



**A statistical report to investigate the effectiveness of
the Furniture and Furnishings (Fire) (Safety)
Regulations 1988**

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EXECUTIVE SUMMARY

Objectives of the review

There were two main objectives to this review:

- To identify the current effectiveness of the Furniture and Furnishings (Fire) (Safety) Regulations 1988 (FFRs); and
- To assess what benefits can be ascribed to each of the tests, in particular the Crib 5 test.

This was to enable the Department for Business, Innovation and Skills (BIS) to establish if the additional stringency of the flammability requirements in the FFRs, above that of the European provisions, continue to be effective and necessary.

Background

The Schedules to the FFRs include the following tests for upholstered furniture:

- **Cigarette ignition test:** Two lit cigarettes (called Source 0) are placed on the fabric being tested. The cover fabric should not smoulder or show flames within one hour of the cigarettes being lit.
- **Match ignition test:** The match is simulated by a 20 second butane flame (called Source 1). Any signs of smouldering on covers should cease within 120 seconds of flame removal.
- **Ignitability of flaming sources:** This tests ignitability from larger flame sources, as well as resistance to fire spread. A wooden crib comprising sticks of Scots pine is placed on a test cover fabric over the filling material and ignited: termed 'the Crib 5 test'. Fillings that produce detectable amounts of heat or smoke 60 minutes after ignition of the crib fail, as do any that flame after 10 minutes.

The latter test is unique to the UK and Ireland.

Approach to the work

First, the causes and lethality of furniture and furnishings (F&F) fires in 1981-88 and 1997-2006 were assessed to explore to what extent there was and remains a material risk that justifies the application of regulations. The first date range was selected to explore the time period prior to the FFRs being introduced. The second was selected to cover the period beginning after the date range of the earlier evaluation¹ ended. A number of case study fires were produced to illustrate the F&F fire risks.

Second, an analysis was made of the impact of the FFRs, bearing in mind that a number of factors have changed since they were introduced, including:

- A large increase in the number of smoke alarms in homes;
- A large reduction in the number of adults who smoke cigarettes; and
- An increase in fire safety education provided to children in schools, and to adults.

¹ The Effectiveness of the Furniture and Furnishings (Fire) (Safety) Regulations 1988. Completed by University of Surrey. Published by the Department for Trade and Industry, 2000.

It was necessary, therefore, to explore whether the number and lethality of F&F fires had fallen more than for other fires (Other Fires). The main types of Other Fires include food, electrical insulation, paper/cardboard, textiles and clothing, bedding, liquids (e.g. petroleum) and gases (e.g. mains gas). Also, it was possible that deaths in F&F fires and Other Fires declined for different reasons, particularly:

- Smoke alarms may have had more impact on F&F fires than Other fires. Therefore it was also assessed whether smoke alarms had the same impact on the lethality of F&F fires as on Other Fires; and
- The reduction in people smoking cigarettes may have impacted on F&F fires more than Other Fires. Therefore, the decline in F&F fires per million smokers was compared with the decline in Other Fires per million smokers.

Third, an exploration was made as to whether those sources of ignition (SOI) targeted by the regulations had declined more than other SOI.

Finally, the number of fires, deaths and non-fatal casualties prevented by the FFRs was estimated.

Key findings

The main findings are that:

- The match, cigarette and Crib 5 tests match the risks posed by F&F fires in that:
 - Matches and cigarettes are the main sources of ignition for F&F fires – as covered by test 0 (match) and 1 (cigarette);
 - Other sources such as paper, candles and lighters also cause a significant proportion of F&F fires (as covered by the Crib 5 test); and
 - F&F fires are more lethal and more likely to spread further than Other Fires (noting that the Crib 5 is intended partly to test for fire resistance and fire growth).
- Whilst the frequency and lethality of F&F fires fell after 1988, they are still more lethal than Other Fires, and matches/cigarettes remain the main SOI. A number of SOI are now more common than before, e.g. lighters, suggesting that some risk factors are rising rather than falling.
- For F&F fires, the numbers of fires, casualties and deaths fell, when the period before the 1988 regulations (1981-85) is compared with the period 2002-07, and at a greater rate than for Other Fires in the same periods, as follows:

Change between 1981-85 and 2002-07 in number of:	F&F fires	Other Fires
Fires	-37%	-10%
Non-fatal casualties	-26%	+75%
Deaths	-64%	-44%

Also, the number of non-fatal casualties in Other Fires rose, whilst the number of non-fatal casualties in F&F fires fell.

F&F fires associated with smokers' materials fell more than for Other Fires.

- There was a far greater decline in the lethality of F&F fires than in Other Fires. A very small part of the decline in the lethality of F&F fires can be attributed to the increased use of smoke alarms. A large part of the reduction in the lethality of Other Fires can be attributed to the increased use of smoke alarms.

Overall, in the period 2002-07, the analysis suggests that the FFRs account for:

- 54 fewer deaths per year;
- 780 fewer non-fatal casualties per year; and
- 1,065 fewer fires each year.

This reduction was valued² at about £140m per year:

- 50% attributed to the cigarette test;
- 10% to the match test; and
- 40% to the Crib 5 test.

These estimates are approximations and should not be treated as literal or exact values.

² These values are taken from the Department for Communities and Local Government toolkit for FRS, "Local Target Setting: the development of a risk based model and toolkit for the fire and rescue service - Fire Research Series 4/2008" at: <http://www.communities.gov.uk/publications/fire/localtargetsetting>

1 INTRODUCTION

1.1 Background

UK Fire data provided by the Department for Communities and Local Government (CLG) shows that the number of dwelling fires and deaths in the UK rose across the 1960s and 1970s. Dwelling fire deaths peaked at 865 in 1979 and fires peaked at 64,500 in 1988. A large proportion of fires involved foam-filled furniture. Concern over such fires and resulting casualties was followed by the introduction of the 1988 Furniture and Furnishings Fire Safety Regulations (FFRs)³.

