table 9) are applied and adjusted by the site assessment.

The fatality rate per fire for each response time is given by:

$$y = (0.0006x + 0.0145) \times 1.7$$

Where:

1.7 is the average number of fatalities, non-fatal casualties and rescues per fire.

x is the response time in minutes.

0.0145 is a constant.

0.0006 is the factor indicating the effect of the response time.

So, for a building with a rate of fire of 0.03843, and a 2 minute response time, the rate of death per year is:

$$0.03843 \times (((0.0006 \times 2)) + 0.0145) \times 1.7) = 0.03843 \times 0.025 = 0.00096 \text{ per year}$$

The response time would be based on the first arrival, given that one appliance may be assumed to handle 1.7 casualties.

Total risk

The predicted deaths from the Societal and Individual risk are summed to give a total rate of death per building. This is then applied as per the current predicted rate of death.

[6] Development of the Fire Service Emergency Cover Planning Methodology, Greenstreet Berman Ltd report for ODPM, November 2003, M Wright, A Antonelli and Sara Marsden.

2.3 Other building property loss

2.3.1 Introduction

A previous study[7] produced evidence demonstrating a consistent relationship between response times and level of loss incurred, with an increase in the average level of fire damage with each incremental increase in response times. The study analysed several samples of fire data to investigate the trend of fire damage with response time and reporting time.

In addition the study estimated the value of loss per m^2 for each occupancy, based on the number of fires, average fire damage and insurance statistics. This value was then combined with the response time – fire damage relationships in order to predict the rate of loss per minute fire attendance is delayed.

The aim of this study is to derive updated response time – fire damage relationships based on recent datasets, and assess whether differences noted compared to the original relationships are due to data volatility or other factors. Specifically the study has entailed:

- the acquisition of data on the value of property loss fires from the Fire Protection Association (FPA) and the Association Of British Insurers (ABI)
- the derivation of fire age time loss regressions per type of other building
- a comparison between the original and updated relationships to ascertain the source of any differences.

2.3.2 Method

Fire age – fire damage method

An assessment of the response time with respect to the associated level of loss provides a consistent statistical relationship, with an increase in average level of fire damage with each incremental increase in response time. The relationships were derived based on FDR1 data (as summarised in Appendix B) supplied by Greenstreet Berman[8] (previously supplied to Greenstreet Berman by CLG) using the method outlined below. As part of the analysis, the FDR1 building categories were merged into the following FSEC other building occupancy types based on guidance in the FSEC manual:

- Care Homes
- Hospitals
- Hotels
- Schools
- Further Education
- Licensed Premises

[7] Further Development of Risk Assessment Toolkits for the UK Fire Service, Technical Note – Financial Loss Model, March 1999, Wright M and Archer, K. http://www.communities.gov.uk/documents/fire/pdf/143711.pdf
[8] *Other Buildings FDR1 Data 2002 – 2006*

- Public Buildings
- Offices
- Factories or Warehouses
- Shops
- Other Workplaces
- Hostels
- Other Premises Open to the Public.

Calculation of fire age

The fire age is defined as the time from ignition to the arrival of the FRS, and is calculated based on the following FDR1 parameters:-

- Time from ignition to discovery – IGNTDISC
- Time from discovery to first call – DISCALL
- Time of first call to the FRS – CALLTIME
- Time of arrival of the FRS – ARRVTIME.

In determining the fire age the reporting time (the time from ignition to the first call) and the response time (the time from fist call to the time the FRS arrives at the fire) were calculated based on Equations 2.1 and 2.2 respectively.

$$\text{Reporting time} = IGNTDISC + DISCALL \qquad \textbf{[Equation 2.1]}$$

$$\text{Response time} = ARRVTIME - CALLTIME \qquad \textbf{[Equation 2.2]}$$

It should be noted that the IGNTDISC and DISCALL FDR1 parameters are defined based on a category basis e.g. times between two and five minutes are defined as Category 2. Since the calculation of the fire age requires a discrete value each category was assigned a representative time based on the geometric mean (Equation 2.4).

Finally, the fire age was calculated by summing the reporting time and the response time, Equation 2.3.

$$\text{Fire age} = \text{reporting time} + \text{response time} \qquad \textbf{[Equation 2.3]}$$

Note that the fire age (and hence the resultant assessment of fire age – fire damage relationships) was calculated for all records with the exception of those in which the FRS played no part in extinguishing the fire. In order to omit such incidents, those records for which FFBRIG1=11 were discounted.

Following the determining of the fire age for each appropriate record, the data was averaged and collated in order to perform a regression analysis. The records were sub-divided into fire age categories, each of which was assigned a representative age based on the geometric mean. The geometric mean was calculated based on Equation 2.4, and was used in preference to the arithmetic mean since it retains information about the distribution of the data.

$$\bar{x}_{geo} = \exp\left[\frac{\sum_{i}^{n} \ln x_i}{n}\right] \qquad \textbf{[Equation 2.4]}$$

The number of records associated with each age category is presented in Section 5.1.1, noting that records were omitted where fire age and / or damage could not be determined due to empty fields.

Calculation of fire damage

The aforementioned previous report[4] calculated the damage associated with each record based on the AREABURN (direct burning) FDR1 parameter. However, it was noted that the more recent FDR1 data was incomplete in terms of the AREABURN parameter (e.g. 59 per cent of fire records in 2005 had a blank AREABURN field) and hence it was decide to use the AREATOT (total area damaged) parameter, for which the records were generally populated.

The AREATOT parameter, similarly to the IGNTDISC and DISCALL parameters is assigned a category code in FDR1, based on the level of damage in m^2. Hence, in order to apply a discrete, representative damage value to each record, as required by the regression analysis, the geometric mean of the maximum and minimum damage for each category was used, Equation 2.4. Note that for records with an AREATOT of 22, defined as damage of over $200m^2$, the ATOTOTH parameter was used directly as the damage value since this provides an actual damage value for large fires.

Following the calculation of the damage associated with each record, the arithmetic mean of the damage for all records in each fire age category was determined based on Equation 2.5.

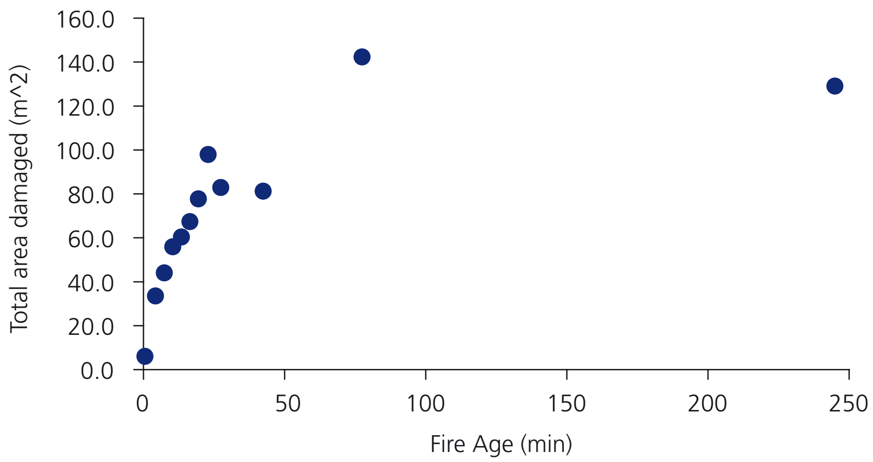
$$\bar{x}_{arith} = \frac{\sum_{i}^{n} x_i}{n} \qquad \textbf{[Equation 2.5]}$$

The average fire damage associated with each age category is presented in Section 5.1

Fire age versus fire size

The variation of the extent of the total damage with fire age for all occupancies is presented in Figure 11. It can be assumed that the damage sustained during the early part of the fire will vary significantly depending on the nature of the ignition and the fire resistance of the environs. In addition, the data suggests that the relationship between damage and age may be exponential and that a linear model may not be suitable beyond around 60 – 70 minutes; the relationship is difficult to estimate beyond this period.

Figure 11: Variation of total area damaged (AREATOT) with fire age for all occupancies



Hence a linear regression was applied to the fire age and damage data between fire ages of six minutes and 60 minutes for each occupancy type, in order to estimate the rate of damage, based on Equation 2.6.

$$\textit{Rate of damage} = \frac{\sum x_i y_i - \dfrac{\sum x_i \sum y_i}{n}}{\sum x_i^2 - \dfrac{(\sum x_i)^2}{n}} \qquad \textbf{[Equation 2.6]}$$

Where: x = *geometric mean of fire age*

y = *arithmetic mean of total damage*

The variation of the total damage with fire age for each occupancy type is shown in 5.3 and Figure 12, including linear trendlines associated with each data series.

The trendlines (Figure 12) illustrate the propagation of the damage from five minutes after ignition, noting the erratic nature of the damage for lower fire ages. The damage at five minutes was calculated based on the average damage associated with fires with an age between four and six minutes; this was necessary in order to increase the size of the sample dataset and hence the robustness of the estimate. Note that the original method[4] estimated the damage at five minutes by calculating the average damage for all fires with an age less than, and including, five minutes. Application of this method to the new data resulted in significantly lower damage at five minutes than the data would suggest for some building types. An example is given in Figure 13, in which it can be seen that the estimate for the damage at five minutes based on the initial estimate results in a model that predicts significantly lower variation of damage with fire age than the data suggests.

Note however, that the use of the AREATOT parameter as opposed to the direct burning damage (AREABURN) may introduce non-linearity into the fire age – damage relationship. This is discussed further in Section 2.3.4.

Figure 12: Variation of total damage (AREATOT) with fire age for different occupancies

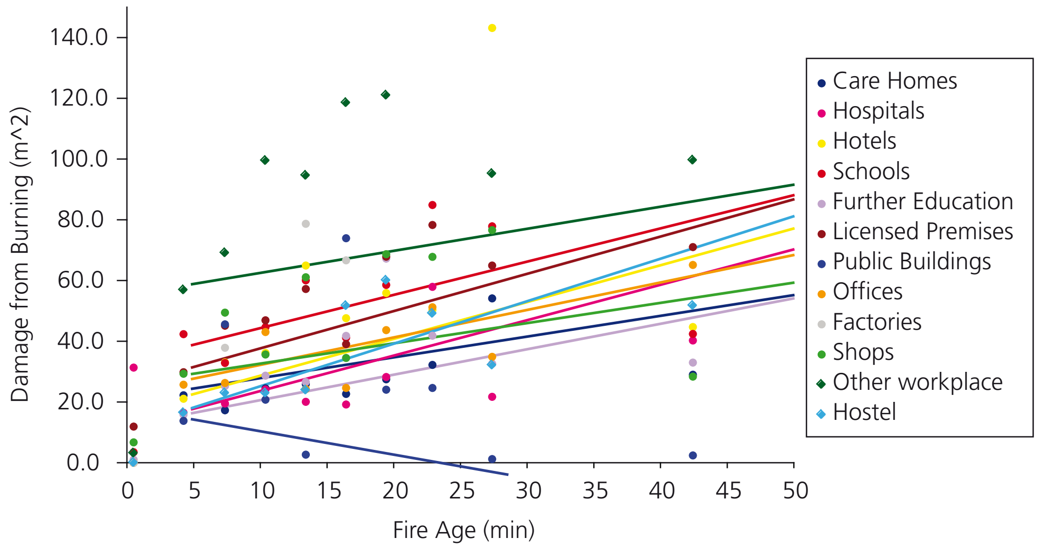
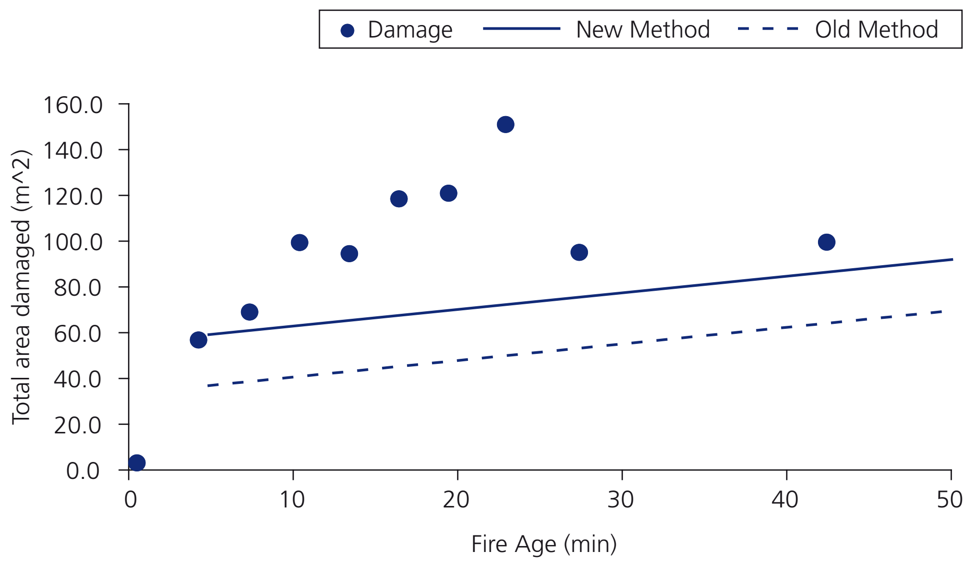


Figure 13: Variation of total damage (AREATOT) with fire age for 'other workplaces' including trendlines based on regression analysis



Comparison of fire damage rates

In the previous study the fire damage rates were categorised as follows:

- **Very high**
  schools, public buildings
- **High**
  licensed premises, factories, hotels
- **Medium**
  universities, hospitals, retail
- **Low**
  care homes
- **Very Low**
  offices

The study also noted that other characteristics of each occupancy, such as the typical size of building and size of compartments, would influence the distribution of fire damage.

The fire damage rates calculated based on the new data are presented in Table 13 including a comparison with the previous values and categories.

Table 13: Rate of damage per delay in FRS attendance time or reporting time

Occupancy	Rate of damage (m^2/min)	Previous rate of damage (m^2/min)	Previous category
Factory or warehouse	2.43	0.58	High
Other premises open to the public	2.35	n/a	n/a
Hostel	1.40	n/a	n/a
Licensed premises	1.23	0.60	High
Hotel	1.21	0.57	High
Hospital	1.17	0.42	Medium
School	1.10	0.82	Very High
Office	0.91	0.16	Very Low
Further education	0.84	0.43	Medium
Other workplace	0.73	n/a	n/a
Care home	0.68	0.30	Low
Shop	0.67	0.40	Medium
Public buildings	–0.77	0.75	Very High

It can be seen that there is generally a degree of correlation between the ranking of the two sets of data, the two notable exceptions being offices, schools and public buildings. In terms of the magnitude of the rates of damage, the new damage rates are around three times the magnitude of those calculated previously.

The higher rates of damage calculated as part of the analysis are likely attributable to the use of the AREATOT parameter (the total area damaged) as opposed to the AREABURN parameter, for which there was significantly less data.