The FFRs require the use of fire resistant fillings and cover fabrics. Initially this was for polyurethane (PU) foam fillings then in 1989 for other filling materials. Second hand furniture was required to comply from March 1993. The FFRs also specify labelling requirements.

The FFRs provide a number of key test requirements (based on British Standards BS 5852 and BS 6807) including:

- Source (IS) 0 – two replicate cigarettes – checks for signs of progressive smouldering or flaming of covers within one hour (fabrics treated with fire retardant receive a water wash before testing);
- Source (IS) 1 – burning match (simulated by a 20 second butane flame) – checks that signs of smouldering on covers ceases within 120 seconds of removal of the flame;
- Source (IS) 2 – a large gas flame – for non foam fillings; and
- Source (IS) 4 to 7 – the most common being Crib 5: a wooden Crib (20 sticks of Scots pine) weighing 17 grams – for foam in slab or cushion form fillings.

For the Crib 5 test, a standard fabric is used to cover the filling material being tested. Fillings that produce detectable amounts of heat, smoke or glowing from smouldering 60 minutes after ignition of the crib fail; failures also include any fillings that continue to flame after 10 minutes, are consumed by burning or smouldering, burn or smoulder to their edges or which must be extinguished due to the extent of smouldering combustion.

The test aims to check for both smouldering and flaming ignition and is unique to the UK (and Ireland). It aims to test for spread of fire to F&F as well as spread of fire from F&F to other items. It therefore replicates ignition sources in excess of those in source 0 and 1 tests. It also aims to guard against flame spread and thence the production of toxic smoke. Whilst the regulations do not prescribe how materials should be manufactured and/or treated to pass the tests, combustion modified foam is generally required to pass the Crib 5 test.

As noted on BIS's website,⁴ "we want a consumer regime that is fit for purpose for the 21st Century. A regime that will empower and protect consumers, support open, competitive and innovative markets, that is as fair to business as it is to consumers and that has the minimum regulation necessary to achieve these goals."

³ The FFRs can be accessed at: http://www.opsi.gov.uk/si/si1988/Uksi_19881324_en_1.htm, and the BIS guide to the FFRs at: <http://www.berr.gov.uk/files/file24685.pdf>

⁴ <http://www.berr.gov.uk/whatwedo/consumers/policy/index.html>

At the same time as assuring consumer safety, BIS aims to promote open and competitive markets, simplify regulations and ensure a fair trading environment. It is therefore critical to ensure that consumer safety regulations protect consumers without creating unjustified barriers to open markets. In this context, Minister Gareth Thomas said⁵:

"Statistics show that the Furniture Regulations have been a great success and saved many lives over the last 20 years. The government, industry, the fire services, consumer groups, enforcement bodies and test laboratories have all worked together to achieve a safety record that's the envy of the world.

"But now we need to ensure that the Furniture Regulations are keeping pace with the latest manufacturing processes. I'll be having a look at the effectiveness of these Regulations so they continue to provide the best protection for consumers."

Thus, the Department has decided that it is timely to review the current effectiveness of the regulations, to simultaneously maintain consumer safety whilst also assuring open and fair trade.

1.2 Previous evaluations

A previous evaluation of the FFRs, completed by the University of Surrey⁶ and published by the Department of Trade and Industry in 2000, concluded that 710 lives saved could be attributed to them over the period 1988 to 1997. This rate of around 70 per year was about half of the fall in UK dwelling fire deaths over the same period. (Fire deaths have continued to fall since 1997, if at a slower rate.)

Surrey concluded that smoke alarms had had relatively small impact in the fall in furniture fire deaths. Subsequently, CLG-commissioned research published in 2004 attributed a proportion (about 50 lives saved per year) of the fall in residential fire deaths across the 1990s to the increase in installation of smoke alarms. This followed a Home Office initiative to increase the number of smoke alarms installed by residents, introduced at the same time as the regulations. Subsequently, CLG-commissioned research⁷ published in 2004 attributed a proportion (about 50 lives saved per year) of the fall in residential fire deaths across the 1990s to the increase in installation of smoke alarms.

Figure 1 below shows a very strong correlation between alarm ownership (using CLG data) and the number of dwelling fire deaths (using CLG Fire Damage Report 1 data – 'FDR1'). The study completed a stepwise regression to identify the **strongest** statistical predictor of fire deaths. The percentage of dwellings with smoke detectors was the best predictor of fire deaths, followed by the percentage of people in the household who smoked cigarettes.

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<http://nds.coi.gov.uk/environment/fullDetail.asp?ReleaseID=385888&NewsAreaID=2&NavigatedFromDepartment=True>

⁶ The Effectiveness of the Furniture and Furnishings (Fire) (Safety) Regulations 1988. Completed by University of Surrey. Published by DTI, 2000.

⁷ Evidence base for the evaluation of community fire safety. Report by Greenstreet Berman Ltd for ODPM. July 2004. Michael Wright, R Genna and S. Cudmore.

The decline in smokers is shown in Figure 2 which may have contributed to a decline in F&F fires.

Figure 1: Smoke alarm ownership and dwelling fire deaths (England 1998 to 2001)

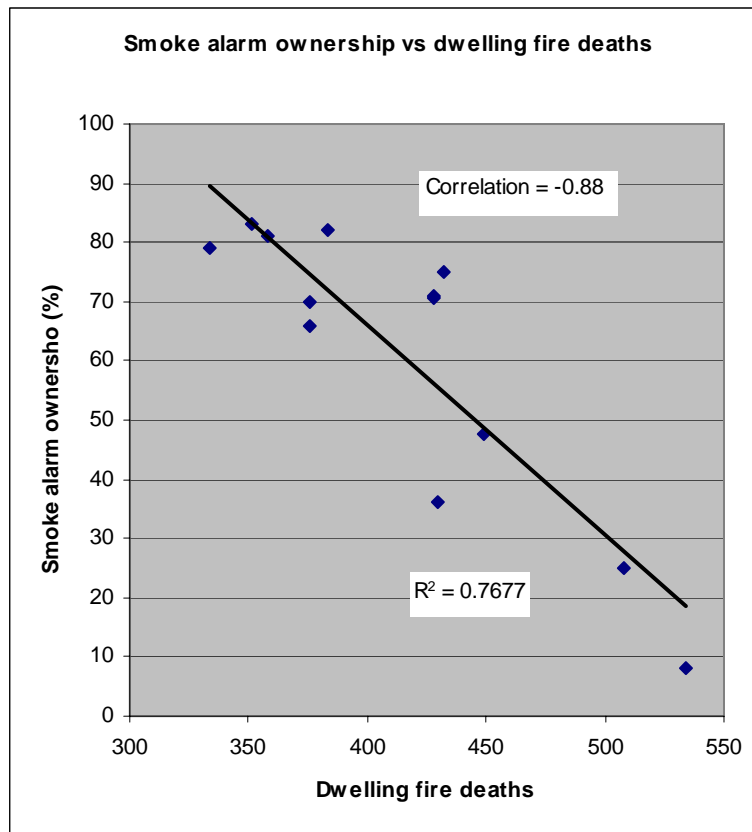
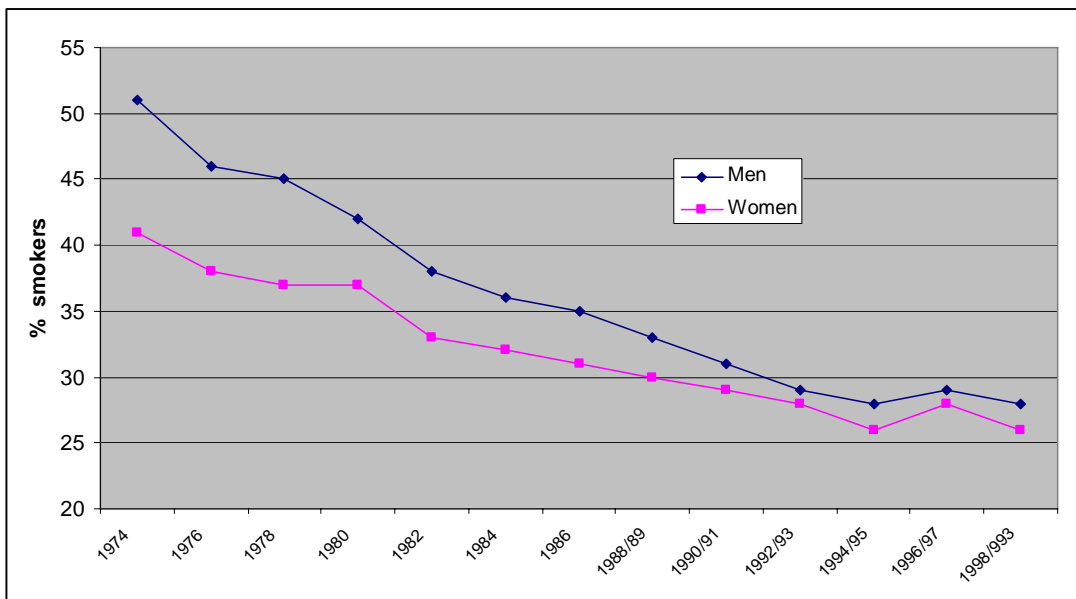


Figure 2: Trend in smokers (Great Britain)



The 2004 CLG study found that the fall in fire deaths in fires not discovered by smoke detectors accounted for the majority of the fall in the total number of dwelling fire deaths. Therefore, smoke alarms cannot account for the majority of the fall in fire deaths.

In addition, over this period there were increases in the number of lone parents, single adult households and elderly persons. All these factors have been found to be related to the incidence of fires, suggesting that there were underlying upward pressures on the rate of fires which did not lead to an increase in fire deaths, perhaps due to fire safety improvements.

The same CLG work found that:

- Dwelling fire deaths due to 'playing with fire' had decreased far more than dwelling fire deaths as a whole;
- Cigarette related dwelling fire deaths had fallen in line with the overall trend; and
- Cooking related dwelling fire deaths had not declined.

Whilst it was difficult to attribute the fall in the category 'children playing with fire' to any single factor, it was reported to have coincided with a focus on schools-based fire safety education, as well as the increase in smoke alarms and the FFRs. Therefore, it is possible that a proportion of the fall in F&F fires was due to the schools-based fire safety education.

The 2004 CLG study concluded that, "The fall in the rate of death per fire not discovered by smoke detectors equates to about 180 fewer deaths per year. This is most likely to be due to a combination of the impact of the 1988 Furniture and Furnishing regulations, the fall in the number of male smokers and the increase in fire safety education activities."

These points demonstrated a need to explore and allow for counterfactual factors in the investigation. In particular, it raised the question of what proportion of the fall in fires and casualties involving F&F could be attributed to:

- The FFRs;
- The increased use of smoke alarms;
- Reduction in cigarette smoking; and
- Community fire safety initiatives.

Current effectiveness

There are a number of questions regarding the currency of the FFRs, including:

- Cigarette-related fires remain the single largest cause of fatal dwelling fires. This raises the issue of whether the source 0 and 1 tests remain current or are out of sync with the ignition strength of current cigarettes and matches.
- Has an increase in the amount of furniture in homes increased the risk of fire spread?