Estimated Occupancy Values

A number of data sources were used in obtaining an estimated financial value of the loss per square metre for each occupancy type. Briefly, the method used calculated an average loss per small fire (loss < £50,000) for all occupancies, and incremented the loss per occupancy type based on large loss fire data. The average loss per occupancy type was then combined with the average damage in order to obtain the value of damage. The method is presented in the following sections.

Calculation of average loss per small fire

The Fire Protection Association (FPA) publishes large fire statistics[9] for fires where the damage incurred exceeds £50,000 or there is at least one fatality. Based on the data provided the overall number of large loss fires, and the associated loss, was determined.

The Association of British Insurers (ABI) provided data on the overall gross incurred commercial claims for the period. It is estimated that the ABI accounts for around 80% of the overall market (with the Lloyds contribution estimated as 20%); hence the figures were factored to account for the overall commercial claims.

Finally, CLG data on the overall number of fires[10] was obtained. The average loss per small fire was then calculated by subtracting the large loss claims from the overall claims, and the large loss fires from the overall fires; this is illustrated below.

	Annual Loss (£m)	# fires	Loss (£)/fire
FPA large loss fires	£129.7	124	£1,046,055
CLG total		16,767	
ABI loss	£748.8		
Lloyds loss	£187.2		
Total loss	£936.0		
Total small fires		16,643	
Total loss (small fires)	£806.3		
			Average loss per small fire £48,446
Note that the average loss per small fire calculated in the previous study was £25,880.			

9 *FPA large loss fire information 2002–2007*

10 *Fires in buildings by location and country, 2006 – Fire Statistics, United Kingdom 2006 08RDS05286*

Calculation of average loss per occupancy type

The average loss per occupancy type for all fires (small and large) was calculated based on applying the average loss due to small fires (as noted above) and incrementing based on loss due to large fires. As such, for each occupancy type, the number of small fires was multiplied by the loss per small fire, and the total loss added to the loss due to large fires. This overall loss figure was then divided by the overall number of fires (small and large) to obtain a figure for the average loss per fire.

The following illustrates the technique as applied to the hotel occupancy type:

# large fires /yr (FPA)	5.5
Loss due to large fires (FPA)	£6,115,999
# fires /yr (CLG)	801
# small fires /yr	795.5
Loss from small fires (x £48,446)	£38,538,416
Total loss (all fires)	£44,654,415
Average loss per fire for hotels (all fires)	**£55,748**

A complete list of average loss vales for each occupancy type is provided at 5.2.

In estimating the rate of damage the average loss per occupancy type was doubled in order to account for consequential loss[11].

2.3.3 Calculation of rate of financial loss

In calculating the rate of financial loss per occupancy type the average total damage (for all fire ages) and average final loss per fire was used to estimate the average value per occupancy, noting that the loss per fire was doubled to account for consequential loss. Subsequently the figure was multiplied by the rate of damage incurred in order to calculate the rate of financial loss (£/min).

The following illustrates the technique as applied to the hotel occupancy type:

Average burn damage (m^2)	54.3
Average loss for hotels (all fires)	£55,748
… factored (x2) for consequential loss	£111,496
Average value per occupancy (m^{-2})	£2,055
Rate of damage for hotels (m^2/min)	1.212
Rate of financial loss for hotels	**£2,490/min**

[11] *Peaker A, Hesketh L and Forester J, Investigation of consequential losses to the economy from fires in industry and the service sector, 1977, Report for the Home Office Scientific Advisory Branch.*

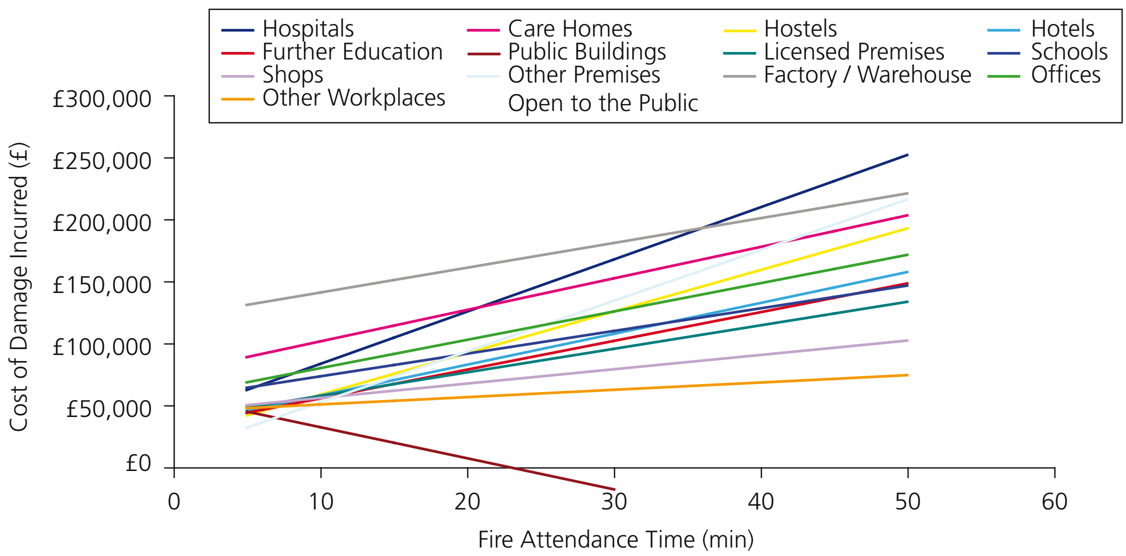
The calculated rate of financial loss for each occupancy type is presented in Table 14, alongside a comparison with the previous values; the full data, in terms of associated loss rate curves is presented in Appendix B. It should be noted that the difference in the updated values can be largely attributed to the fact that the total area damage (AREATOT) FDR1 parameter has been used in the calculation of damage rates. This is discussed further in Section 2.3.4.

Table 14: Rate of loss per occupancy type

Occupancy	Average damage (m^2)	Rate of financial loss (£/min)	Previous rate of financial loss (£/min)
Other premises open to the public	64.5	4,090	n/a
Hospital	27.0	4,211	3,700
Factory or warehouse	194.6	1,997	1,600
Hostel	40.4	2,490[12] (hotel)	n/a
Further education	41.3	2,318	1,700
Hotel	54.3	2,490	2,900
Care home	26.4	2,539	2,300
Office	46.4	2,284	700
School	68.2	1,830	3,300
Licensed premises	62.6	1,897	2,300
Shop	59.1	1,156	2,400
Other workplace	124.7	591	n/a
Public building	34.5	4,090[13]	2,100

The rate of loss curves for all occupancy types are presented in Figure 14.

Figure 14: Loss rate curves for all occupancy types



12 *This figure is read across from the hotels category, see Section 2.3.4*
13 *This figure is read across from the other premises open to the public category, see Section 2.3.4*

2.3.4 Discussion of Other Building financial loss results

The analysis has used available data to produce a new set of relationships. If the previous modelling approach is used, excepting the measure of fire size, the expected increase in loss per minute is found in many but not all of the occupancies. The percentage change in predicted loss, assuming a five minute fire age, is shown in Table 15.

An overall change was calculated by multiplying the loss per fire (assuming a five minute response) by the reported number of fires per occupancy (as used in the analysis). It shows that overall, the predicted loss would fall by 2 per cent using the new values. This is due to the reduction in loss rates for schools and licensed premises, which account a large proportion of fires.

Table 15: Impact of changes in Other Building loss rates on predicted loss in £

Occupancy	Change in predicted loss (£)
Other premises open to the public	95%
Hospital	14%
Factory or warehouse	25%
Hostel	–14%
Further education	36%
Hotel	–14%
Care home	10%
Office	226%
School	–45%
Licensed premises	–18%
Shop	–52%
Other workplace	–16%
Public building	95%
All	**–2%**

Some of the data is anomalous, due to small numbers of incidents, particularly the results for Public buildings and hostels. It is suggested, as a practical solution, that the regression for hotels is also applied to hostels.

The complete results of the analysis, in terms of the loss rate curves, are presented in 5.3. The plots also include a comparison with the results obtained from the previous analysis. Generally the results demonstrate reasonable agreement with the previous analysis in terms of the magnitude of the rate of loss; Table 14 presents a direct comparison of the two sets of results. There is less agreement observed when comparing the rankings of the occupancy type, although some similarity is apparent.

In terms of the magnitude of the rate of loss curves calculated, the updated values demonstrate a greater degree of variability, with the highest ranked occupancies showing an increased rate of loss and the lower ranked a decrease over previous values.

However, it should be noted that the similarity between the two sets of data is not indicative of consistently similar factors calculated in determining the rate of loss curves. The rate of loss curves were determined based (simply) on dividing the *higher than previous* fire damage curves by the *higher than previous* financial loss associated with each fire, resulting in a broadly similar overall value. The higher values associated with the damage and financial losses are discussed below.

The use of the AREATOT parameter rather than the AREABURN parameter used previously significantly increased the damage associated with each fire (Section 2.3.2). In addition, the updated damage values may also have changed due to other factors such as response times, risk based allocation of cover, fire prevention activities etc. However, it is reiterated that the use of the AREATOT parameter may be more suitable in evaluating the rate of loss associated with each fire since damage not caused directly from fire contributes to the overall cost associated with the fire.

The financial loss associated with fires for each occupancy type was determined based on assigning a generic cost applicable to all fires, and applying an increment based on large loss fires associated with each occupancy type (Section 2.3.3). The values were determined based on CLG fire records, ABI claims data and FPA large loss fire claims data. Comparison with the previous data used demonstrated that, while the number of fires has generally remained static (CLG data) or reduced (FPA large loss fire data), the associated claims per fire had increased; therefore both the average loss per small fire and the associated increment for large fires had increased since the previous study.

When considering the rankings of loss rate curves for each occupancy type, it can be expected that the use of the AREATOT parameter in determining the extent of the damage associated with each fire, rather than the AREABURN parameter used previously, may affect the rankings to a degree. This assumes that the rate of increase of total damage during a fire is not the same as direct damage, reasonable since e.g. fires in buildings with restricted access may result in disproportionate resources being used to fight the fire therefore potentially increasing the total damage for a smaller fire.

Robustness of data

In determining the number of years of FDR1 data on which to base the regression analysis, and hence derive the damage – fire age relationships, an assessment of the robustness of the data was undertaken. This assessment involved performing the overall assessment of loss rate curves based on the regression analysis for a number of FDR1 data samples. The analysis was performed for each individual year of FDR1 data (2002–2006) as well as the whole five years data and the three most recent years (2004–2006), noting that the three year window was the preferred option given that it offers a balance between robustness and currency.

The complete set of results is presented in 5.3.3. The results demonstrate that there is significant variation in the loss rate curves for individual years, particularly for those occupancy types with lower numbers of fires. The three year average curves demonstrate that they are generally not significantly skewed towards a single year and hence give confidence that the approach taken is robust.

3 Recommendations

3.1 Special services

It was concluded that:

- The new special service fatality rates, as per [TEXT MISSING], could be applied to an update of FSEC. However, as it was uncertain whether the new data offers any more reliability, it was not essential to revise the special service fatality rates.
- This analysis is repeated once one or more years of data have been collated from the forthcoming Incident Reporting System, which should provide a far higher standard of data.

The Incident Reporting System uses a new and more meaningful set of special service categories. This will provide the opportunity to streamline the categories used in FSEC and align them with those in the IRS. Therefore, it was recommended that:

- no revisions are made to the FSEC special service categories until an analysis of data from the IRS has been completed and the value of retaining, deleting, adding or redefining special service categories is clear.

3.2 Other Building fatality rates

It was suggested by the researchers that the new method offers the following advantages:

- it can be replicated using data held by CLG
- it provides testable results
- it is a simpler and more transparent method
- it provides lower predicted fatality rates for HMOs and flats, which may have greater face validity
- the new approach includes Individual and Societal risk.

The new approach would provide a similar estimate of fatalities for Other Buildings excluding HMOs (far fewer Societal Risk deaths balanced out by incorporating Individual Risk fire deaths). The estimate of Societal Risk in HMOs with the new method would be close to the reported number of Societal Risk deaths in HMOs and far lower than the current method. As noted in Section 2.2.6, the main reasons for the differences in results between the current and proposed method are the use of more representative fatality data for Societal Risk fires and the incorporation of

Individual Risk into Other Buildings, i.e. the proposed new approach provides a more accurate and valid result.

Whilst this would require some revision of the coding in FSEC, no additional Other Building data would be needed. The prediction using the new proposed approach would be within ~10 per cent of the reported rate of fire death in Other Buildings, possibly overestimating the number of deaths by ~10 per cent.

Therefore it was recommended that the FSEC Other Building incident module is modified to:

- apply Individual risk rates (Table 9) of fire to Other Building, excluding HMOs, purpose built flats and houses converted to flats (which are already accounted for in the Dwellings module)
- the new Other Building fatality rate-response time regression is applied ($y = 0.0006x + 0.0145$) to both Individual and Societal risk fires (with 1.7 (FCR) casualties per Individual risk fire, and an MPL for societal risk fires as currently modelled in FSEC)
- the current Societal Risk rates of fire are still applied
- that the assumption that each appliance can rescue two persons is applied
- the total Other Building loss of life is the sum of Individual and Societal Risk.

3.3 Other Building property loss rates

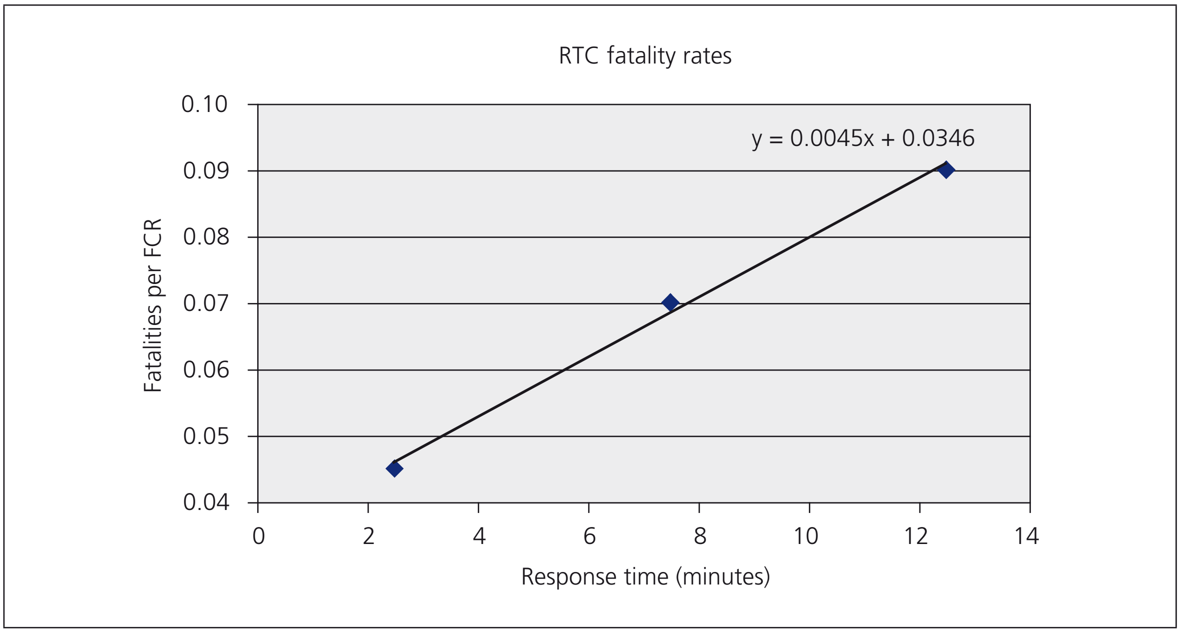
The analysis has derived a set of loss rate curves for all occupancy types based on a considered approach and robust data. Comparison with the previous study has demonstrated that, while ultimately the overall loss rates derived are similar in magnitude (though higher), the associated fire damage and financial loss values are higher than those previously calculated in some cases. Excepting the measure of fire size, the expected increase in loss per minute was apparent to a degree, but not for all occupancies.

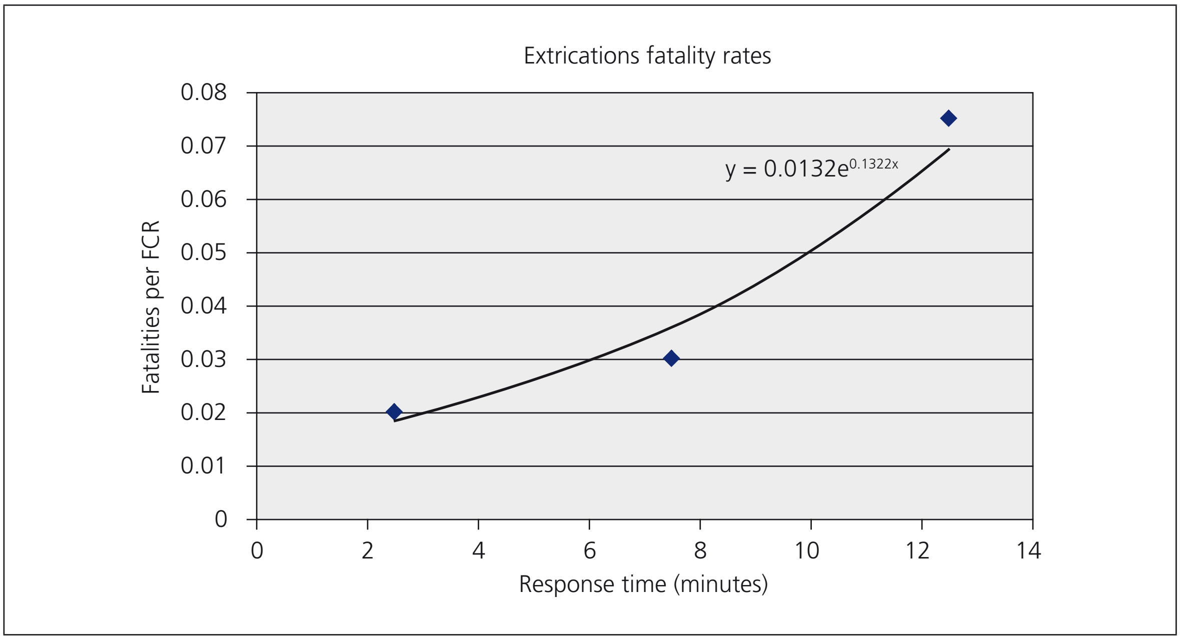
Hence, it was recommended that the updated loss rate curves are applied based on the fact that they are derived based on recent data (with the associated maturity of the FDR1 reporting process and trends in the insurance claims market) and included a measure of the total damage associated with fires.

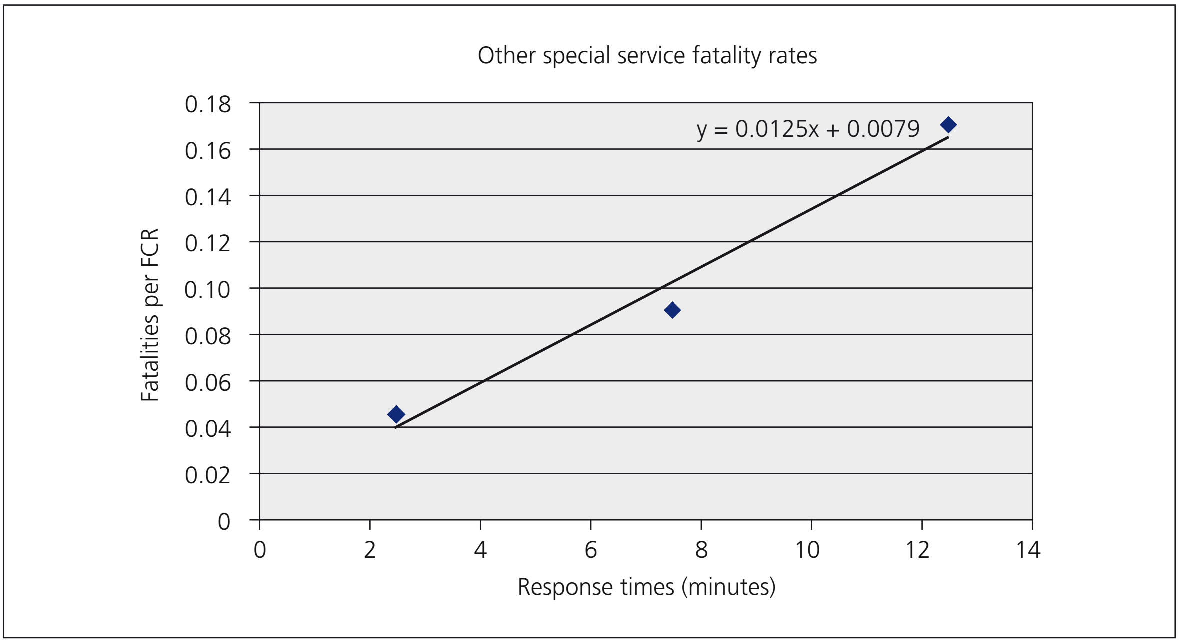
It was noted that some of the data may be anomalous, due to small numbers of incidents, particularly with regards the results for public buildings and hostels. It was recommended, as a practical solution, that the regression for other premises open to the public is applied to public buildings, and likewise the regression for hotels is applied to hostels.

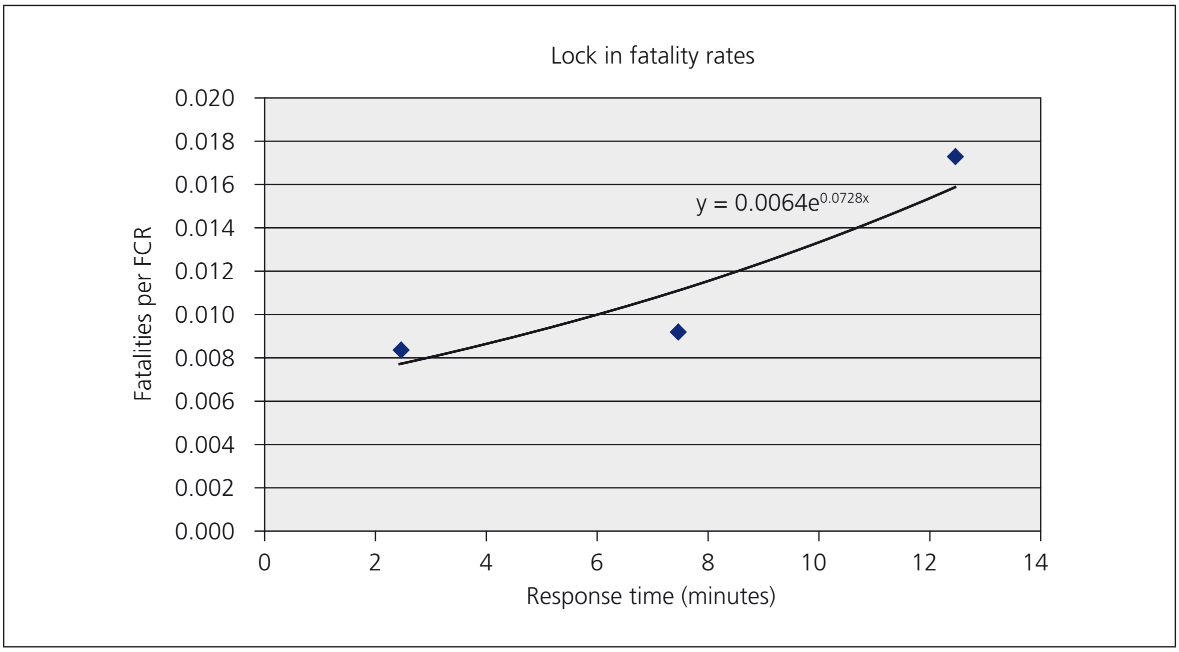
4 Appendix A Special service scatter plots and regressions

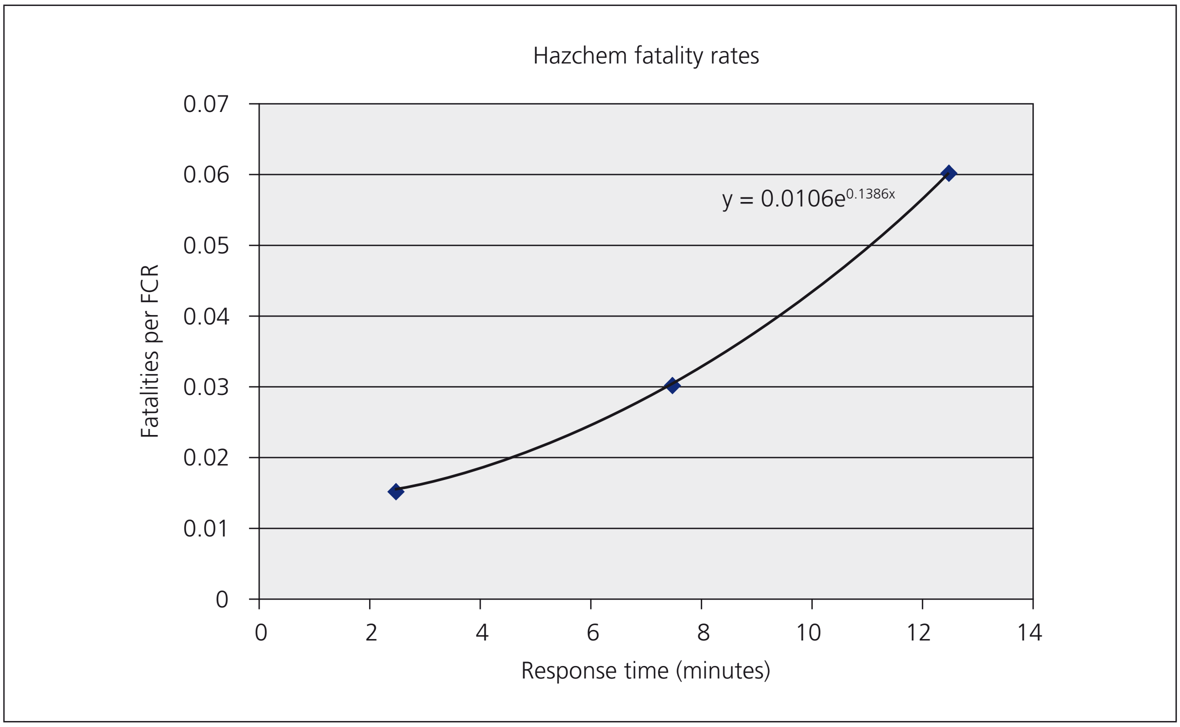
FCR = all fatalities, casualties and rescues