Also, CLG initiatives have led to the installation of ~2m smoke alarms in the past few years, whilst the rate of cigarette smoking continues to fall. This naturally raises the question of whether recent trends in F&F fires can be attributed to these developments.

It should also be noted that the rate of decrease in F&F fires may have declined due to the progressive replacement of pre-1998 furniture. The previous study assumed that people replace furniture at a rate of between 4% and 8% per year. Thus, since 1988 and 2007, between 76% and over 100% of furniture in the home may have been replaced. If furniture was replaced at 8% per year, all pre-1988 furniture would have been replaced by 2000-2005. It is possible, therefore, that the decline in F&F fires related to the FFRs may have ended in 2005.

As previously noted, the Crib 5 test is unique to the UK (and Ireland). Whilst the source 0 and 1 tests replicate smokers' materials fires, the Crib 5 test is a clearly a more stringent test of resistance to fire growth and spread. Smokers' material fires were a key cause of dwelling fires and remain the single largest cause of fatal dwelling fires. Fires caused by smokers' materials also have a rate of deaths per 1,000 fires that is 5 times greater than the rate for all causes of fire (2005 UK national fire statistics). This may be interpreted to show the continued need to protect against such fires, or that the regulations are less effective than they could be. However, the Crib 5 test goes beyond testing against ignition by cigarettes and matches. It tests the extent to which fire growth and spread is inhibited subsequent to ignition. This issue, therefore, needs to be further explored.

1.3 Aims of this statistical review

The FFRs are unique to the UK (and Ireland, which has similar regulations in place) and are acknowledged as a barrier to trade in Europe, i.e. because furniture importers to the UK need to make special provision in order that their products meet the stringent flammability requirements of the FFRs. The continuation of the FFRs is therefore dependent on both the existence of an ongoing danger from fires in domestic upholstered furniture and evidence that the regulations are effective in reducing such risk. Any such evidence must be statistically based. The objective of this report was:

- To identify the current effectiveness of the FFRs;
- To assess what benefits could be ascribed to Crib 5/large source testing (as prescribed by the FFRs); and
- To assess if the FFRs reduced deaths and injuries due to a reduction in the ignition of furniture or because F&F fires had become less lethal due to the reduced flammability of foam-filled furniture; or, to determine what was the proportion between the two.

In short, BIS wished to determine if the extra stringency of the flammability requirements in the FFRs continues to be necessary, as well as assessing the impact of tests 0 and 1.

Thus, this study aimed to assess the case for each of the three tests (and their associated fire resistance standards). (The University of Surrey study considered the regulations as a whole.)

This study was primarily a statistical review. Statistical reviews can identify associations between, for example, rates of fire deaths and the rate of installation of smoke alarms. They can also compare before and after trends to identify changes in trends that follow on from an event such as the introduction of new regulations. As with all statistical reviews, they cannot determine cause and effect. In addition, the review was limited by the scope of available data. Therefore, the aim of this review was to assess the impact of each of the three tests as far as it was possible using currently available data.

2 APPROACH

2.1 Overview

There were three main parts to the analysis, namely:

- To assess the causes and lethality of F&F fires in the periods 1981-88 and 1997-06 in order to assess the match of risk factors to the FFRs' requirements and the extent to which there remains a significant and ongoing fire risk.
- To assess the evidence regarding the impact of each of the three main test requirements of the FFRs.
- To quantify the number of averted fires, casualties and deaths that can be statistically attributed to the FFRs.

FDR1 data was acquired for the period 1981 to 2007. This data was checked and sorted. In many cases, the data for 1994 and 2007 was rejected as anomalous. Discussions with CLG indicated that these anomalies were related to the change in coding in 1994 (which coincided with anomalies in some of the fire data in 1993) and data-processing errors within CLG in 2007.

2.2 Retrospective and current positions

In the first instance, the profile of F&F fires in 1981-88 and 1997-2006 was assessed to explore to what extent there was and remains a material risk that warrants the application of regulations. A number of case study fires were produced to illustrate the circumstances and factors involved in F&F fire deaths.

The period 1997-2006 was taken as the current position partly because it corresponds to the period following the Surrey/DTI report.

These profiles covered:

- Comparisons of the number of F&F fires, deaths and casualties with all dwelling fires – to assess the significance of the risk posed by F&F;
- Sources of ignition (e.g. matches) – to see if they match the FFRs tests;
- Item first ignited where F&F was the material mainly responsible – to again see if the causes match the FFRs tests;
- Contribution of children playing with matches, care handling and other behaviours – to see if they match the risks addressed by the FFRs;
- Lethality (deaths per fire) – to see if F&F fires were and remain more lethal than Other Fires;
- Extent of fire spread – to see if F&F fires spread further than Other Fires;
- Lethality by extent of fire spread – to see if fires that spread more are also more lethal, and if this was particularly so in the case of F&F fires; and
- Type of injury – to see if F&F fires were more likely to involve smoke injuries than Other Fires.

Further details of these analyses can be seen in Appendix C at section 7 and Appendix D at section 8.

2.3 Impact analysis

This included a series of analyses which aimed to:

- Assess if the trends in F&F incidents differed from those for Other Fires. The main types of Other Fires include food, electrical insulation, paper/cardboard, textiles and clothing, bedding, liquids (e.g. petroleum) and gases (e.g. mains gas). Other Fires are used as a "control". The trend in Other Fires was assumed to represent a "background" trend independent of the impact of the FFRs; and
- Assess if the trends in F&F fires were influenced by different factors than Other Fires, such that where trends were similar they might be attributed to different factors. This was particularly relevant to the impact of smoke alarms on the lethality of fires.