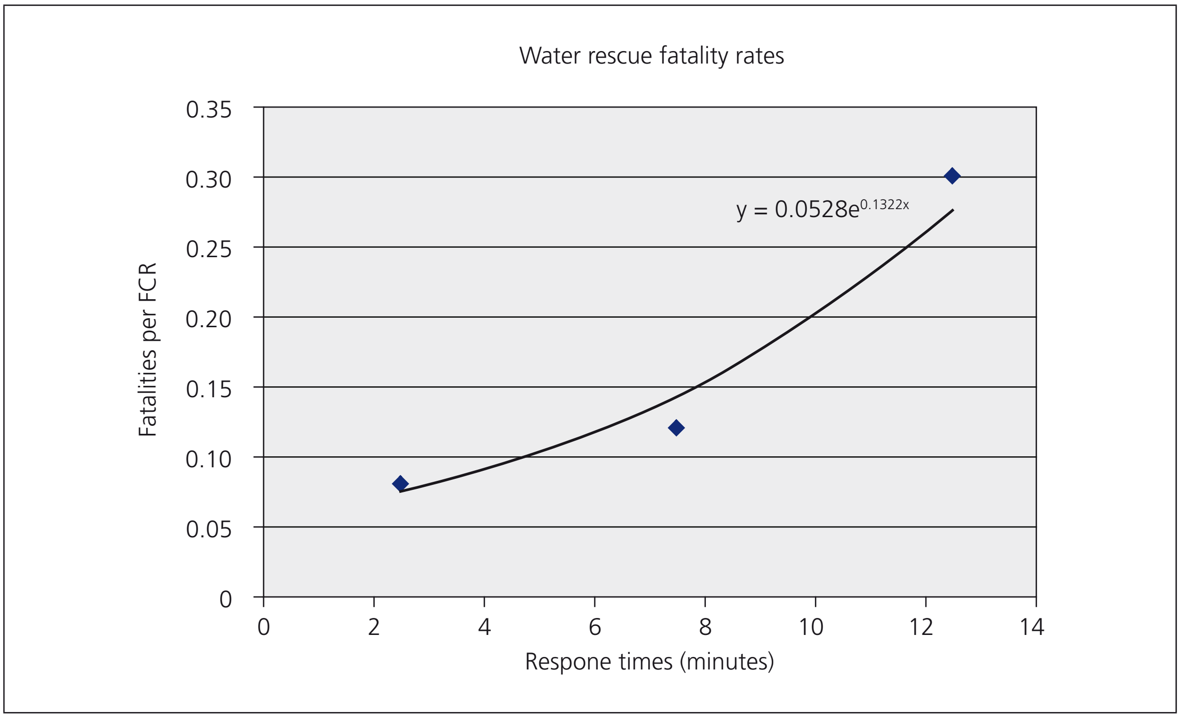


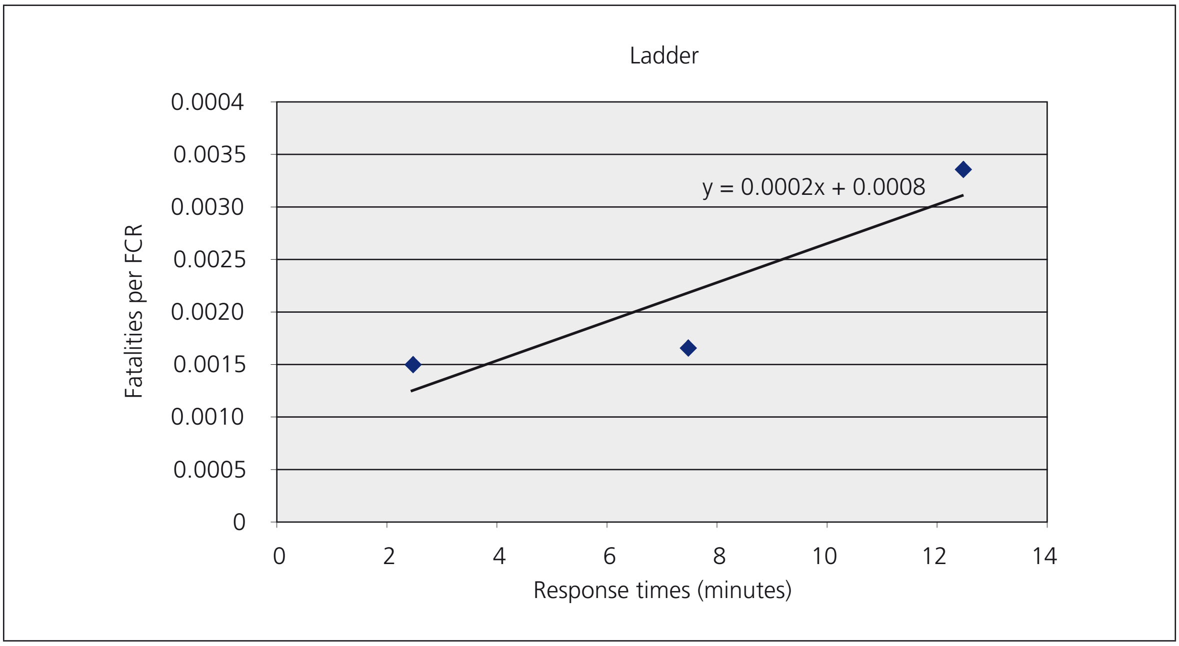


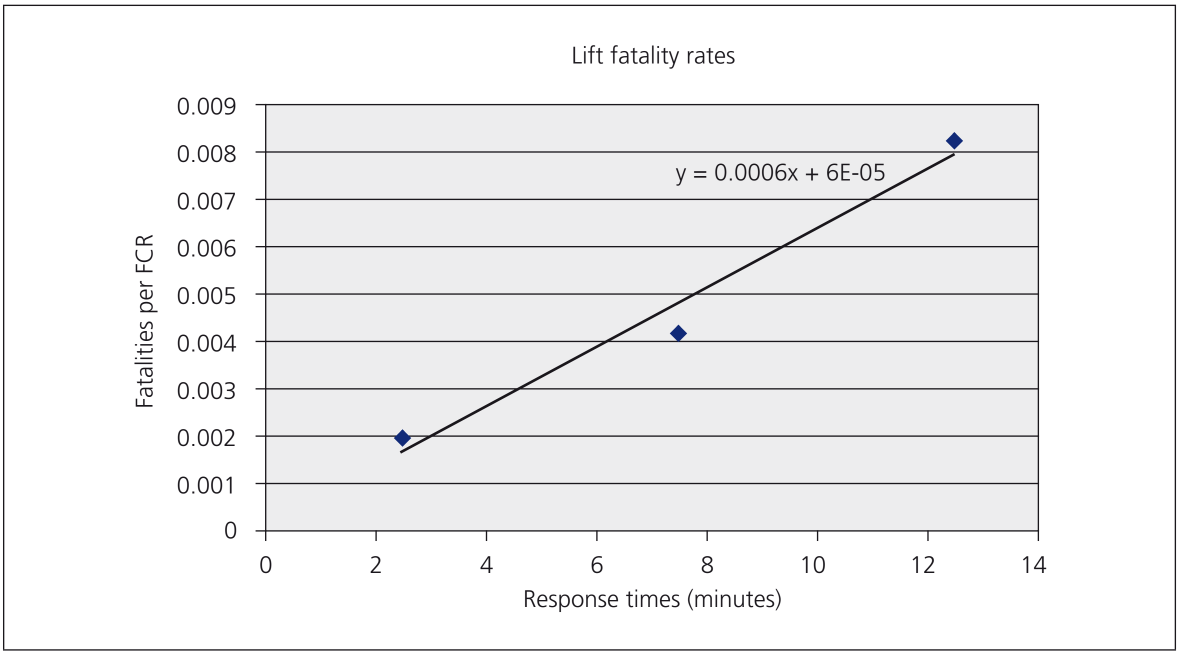

Other special service fatality rates
y = 0.0125x + 0.0079
Fatalities per FCR
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0
0
2
4
6
8
10
12
14
Response times (minutes)

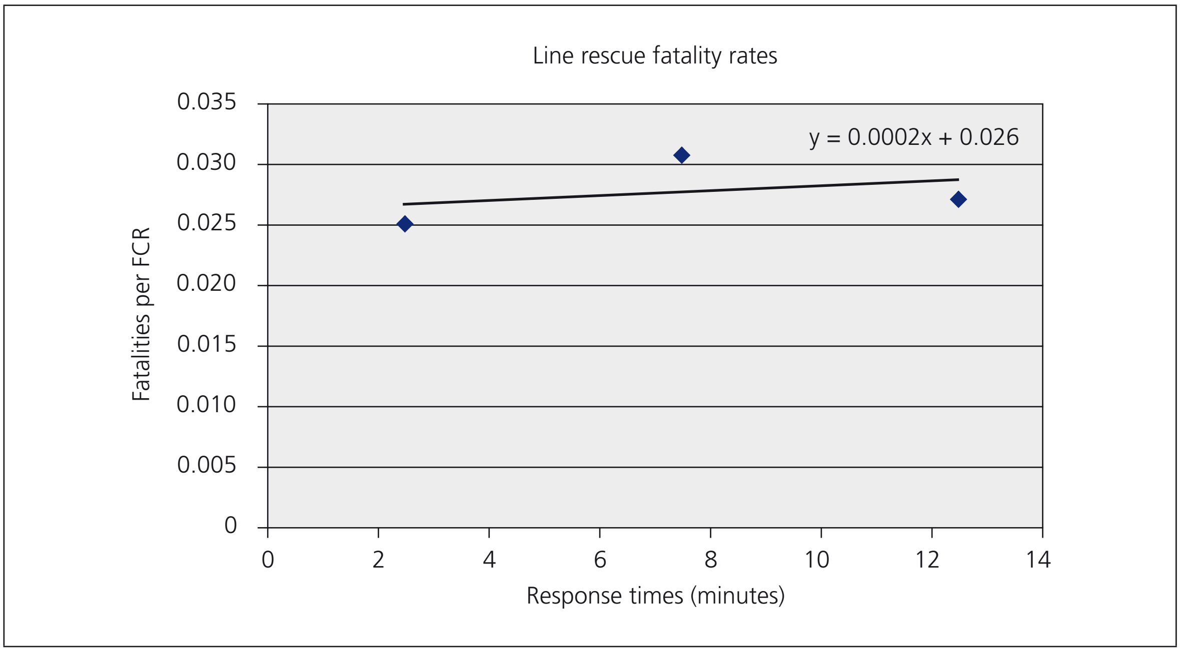

Lock in fatality rates
$y = 0.0064e^{0.0728x}$
Fatalities per FCR
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0
2
4
6
8
10
12
14
Response time (minutes)


Hazchem fatality rates
y = 0.0106e^0.1386x
Fatalities per FCR
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
2
4
6
8
10
12
14
Response time (minutes)


Water rescue fatality rates
y = 0.0528e^0.1322x
Fatalities per FCR
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
0
2
4
6
8
10
12
14
Respone times (minutes)


Ladder
0.0004
0.0035
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0
Fatalities per FCR
y = 0.0002x + 0.0008
0
2
4
6
8
10
12
14
Response times (minutes)


Lift fatality rates
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Fatalities per FCR
y = 0.0006x + 6E-05
0
2
4
6
8
10
12
14
Response times (minutes)


Line rescue fatality rates
y = 0.0002x + 0.026
Fatalities per FCR
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0
0
2
4
6
8
10
12
14
Response times (minutes)

5 Appendix B Other Building property loss data and tables

5.1 Relationships between age and damage from total area burning

5.1.1 Number of records

"Descriptive age category Damage always expressed in m^2 Age always expressed in min"	Min age	Max age	Geometric mean of age	Care Home	Hospital	Hotel	School	Further Education	Licensed Premise	Public Building	Office	Factory or Warehouse	Shop	Other workplace	Hostel	Other premises open to the public	All Occupancies
0 <= age <= 3	-1	3	0.5	0	1	0	1	2	3	0	0	0	1	9	0	1	18
3 < age <= 6	3	6	4.2	27	60	21	16	11	156	3	35	9	139	134	27	40	678
6 < age <= 9	6	9	7.3	124	246	112	137	76	522	15	184	51	632	657	82	260	3098
9 < age <= 12	9	12	10.4	313	446	204	353	142	833	26	355	143	1171	1372	150	541	6049
12 < age <= 15	12	15	13.4	153	200	126	200	69	348	7	148	95	497	890	52	263	3048
15 < age <= 18	15	18	16.4	53	62	41	90	25	215	5	102	32	257	510	24	147	1563
18 < age <= 21	18	21	19.4	103	173	167	292	98	732	20	370	175	1091	1086	118	551	4976
21 < age <= 25	21	25	22.9	127	151	133	432	92	683	18	408	221	1129	1719	78	702	5893
25 < age <= 30	25	30	27.4	28	25	41	84	13	167	2	100	42	209	853	21	207	1792
30 < age <= 60	30	60	42.4	17	22	39	79	20	162	5	94	43	200	699	20	118	1518
60 < age <= 100	60	100	77.5	42	44	63	148	40	387	9	186	112	471	881	40	268	2691
100 < age <= 600	100	600	244.9	13	21	26	98	23	231	3	109	44	222	464	10	150	1414
all ages	all	all		1000	1451	973	1930	611	4439	113	2091	967	6019	9274	622	3248	32738

5.1.2 Arithmetic mean of total damage

"Descriptive age category Damage always expressed in m^2 Age always expressed in min"	Min age	Max age	Geometric mean of age	Care Home	Hospital	Hotel	School	Further Education	Licensed Premise	Public Building	Office	Factory or Warehouse	Shop	Other workplace	Hostel	Other premises open to the public	All Occupancies
0 <= age <= 3	-1	3	0.5	0.0	31.3	0.0	3.5	1.0	11.9	0.0	0.0	0.0	6.7	3.1	0.0	1.4	6.0
3 < age <= 6	3	6	4.2	22.2	16.4	21.1	42.3	15.8	29.8	13.8	25.7	158.7	29.3	56.8	16.4	17.9	33.6
6 < age <= 9	6	9	7.3	17.3	19.5	33.0	32.9	25.2	45.1	45.6	26.3	37.9	49.4	69.0	22.9	38.4	44.1
9 < age <= 12	9	12	10.4	24.5	24.1	36.1	44.6	28.7	46.9	20.8	43.0	265.4	35.6	99.4	22.9	34.2	56.0
12 < age <= 15	12	15	13.4	25.9	20.1	64.9	60.0	26.6	57.2	2.6	24.3	78.7	61.1	94.6	23.9	28.0	60.4
15 < age <= 18	15	18	16.4	22.7	19.2	47.6	41.1	41.8	39.1	73.9	24.6	66.6	34.5	118.5	51.7	83.3	67.4
18 < age <= 21	18	21	19.4	27.5	28.3	55.9	58.6	67.2	67.9	24.0	43.7	159.2	68.7	121.0	60.0	69.8	77.7
21 < age <= 25	21	25	22.9	32.2	57.9	50.4	84.9	41.8	78.3	24.6	51.2	253.7	67.8	151.0	49.1	65.9	97.9
25 < age <= 30	25	30	27.4	54.1	21.7	143.2	77.9	32.6	64.9	1.2	34.9	191.2	76.6	95.1	32.1	65.1	82.9
30 < age <= 60	30	60	42.4	29.0	40.2	44.7	42.4	32.9	71.0	2.4	65.1	193.3	28.3	99.6	51.7	118.3	81.2
60 < age <= 100	60	100	77.5	29.2	34.5	93.0	155.1	78.0	86.6	75.1	76.6	222.2	97.0	217.6	94.8	126.2	142.3
100 < age <= 600	100	600	244.9	56.2	37.0	62.9	86.1	67.2	100.8	210.8	82.7	275.3	91.6	191.7	51.0	97.1	129.1
all ages	all	all		26.4	27.0	54.3	68.2	41.3	62.6	34.5	46.4	194.6	59.1	124.7	40.4	64.5	79.1

5.1.3 Linear regression constants

	Care Home	Hospital	Hotel	School	Further Education	Licensed Premise	Public Building	Office	Factory or Warehouse	Shop	Other workplace	Hostel	Other premises open to the public	All Occupancies
Slope (m^2/min)	0.684	1.166	1.212	1.095	0.839	1.226	–0.771	0.906	2.426	0.666	0.726	1.399	2.349	1.587
Pearson r^2	0.498	0.509	0.300	0.254	0.144	0.676	–0.474	0.757	0.393	-0.083	0.242	0.552	0.862	0.710
∑ x	13488	18586	14379	30065	8589	62022	1625	31972	15102	88994	152925	8758	50950	497454
∑ y	23890	35802	44852	99615	20379	216444	2550	72884	149756	285362	867937	20415	160240	2000126
∑ xy	379315	568081	815347	1912575	353854	3960727	37038	1432130	2942786	5106235	17547266	374269	3334165	38763789
∑ x^2	239559	317211	295731	648198	169704	1290963	33738	700716	335013	1841319	3692487	173772	1103976	10842387
∑ y^2	659865	1147523	2790267	6488677	896130	13443301	92256	3230374	32675262	16915744	101520356	903213	10501491	152076106
# records	918	1325	863	1667	535	3662	98	1761	802	5186	7786	545	2789	27937
Rank of slope	11	6	5	7	9	4	13	8	1	12	10	3	2	
Value of property (£/m^2)	£3,714	£3,612	£2,055	£1,672	£2,763	£1,547	£3,252	£2,522	£824	£1,735	£814	£2,395	£1,741	
Rank of property value	1	2	7	10	4	11	3	5	12	9	13	6	8	
Value of loss per min (£/min)	£2,539	£4,211	£2,490	£1,830	£2,318	£1,897	-£2,506	£2,284	£1,997	£1,156	£591	£3,351	£4,090	
Rank of value loss	4	1	5	10	6	9	13	7	8	11	12	3	2	
Average damage within and including 5 mins	4.40	10.99	13.43	48.44	13.14	31.16	5.09	38.59	1.41	35.15	35.97	13.37	6.85	28.10
Average damage between 4 and 6 minutes	23.84	17.16	21.94	38.22	15.80	30.91	13.83	27.06	158.68	28.74	58.29	17.53	18.16	34.31