The impact analyses included:

- Comparing the trends in the number of F&F incidents versus Other Fires – to see if F&F fires declined at a faster rate than Other Fires;
- Exploring if those Sources of Ignition (SOI) targeted by the regulations (cigarettes, matches and other stronger sources of ignition) had declined overall and relative to other SOI;
- Exploring the item first ignited for fires where F&F were the material mainly responsible – again, to see if those causes targeted by the regulations (cigarettes, matches and other stronger sources of ignition) had declined overall and relative to other SOI;
- Assessing if the decline in fires related to smokers' materials was greater than the decline in adult smokers, and whether the decline in F&F fires per million smokers was greater than the decline in Other Fires per million smokers; and
- Checking:
 - The extent to which the decline in fires involving children playing with matches (which could be related to fire safety education work) might account for the fall in F&F fires;
 - If trends in the impairment of victims might account for the faster decline in the lethality of F&F fires; and
 - If the downward trend in F&F fires followed a downward trend in furniture sales.

In addition:

- The Crib 5 test tests the rate of fire growth, associated with which is the production of toxic smoke. The potential impact of this test would be reflected by trends in the lethality of fires. Therefore, analysis was conducted to identify whether the reduction in the lethality of F&F fires between 1981 and 2006 exceeded that of Other Fires.

- As the number of smoke alarms in homes increased over the period, a second step in the analysis estimated the lives saved by smoke alarms for F&F fires and Other Fires. This assessed whether the reduction in lethality was equally attributed to smoke detectors in the case of F&F and Other Fires.
- Furniture was thought to be more lethal and cause more injuries due to the production of toxic smoke associated with the foam fillings and a greater spread of fire, resulting in a greater proportion of deaths that were due to smoke. Therefore, the types of injury that caused fatalities and casualties in F&F and Other Fires were analysed to determine if the regulations had an impact on the injury type in fires.

Within these comparisons it was considered:

- Whether F&F and Other Fires follow the same trends before and after the introduction of the FFRs – as their trends could coincide after 1988, having previously diverged – with the possibility that the FFRs caused F&F fires trends to shift to the same trend as Other Fires; and
- Whether F&F and Other Fires trends may be related to different factors, despite being similar.

It should be noted that two trends may coincide incidentally, and might actually be influenced by different factors. Where there was scope to explore this, the factors underlying trends were examined.

Further details of these analyses can be found at Appendix E in section 9.

2.4 Incidents averted by the FFRs

We assessed the number of incidents averted by the FFRs, based on the assumption that:

- Both F&F and Other Fires fell due to non-specific other factors, such as general improvement in residential fire safety – but the difference in the decline in fires between F&F and Other Fires could potentially be associated with the FFRs;
- The reduction in deaths per fire was mostly due to the FFRs in the case of F&F fires, but smoke alarms had a major impact on Other Fire deaths. This was taken into account in this part of the assessment; and
- The decline in F&F fires casualties was associated with the FFRs, whilst Other Fire casualties rose due to factors unspecified in this analysis.

The analysis method is elaborated in Appendix E at section 9.6.

2.5 Comparison with the 2000 study

The current study differs from the previous study published in 2000 in a number of respects, including:

- The current study limited the impact of the FFRs to the difference between the trends in F&F and Other Fires (with the exception of fire deaths), rather than attributing the overall fall in smoke-related deaths to the FFRs;
- The current study limited the reduction in F&F fires, deaths and casualties to those incidents where F&F was the item first ignited – whilst the previous study considered all fire deaths due to smoke; and
- The current study assessed the contribution of fewer adult smokers.

Thus, the current study applied a far narrower scope to estimating the lives saved by the FFRs. These differences make comparison of the two sets of results difficult.

3 FINDINGS

3.1 Overview

The analysis addressed the following three issues:

- The need for the FFRs tests – in accordance with the retrospective review of F&F fires in Appendix C at section 7;
- The current picture of F&F fires - in accordance with Appendix D at section 8; and
- The impact of the FFRs on F&F fires - in accordance with Appendix E at section 9.

Overall the findings show that:

- The requirements to protect against ignition by smokers' materials and other stronger ignition sources, whilst also reducing the rate of fire growth and generation of toxic smoke, clearly matched the main causes and lethality of F&F fires in the mid 1980s;
- The latter requirements still matched the main causes and consequences of F&F fires in the period 1997 to 2006;
- Both the number and lethality of F&F fires rose before the introduction of the regulations and fell afterwards;
- When the trend in F&F fires was compared to the trend in Other Fires, using Other Fires as a "control" group of fires that were unlikely to be impacted by the FFRs, it was found that:
 - The number of F&F fires fell at a faster rate than Other Fires, declining by 37% compared to 10% between 1981-85 and 2003-07;
 - The number of fire deaths fell by 64% for F&F fires and 44% for Other Fires between 1981-85 and 2003-07;
 - The number of F&F fire casualties fell by 26% over the study period compared to a rise of 75% in Other Fire casualties; and
 - There was a marked difference in the trend for the lethality of F&F fires relative to Other Fires, i.e. there was a far greater decline in the lethality of F&F fires than Other Fires;
- Whilst both F&F and Other Fires may have declined due to fewer adult smokers, the decline in F&F fires associated with smokers' materials was greater than the decline for Other Fires;
- A very small part of the decline in the lethality of F&F fires can be attributed to the increased use of smoke alarms, whilst a larger part of the reduction in the lethality of Other Fires can be attributed to the increased use of smoke alarms;
- Thus, whilst there were some common factors underlying the trends in F&F and Other Fires, F&F fires, deaths and casualties were found to have declined more so.

The reduction in the rate and lethality of F&F fires was estimated to equate to 54 lives saved per year, 780 fewer casualties per year and 1065 fewer fires per year in the period 2003-2007.