5.1.4 Propagation of fire based on slope and average damage between 4 and 6 minutes

No. of records with age between 4 – 6 mins		25	57	17	14	11	132	3	32	9	133	125	25	38	621
Average damage between 4 – 6 minutes	5	23.84	17.16	21.94	38.22	15.80	30.91	13.83	27.06	158.68	28.74	58.29	17.53	18.16	34.31
Damage at 60 mins	60	61.45	81.29	88.58	98.42	61.93	98.35	-28.56	76.86	292.08	65.39	98.22	94.48	147.35	121.58

5.2 Average loss for all fires (CLG and FPA data), mainland Britain

Location	# large fires	loss £ (large fires)	avg loss large fires £/fire	total # fires	# small fires	loss from small fires £	total loss £	avg loss all fires £/fire
Agricultural buildings	2.0	£712,500	£356,250	1120	1118	£54,162,098	£54,874,598	£48,995
Industrial premises								
Mining and quarrying	0.0	£0		19	19	£920,465	£920,465	£48,446
Electricity, gas, water, coke, Nuclear	0.0	£0		203	203	£9,834,442	£9,834,442	£48,446
Metal manufacture	0.0	£0		174	174	£8,429,522	£8,429,522	£48,446
Non-metallic mineral products	0.0	£0		53	53	£2,567,613	£2,567,613	£48,446
Chemicals	1.5	£2,950,000	£1,966,667	105	104	£5,014,112	£7,964,112	£75,849
Metal goods engineering	2.0	£630,500	£315,250	265	263	£12,741,173	£13,371,673	£50,459
Vehicle manufacture	0.0	£0		85	85	£4,117,870	£4,117,870	£48,446
Food, drink and tobacco	12.5	£6,740,589	£539,247	334	322	£15,575,237	£22,315,826	£66,814
Textiles, footwear etc	1.5	£1,090,500	£727,000	97	96	£4,626,548	£5,717,048	£58,939
Timber, wood products	0.5	£400,000	£800,000	166	166	£8,017,735	£8,417,735	£50,709
Paper, printing	0.0	£0		324	324	£15,696,351	£15,696,351	£48,446
Rubber, plastics	0.0	£0		179	179	£8,671,749	£8,671,749	£48,446
Other manufacturing	18.5	£24,087,500	£1,302,027	357	339	£16,398,811	£40,486,311	£113,407
Construction	0.0	£0		182	182	£8,817,086	£8,817,086	£48,446
Trade, hotels, catering, repairs etc								
Wholesale distribution	18.5	£14,694,212	£794,282	87	69	£3,318,519	£18,012,731	£207,043
Recycling	4.0	£6,376,189	£1,594,047	122	118	£5,716,572	£12,092,761	£99,121

(continued)

Location	# large fires	loss £ (large fires)	avg loss large fires £/fire	total # fires	# small fires	loss from small fires £	total loss £	avg loss all fires £/fire
Retail distribution	20.0	£11,234,613	£561,731	3676	3656	£177,116,844	£188,351,457	£51,238
Sale, repair etc of vehicles	4.5	£1,531,846	£340,410	418	414	£20,032,225	£21,564,071	£51,589
Hotels	5.5	£6,115,999	£1,112,000	801	796	£38,538,416	£44,654,415	£55,748
Hostels, holiday camps etc	0.0	£0		1210	1210	£58,619,087	£58,619,087	£48,446
Restaurants	0.0	£0		1325	1325	£64,190,322	£64,190,322	£48,446
Public houses, clubs etc	0.0	£0		1415	1415	£68,550,420	£68,550,420	£48,446
Transport and communications premises	0.0	£0		431	431	£20,880,022	£20,880,022	£48,446
Banking, finance, insurance, real estate etc	1.0	£4,277,336	£4,120,000	501	500	£24,220,913	£28,498,249	£56,883
Other services								
Public administration, defence, law enforcement etc	7.0	£13,152,673	£1,889,260	1188	1181	£57,216,017	£70,368,690	£59,233
Schools	9.1	£11,660,280	£1,285,840	1308	1299	£62,927,434	£74,587,713	£57,024
Further education etc	3.4	£4,412,720	£1,285,840	495	492	£23,814,281	£28,227,002	£57,024
Hospitals – non psychiatric	0.5	£542,800	£1,085,600	1321	1321	£63,972,318	£64,515,118	£48,838
Hospitals – pyschiatric	0.0	£0		614	614	£29,745,553	£29,745,553	£48,446
Other medical care	0.0	£0		259	259	£12,547,391	£12,547,391	£48,446
Recreational and other cultural services	7.0	£15,283,058	£2,183,294	1947	1940	£93,984,321	£109,267,379	£56,121
Elderly persons home	0.5	£500,000	£1,000,000	721	721	£34,905,002	£35,405,002	£49,105
Childrens home, homes for disabled or handicapped	0.0	£0		277	277	£13,419,411	£13,419,411	£48,446
Other miscellaneous services	0.0	£0		527	527	£25,530,792	£25,530,792	£48,446
Other buildings	0.5	£402,500	£805,000	2891	2891	£140,031,794	£140,434,294	£48,576
Unspecified buildings	4.0	£2,915,000	£728,750	227	223	£10,803,352	£13,718,352	£60,433

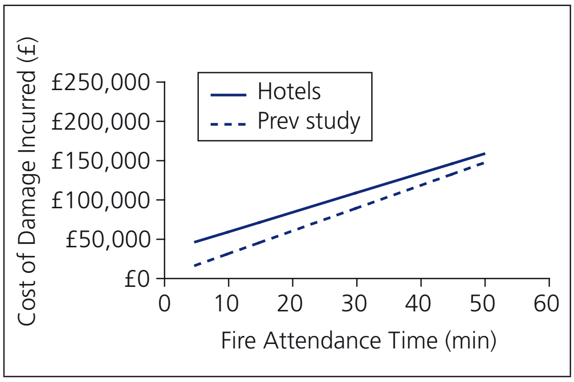
5.3 Loss rate curves

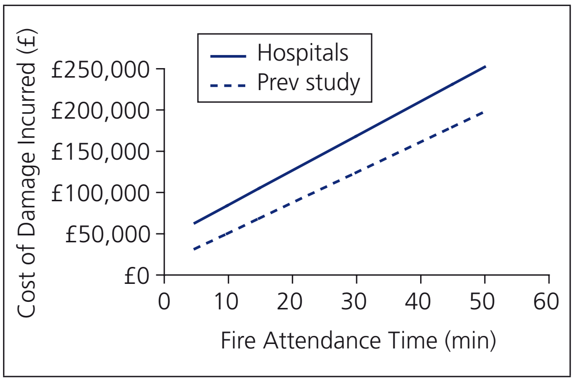
5.3.1 Rate of loss (£/min) curves per FSEC occupancy type[14]

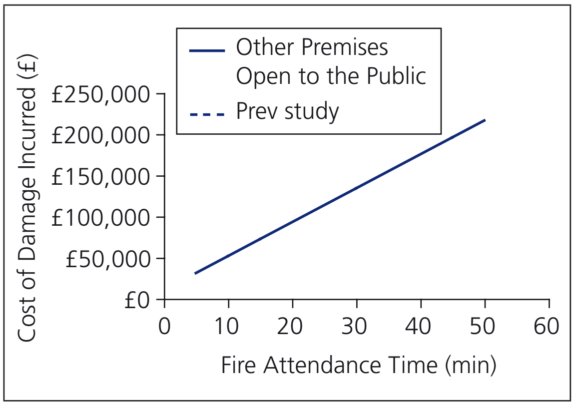
Occupancy	Average damage	Average damage (attended within 5 min)	Property value	Average loss rate	% Decrease based on max value	Initial loss (incurred within first 5 min)	Cost of damage (£) incurred for delayed fire attendance (min)					
	m^2	m^2	£/m^2	£/min		£	5	10	15	30	45	50
Hospital	27.0	17.16	£3,612	£4,211	0%	£61,984	£61,984	£83,039	£104,094	£167,258	£230,423	£251,478
Care Home	26.4	23.84	£3,714	£2,539	40%	£88,539	£88,539	£101,235	£113,932	£152,020	£190,109	£202,805
Hostel	40.4	17.53	£2,395	£3,351	20%	£41,981	£41,981	£58,738	£75,495	£125,765	£176,035	£192,791
Hotel	54.3	21.94	£2,055	£2,490	41%	£45,084	£45,084	£57,535	£69,986	£107,339	£144,692	£157,143
Further Education	41.3	15.80	£2,763	£2,318	45%	£43,647	£43,647	£55,236	£66,825	£101,592	£136,359	£147,948
Public Building	34.5	13.83	£3,252	-£2,506	160%	£44,965	£44,965	£32,433	£19,901	-£17,695	-£55,291	-£67,823
Licensed Premise	62.6	30.91	£1,547	£1,897	55%	£47,834	£47,834	£57,320	£66,807	£95,265	£123,723	£133,209
School	68.2	38.22	£1,672	£1,830	57%	£63,889	£63,889	£73,038	£82,187	£109,633	£137,079	£146,227
Shop	59.1	28.74	£1,735	£1,156	73%	£49,875	£49,875	£55,656	£61,437	£78,781	£96,125	£101,906
Other premises open to the public	64.5	18.16	£1,741	£4,090	3%	£31,632	£31,632	£52,083	£72,535	£133,889	£195,244	£215,695
Factory or Warehouse	194.6	158.68	£824	£1,997	53%	£130,673	£130,673	£140,660	£150,648	£180,610	£210,572	£220,559
Office	46.4	27.06	£2,522	£2,284	46%	£68,248	£68,248	£79,667	£91,086	£125,345	£159,603	£171,022
Other workplace	124.7	58.29	£814	£591	86%	£47,436	£47,436	£50,391	£53,345	£62,207	£71,070	£74,024

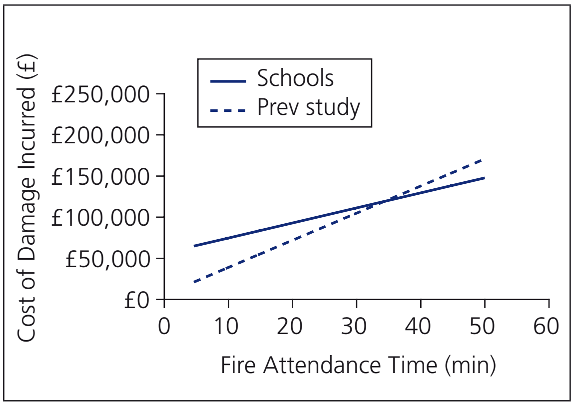
[14] *The property value associated with 'public buildings' is associated with FDR1 data for 'other premises open to the public' due to a lack of data*

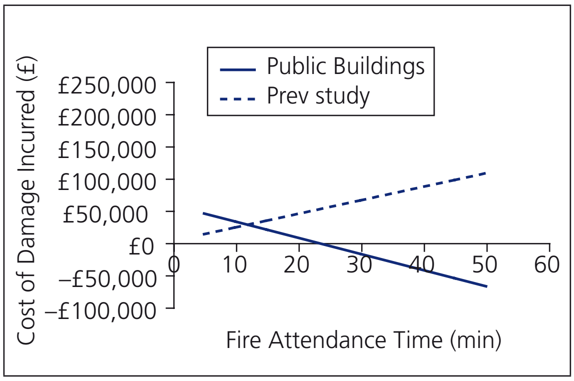
5.3.2 Loss rate curves – comparison with previous study

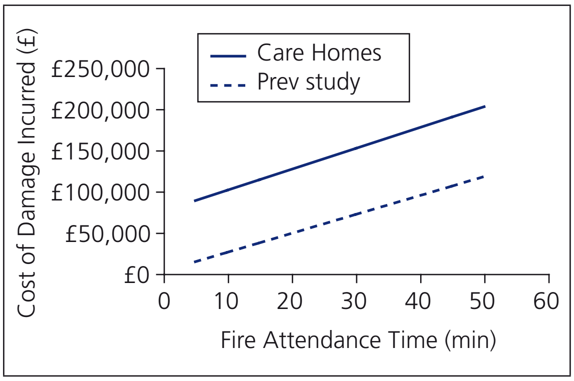


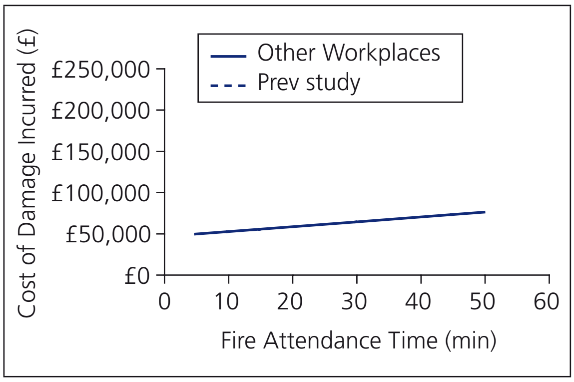


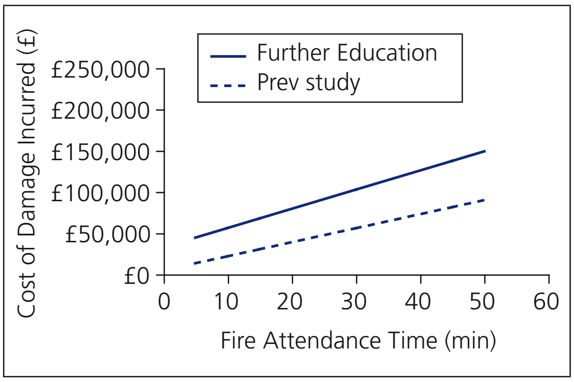


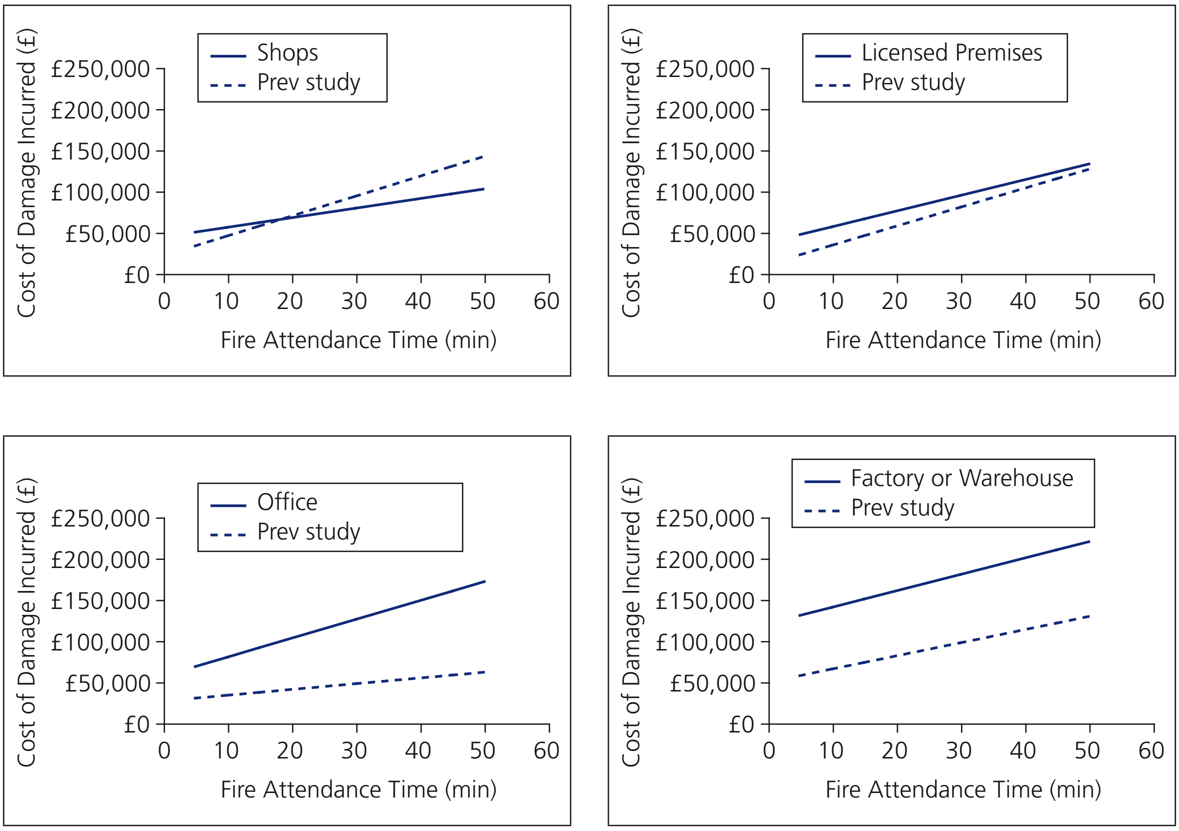






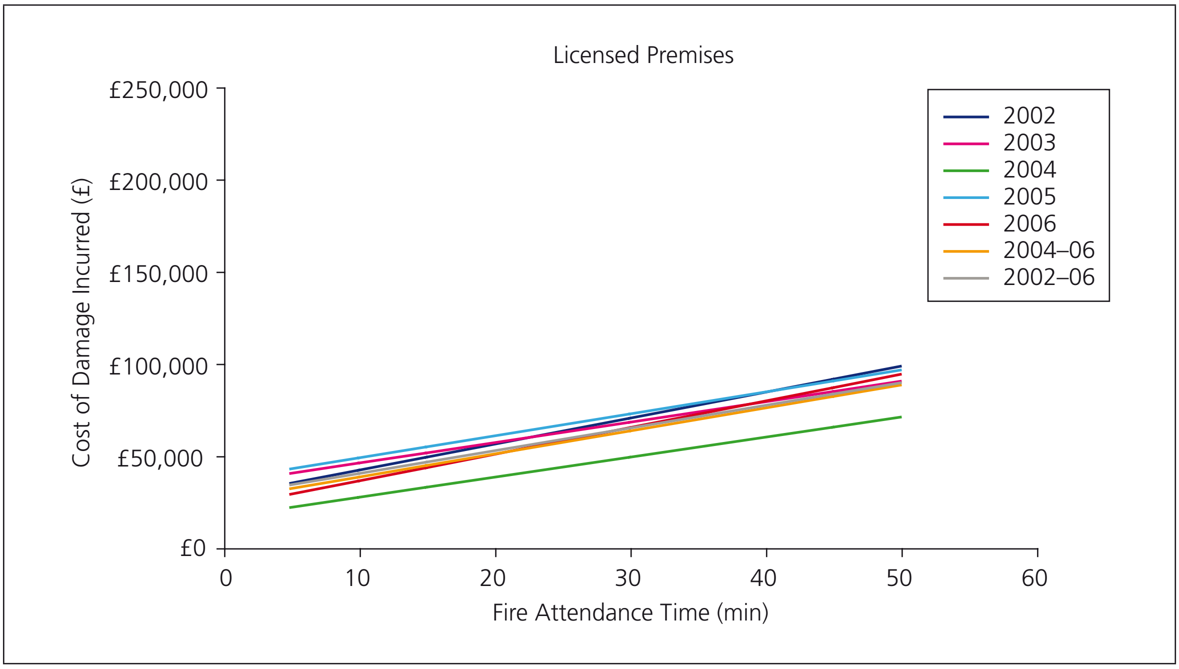


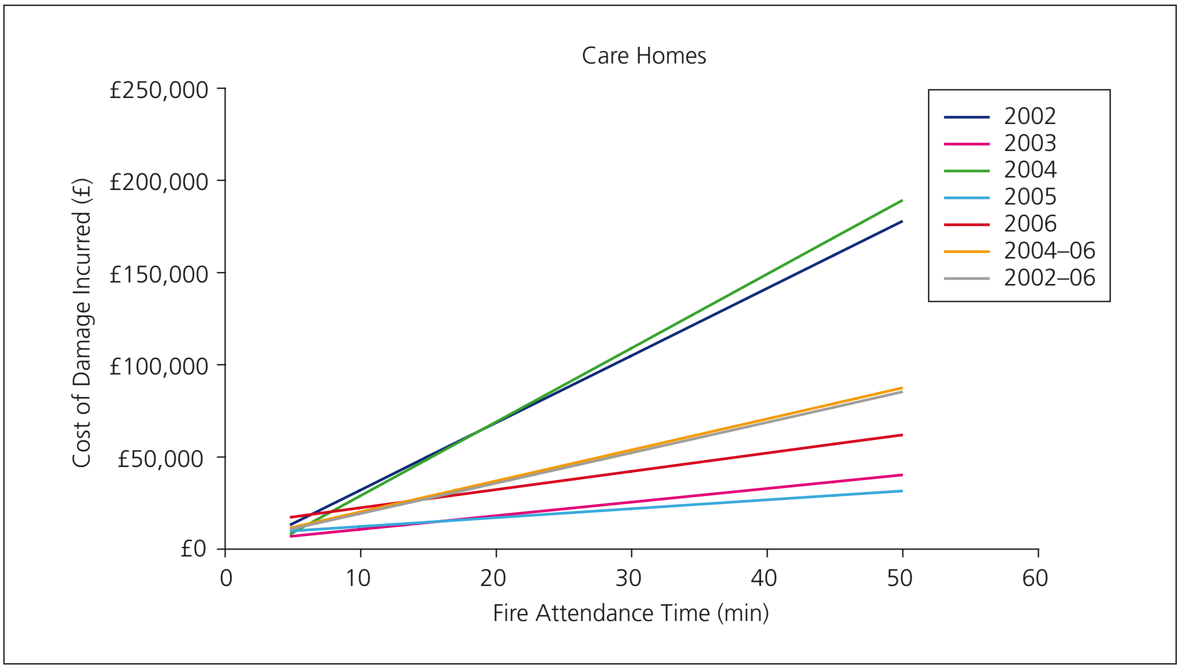


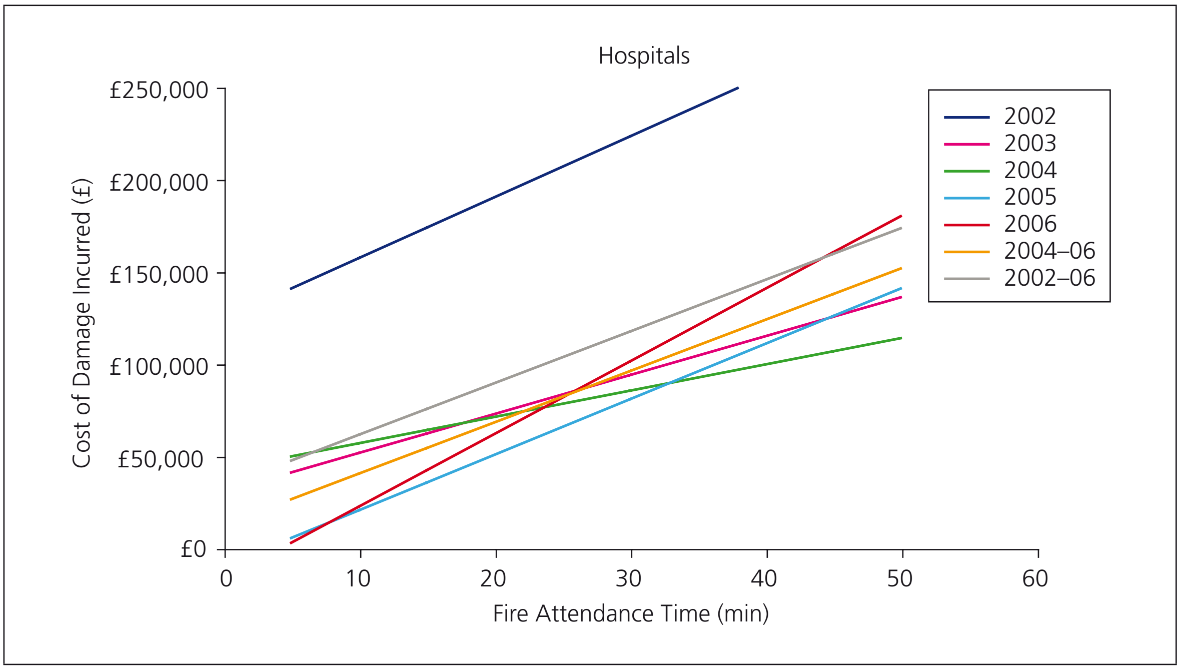


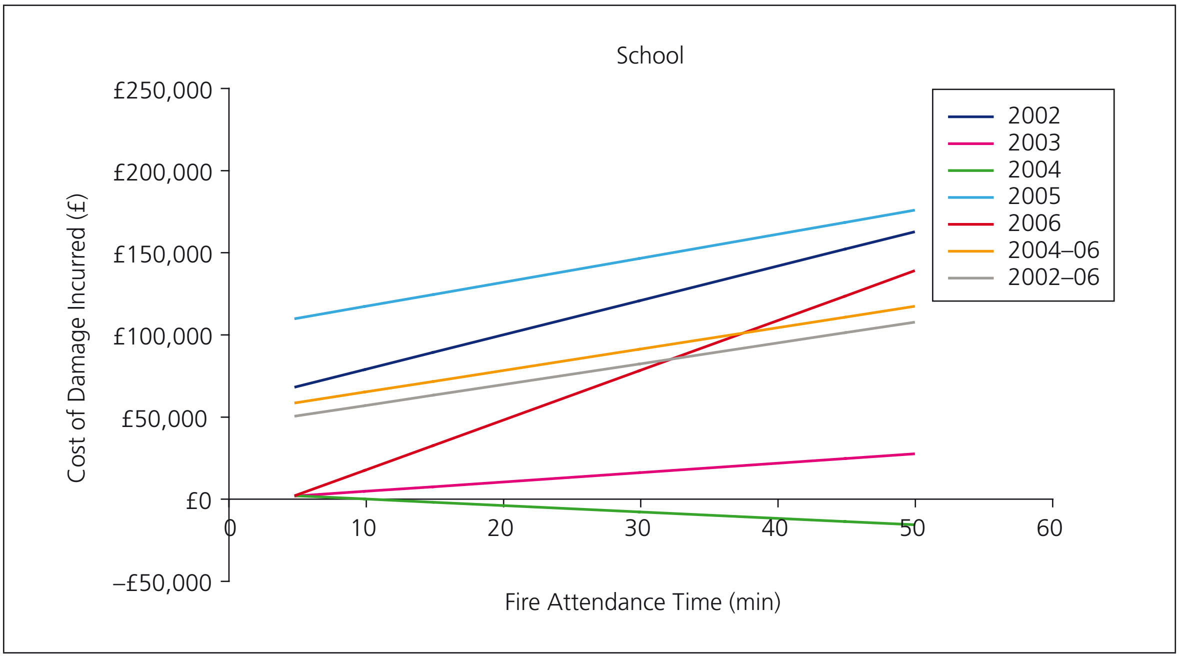
5.3.3 Loss rate curves – calculated per year of data