3.2 Context of the FFRs' specific requirements

The FFRs were designed to protect against a number of specific fire risks associated with F&F. These risks are highlighted here by the use of a series of case studies. The case studies have been selected from the years 2002 to 2005, and serve to indicate the extent to which the requirements remain relevant today.

The specific aims of the FFRs include:

- To resist ignition by:
 - Cigarettes;
 - Matches; and
 - Other (unspecified) stronger ignition sources.

Cigarettes and matches were thought to be the most frequent causes of F&F fires, with other stronger sources also being a factor.

- To restrict the rate of fire growth and production of toxic smoke.

F&F fires were considered to be relatively more lethal than Other Fires due to the toxicity of smoke produced by the combustion of foam and the rapid rate of fire growth associated with foam. Also, victims were thought to need additional time to escape from F&F fires as they tend to be intimate with the F&F (e.g. they are sitting on the item first ignited at the time of ignition, or in the same room), and may be impaired by alcohol, or asleep.

Therefore, tests 0 and 1 test fire resistance to matches and cigarettes, whilst Crib 5 tests resistance to other stronger ignition sources and rapid fire growth.

Ten case studies of F&F fire fatalities were produced using Fatal Fire Investigation Reports. These reports are completed by the fire service for every fatal fire. They provide more descriptive information and assessment of the causes and circumstances of fires than the standard FDR1 report. The following provides a brief summary of these case studies. More information can be found in Appendix B at section 6.

It can be seen that:

- 4 cases involved smokers' materials as ignition source;
- Smoke was a cause of death in 6 cases;
- The victim was impaired in 6 cases; and
- 4 cases involved the fire spreading beyond the room of origin.

Thus, the factors that gave rise to the FFRs can still be observed in latter day fires.

- Case study 1 (see 6.1)

The victim was a 62 year old male, a heavy smoker and drinker, living alone in a bungalow that was in a state of disrepair. The fire was started by smokers' materials, candles or an electrical fault, which set fire to a two-seater settee that did not comply with the FFRs. The victim died as a result of the effects of smoke inhalation.

- Case study 2 (see 6.2)

The victim was a 72 year old male living with his daughter in a five room maisonette. He was under the influence of alcohol and asleep at the time of the fire. It is thought the source of ignition was the application of a naked flame to the upholstery of a settee. The fire was confined to the room of origin.

- Case study 3 (see 6.3)

The victim was a 61 year old male, a heavy smoker who suffered from health problems such as asthma and diabetes. He was also on daily medication that made him drowsy. He lived in a four room ground floor flat and was asleep and under the influence of medication at the time of the fire. It was suggested that the fire was accidentally ignited by a cigarette to a settee. The victim died of the effects of smoke inhalation.

- Case study 4 (see 6.4)

The victims were a 21 year old female, her two children – a 3 year old boy and a 1 year old girl - and a 4 year old boy who was the son of the registered tenant. They lived in a semi-detached house with two other adults and one other child. The fire originated in the lounge/dining area close to or underneath a pine table. It is believed the source of ignition was a child playing with matches. The adult female escaped the property but later re-entered in an attempt to rescue the children. They all then became trapped and died in the property.

- Case study 5 (see 6.5)

The victim was a 44 year old man who lived with a 53 year old woman in a mid-terrace house and who was under the influence of alcohol at the time of the fire. The source of ignition was believed to be an inspection lamp without a protective cage that was used as a temporary or extra light, placed on an upholstered chair. Due to being left unattended or due to the intoxicated state of the occupants, the chair was ignited and fire quickly developed. Open doors and rubbish on the floor allowed the fire to reach severe proportions and spread heat and smoke throughout the premises.

- Case study 6 (see 6.6)

The victim was a 2 year old boy. His mother (23) and father (33) and 3 year old brother were also in the property at the time of the fire but escaped. The property was a two-story terraced house kept to a poor standard. The fire started in the children's bedroom and was believed to be due to unattended children playing with matches. The fire spread from the floor level mattress to the adjacent mattress supported by the bed frame. A further seat of fire was located on a futon, on the top surface of the fabric. The futon was modern enough to be fire retardant and an attached label confirmed this to be the case. All survivors were suffering from the effect of smoke inhalation. The victim suffered up to 70% burns and severe smoke inhalation.

- Case study 7 (see 6.7)

The victim was an adult male living in a mid terrace 3-bedroom house on two floors where there was evidence of excessive hoarding. The fire originated under the window near the head of the bed, due to careless discarding of cigarettes when the victim fell asleep after drinking and smoking. The fire then spread from a low level to involve the bed on one side of the room and the fitted wardrobe on the other. The victim was reported to have suffered from severe smoke inhalation.

- Case study 8 (see 6.8)

The victim was an 87 year old female who lived alone. She suffered from dementia and took tablets for a thyroid problem; she also had deteriorating health after suffering two falls. The property was a purpose built flat in a private three storey building. The fire started in the lounge. It is thought that the victim fell asleep in an armchair and her lit cigarette dropped onto the seat cushion of her armchair. Once flaming occurred the fire spread up the victim's clothing and the arm and back of the chair. Labels from the chair indicated that it did not comply with the current FFRs. The victim attempted to escape but was unable to do so and collapsed.

- Case study 9 (see 6.9)

The victim was a 57 year old man who lived alone in a mid-terrace house. He had failing health and used candles for lighting throughout the property. The room of origin contained various items of furniture and fittings together with plastic bags containing waste. It was believed that the fire was caused by accidental ignition due to the victim leaving a lighted candle on the floor adjacent to the sofa. The sofa was ignited at a low level, with the fire spreading upwards and involving the victim. The victim's ability to recognise and respond to the developing fire may have been impeded due to medication and/or alcohol. He was found lying on the sofa suffering approximately 80% burns.