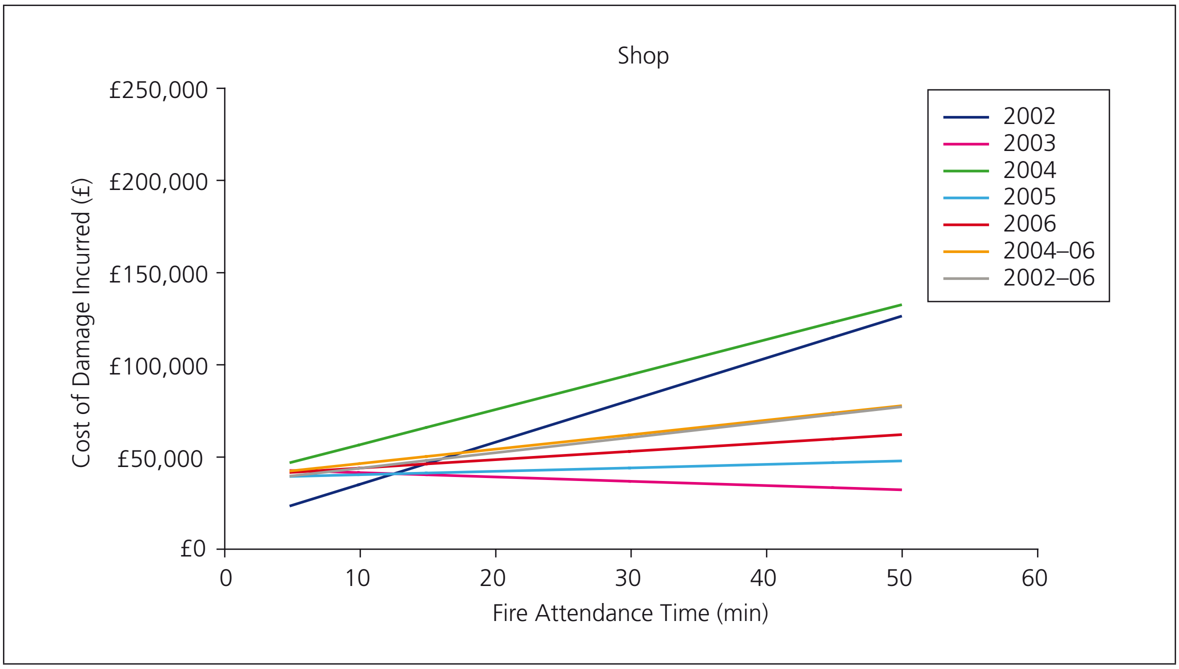
Loss rate curves per occupancy type

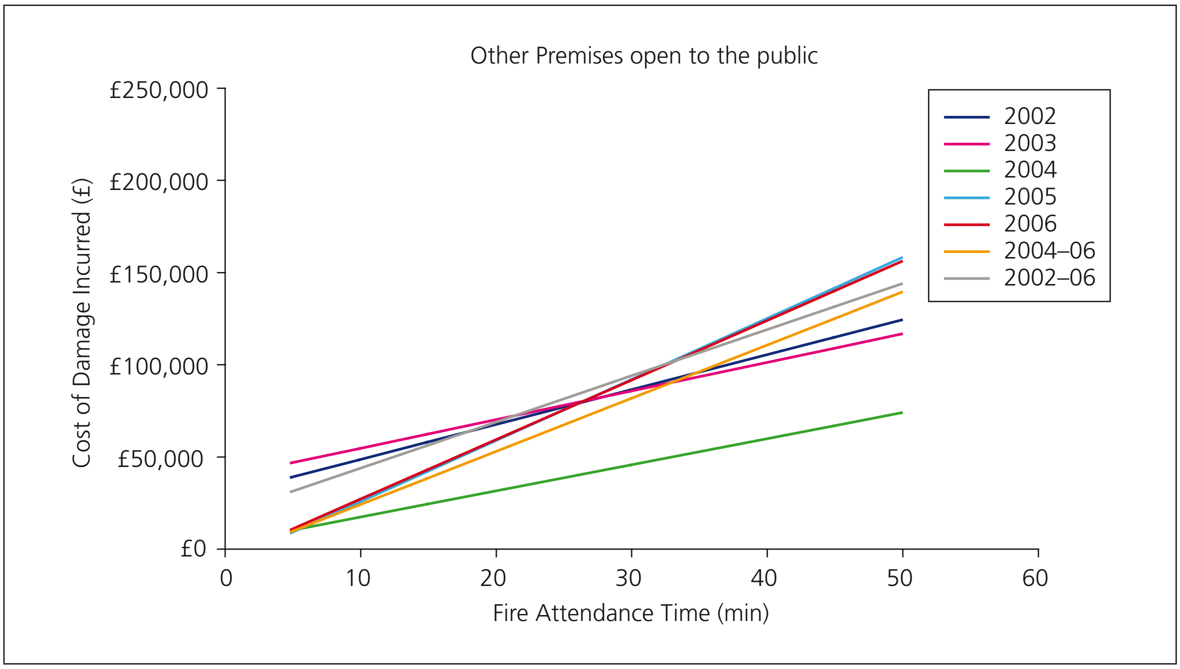


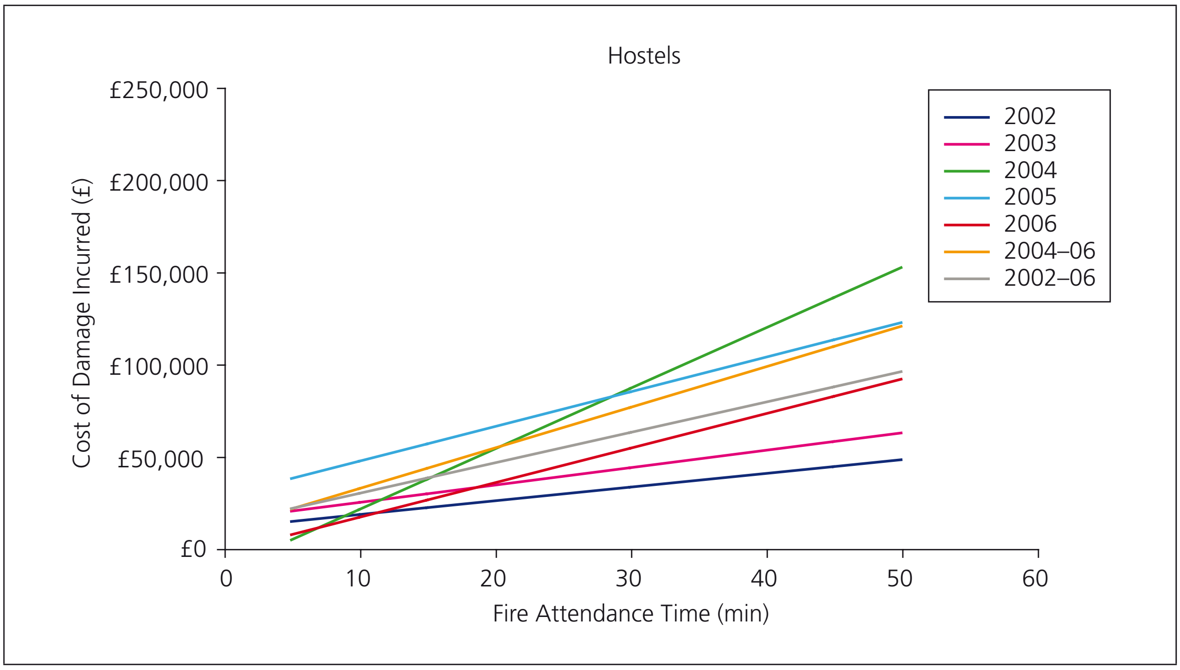

Care Homes
£250,000
£200,000
£150,000
£100,000
£50,000
£0
Cost of Damage Incurred (£)
0
10
20
30
40
50
60
Fire Attendance Time (min)
2002
2003
2004
2005
2006
2004–06
2002–06

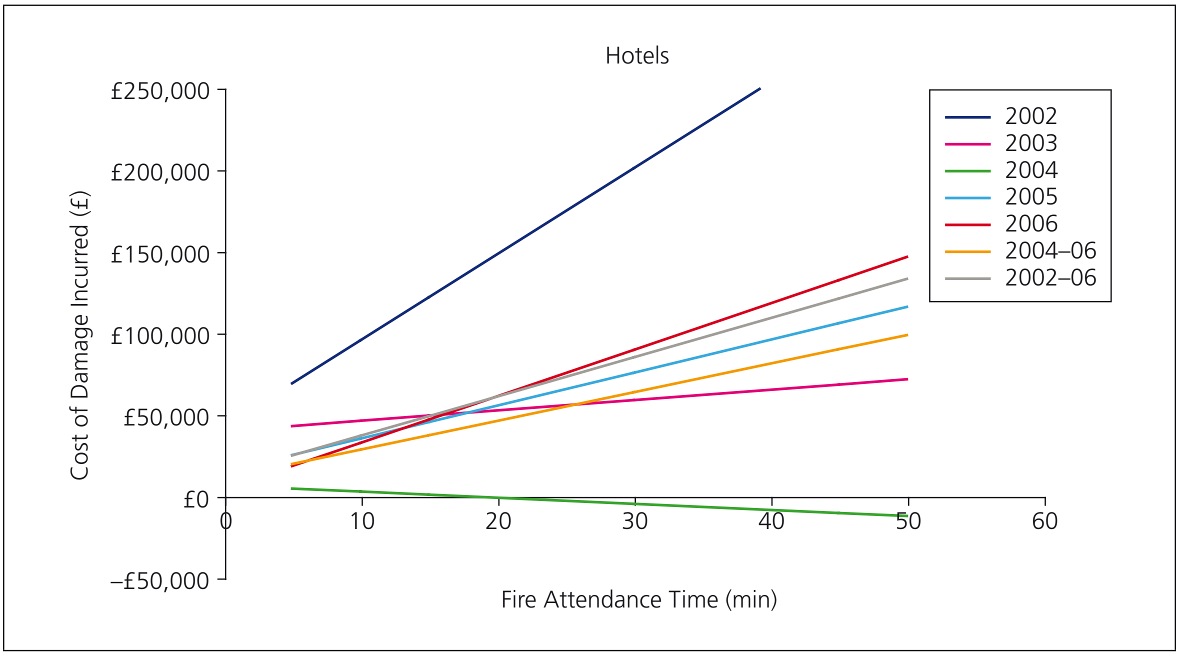

Hospitals
£250,000
£200,000
£150,000
£100,000
£50,000
£0
Cost of Damage Incurred (£)
0
10
20
30
40
50
60
Fire Attendance Time (min)
2002
2003
2004
2005
2006
2004–06
2002–06

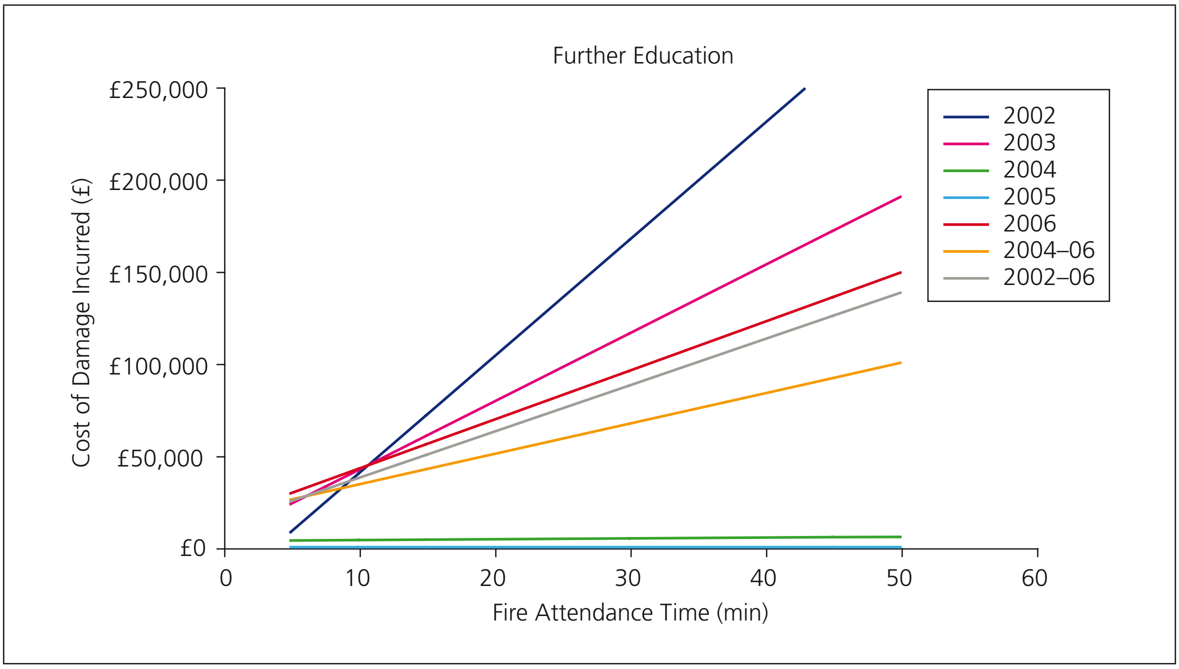

School
£250,000
£200,000
£150,000
£100,000
£50,000
£0
–£50,000
Cost of Damage Incurred (£)
0
10
20
30
40
50
60
Fire Attendance Time (min)
2002
2003
2004
2005
2006
2004–06
2002–06

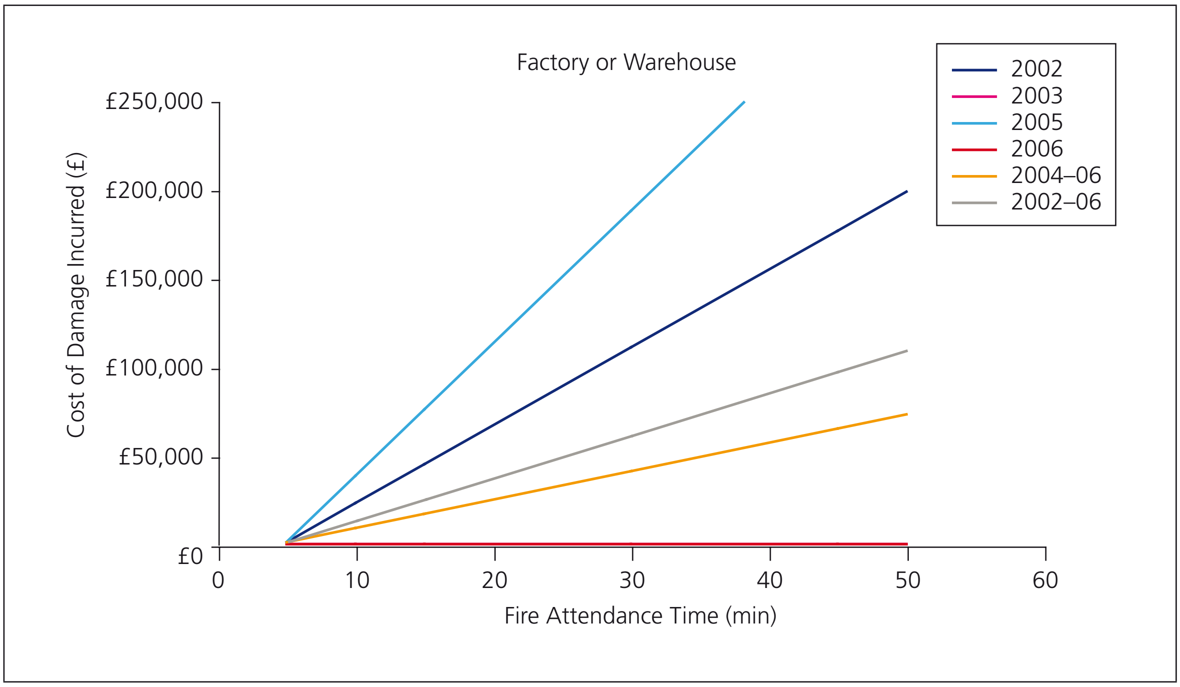

Shop
£250,000
£200,000
£150,000
£100,000
£50,000
£0
Cost of Damage Incurred (£)
0
10
20
30
40
50
60
Fire Attendance Time (min)
2002
2003
2004
2005
2006
2004–06
2002–06

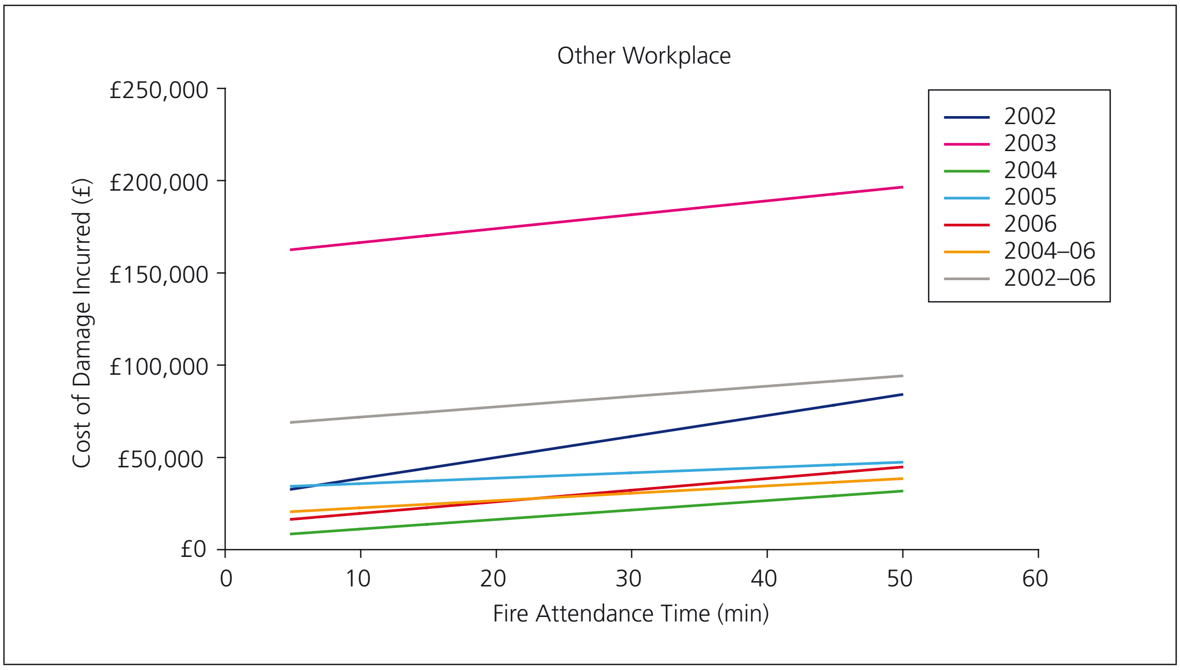

Other Premises open to the public
Cost of Damage Incurred (£)
£250,000
£200,000
£150,000
£100,000
£50,000
£0
0
10
20
30
40
50
60
Fire Attendance Time (min)
2002
2003
2004
2005
2006
2004–06
2002–06