- Case study 10 (see 6.10)

The victim was a 79 year old female who lived alone in a two-storey house. The fire originated in or close to the hearth in the lounge. The victim fed the open fire in the hearth with a length of timber from a broken up window frame. The paint on the timber had ignited and spread to ignite the fabric and fillings of a nearby armchair. The fire was confined to the room of origin as the fire brigade were called early and prevented its development. The victim suffered the effects of smoke inhalation and burns to her hands and arms. She was given oxygen and taken to hospital where she later died.

3.3 Situation before 1988 and since 1997

Appendix C at section 7 and Appendix D at section 8 provide a review of F&F fires before and after the introduction of the FFRs with the aim of providing statistical evidence of:

- The extent to which the requirements of the FFRs were consistent with the causes and consequences of F&F fires before 1988;
- The extent to which F&F fires remain a particular fire risk, and what the profile of causes and consequences are; and
- To highlight differences between the pre-1988 position and the position since 2001.

The specific requirements of the FFRs were explored by examining:

- Whether the number of F&F fire deaths and casualties was high enough, as a proportion of all dwelling fires, to warrant specific regulations;
- Whether the requirement to resist ignition by cigarettes, matches and other stronger ignition sources reflected the SOI; and
- Whether the requirement to restrict the rate of fire growth and production of toxic smoke was reflected by:

- The lethality of F&F fires relative to Other Fires;
- The extent of fire spread of F&F fires relative to Other Fires; and
- The extent to which victims needed additional time to escape due to being impaired by alcohol or asleep.

The key points are summarised below.

F&F as a cause of fires, deaths and casualties

It was noted that:

- Before 1988, F&F fires were a significant proportion of all dwelling fire deaths (i.e. 24%) and casualties (i.e. 15%) despite being a small minority (i.e. 6%) of dwelling fires; and
- Since 1997, whilst F&F fires have declined, they remain a significant cause of death and injury: at 15% of dwelling fire deaths and 7% of dwelling fire casualties.

Sources of ignition

It can be noted from Figure 3 and Figure 4 that:

- The main sources of ignition clearly matched the requirements of the FFRs, namely cigarettes (52% of F&F fires) and matches (16% of F&F fires) as well as a range of other stronger ignition sources such as embers from open fires;
- Whilst the number of F&F fires due to cigarettes fell, they remain the main source of ignition in recent years; and
- A number of other sources have increased in frequency, such as cigarette lighters and electric blankets.

As noted above, the number of F&F fires caused by lighters, candles, paper and other naked flames has increased since before the regulations. This indicates that the Crib 5 test may not have been effectively preventing these ignition sources. However, these sources of ignition may be rising, in part due to social trends, e.g. increased use of candles as a decorative feature, change from use of matches to cigarette lighters and wider use of electric blankets.

Figure 3: Sources of ignition of F&F fires – before the FFRs

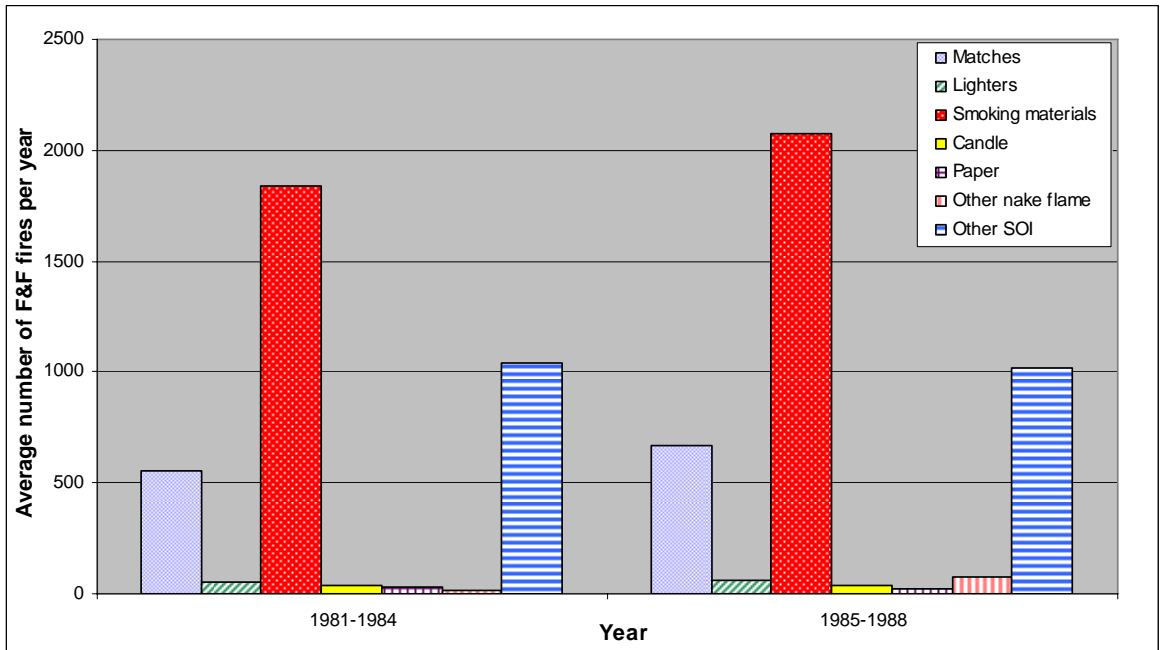
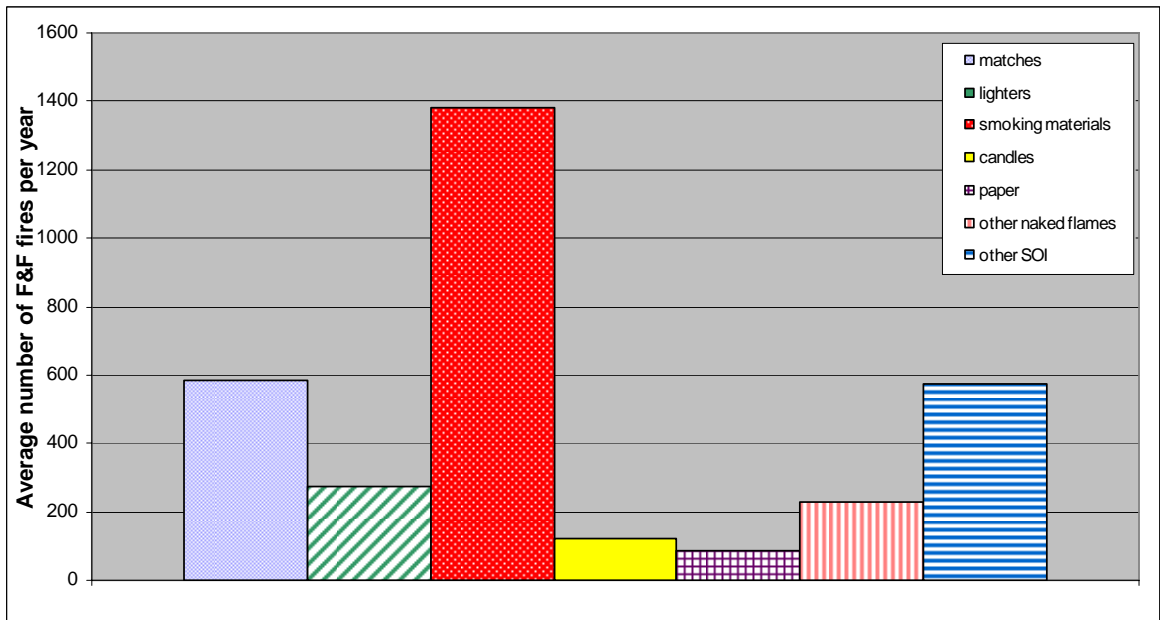