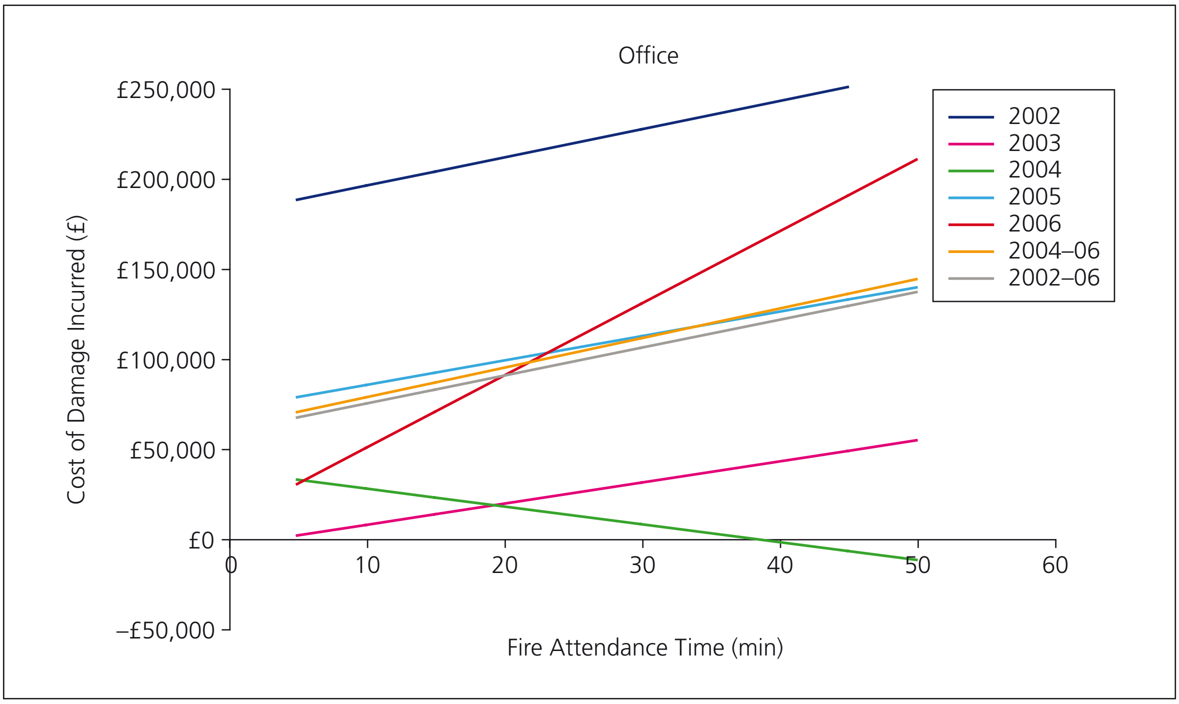

Hostels
Cost of Damage Incurred (£)
£250,000
£200,000
£150,000
£100,000
£50,000
£0
0
10
20
30
40
50
60
Fire Attendance Time (min)
2002
2003
2004
2005
2006
2004–06
2002–06


Hotels
£250,000
£200,000
£150,000
£100,000
£50,000
£0
–£50,000
Cost of Damage Incurred (£)
0
10
20
30
40
50
60
Fire Attendance Time (min)
2002
2003
2004
2005
2006
2004–06
2002–06


Further Education
£250,000
£200,000
£150,000
£100,000
£50,000
£0
Cost of Damage Incurred (£)
0
10
20
30
40
50
60
Fire Attendance Time (min)
2002
2003
2004
2005
2006
2004–06
2002–06


Factory or Warehouse
2002
2003
2005
2006
2004–06
2002–06
£250,000
£200,000
£150,000
£100,000
£50,000
£0
Cost of Damage Incurred (£)
0
10
20
30
40
50
60
Fire Attendance Time (min)

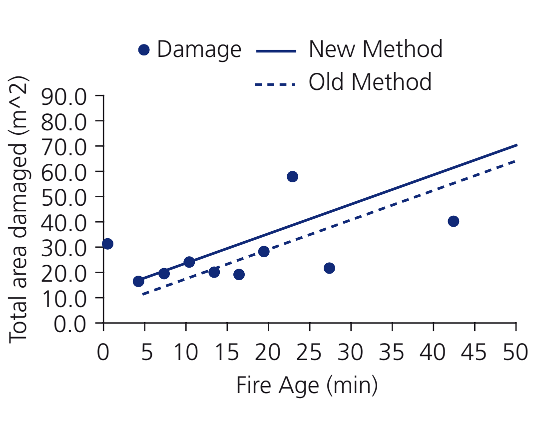

Other Workplace
2002
2003
2004
2005
2006
2004–06
2002–06
£250,000
£200,000
£150,000
£100,000
£50,000
£0
Cost of Damage Incurred (£)
0
10
20
30
40
50
60
Fire Attendance Time (min)


Office
£250,000
£200,000
£150,000
£100,000
£50,000
£0
–£50,000
Cost of Damage Incurred (£)
0
10
20
30
40
50
60
Fire Attendance Time (min)
2002
2003
2004
2005
2006
2004–06
2002–06

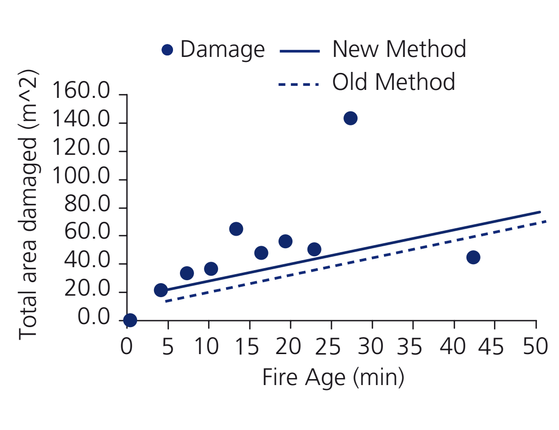
5.4 Fire age – damage relationship – method of determining damage at five minutes

5.4.1 Fire age – damage curves per occupancy type

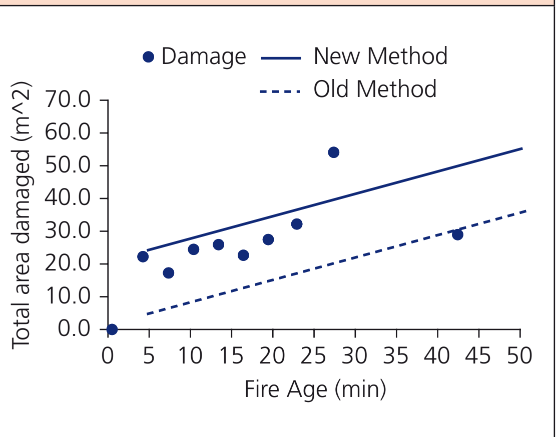
Hospitals



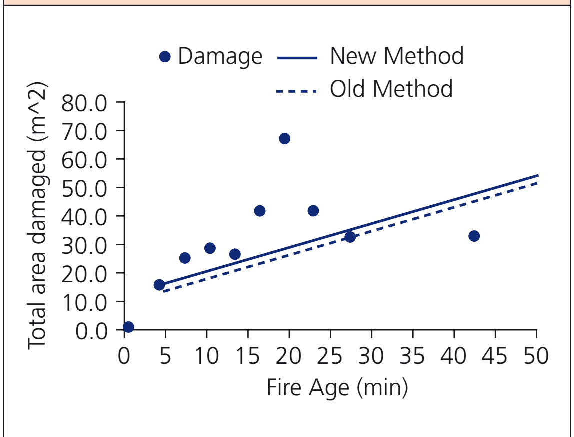
Care Homes



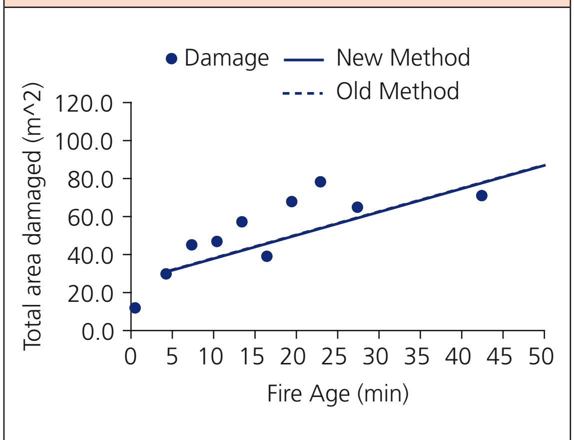
Hotels



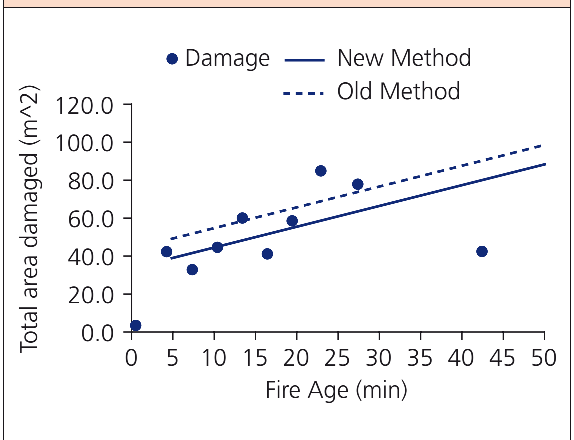
Further education



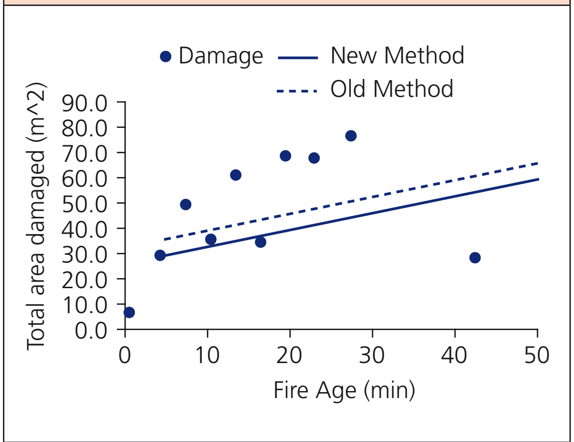
Licensed premises



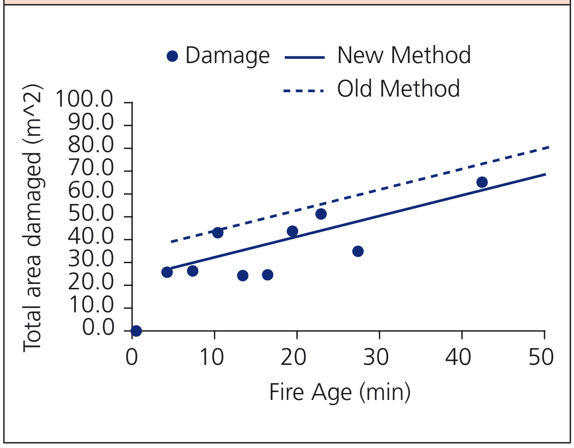
Schools



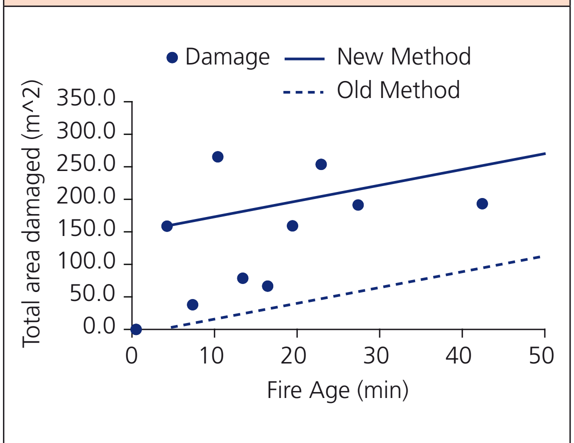
Shops



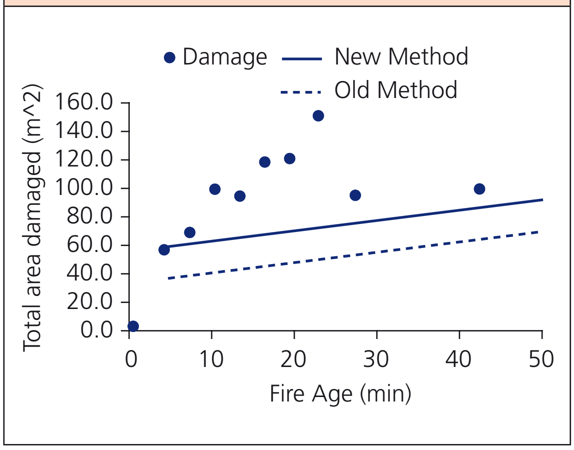
Offices



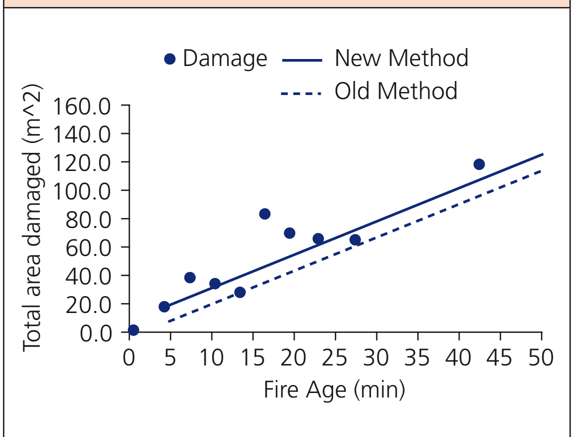
Factory or warehouse



Other workplaces



Other premises open to the public



ISBN 978-1-4098-2437-4

ISBN 978-1-4098-2437-4

9 781409 824374