Figure 4: Source of ignition of F&F fires – 1997 to 2006



Lethality

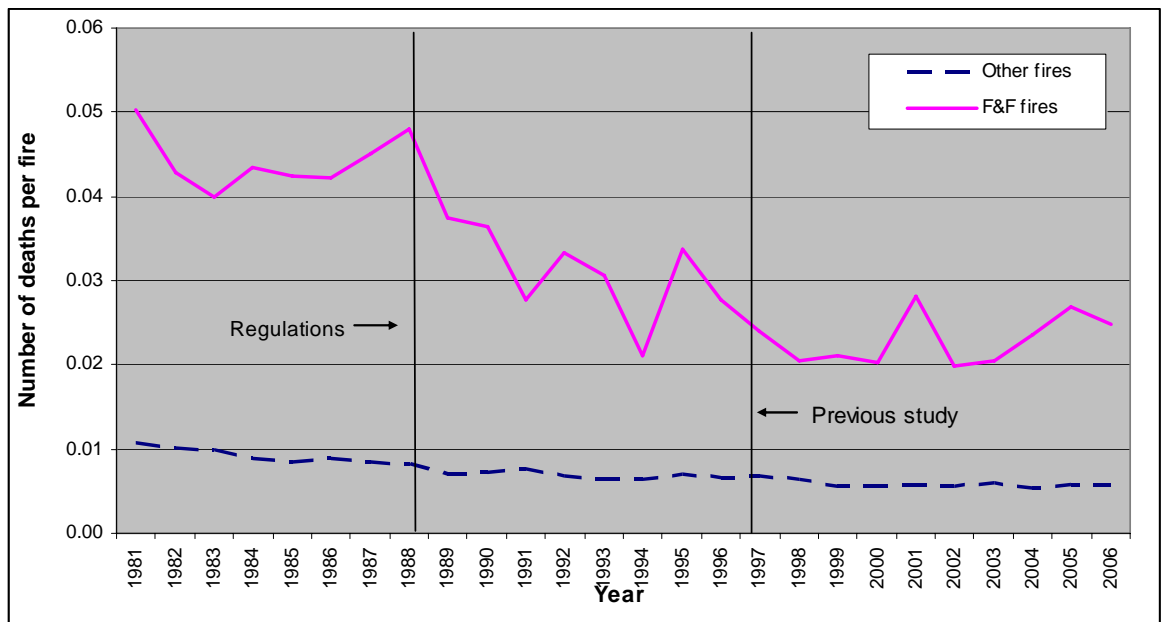
F&F fires were suggested as being very lethal before the FFRs were introduced due to foam fillings when ignited producing toxic smoke and spreading very quickly. This concern underpinned the proposal to 1) prevent F&F fires by resisting ignition, and 2) reduce the lethality of fires if they do occur. The Crib 5 test was intended, in part, to demonstrate performance in respect of limiting the speed of fire growth and the rate at which toxic smoke is produced. Clearly, by reducing the size and toxicity of fires, they should be less lethal.

Figure 5 shows the deaths per fire for F&F and Other Fires, from which it can be noted that:

- F&F fires were 4.6 times more lethal than Other Fires before 1988;
- The lethality of F&F fires has fallen greatly; and
- F&F fires remain more lethal than Other Fires, i.e. they are now 4.3 times more lethal than Other Fires.

Thus, there was and remains clear statistical evidence that F&F fires were/are particularly lethal. There is no evidence that the lethality of F&F fires was rising due to a reduction in their effectiveness.

Figure 5: Relative lethality of F&F versus Other Fires



Fire spread

The case for resisting fire growth was also explored by examining the extent of it. Figure 6 shows the proportion of F&F and Other Fires that spread "beyond the room of origin". It can be noted that:

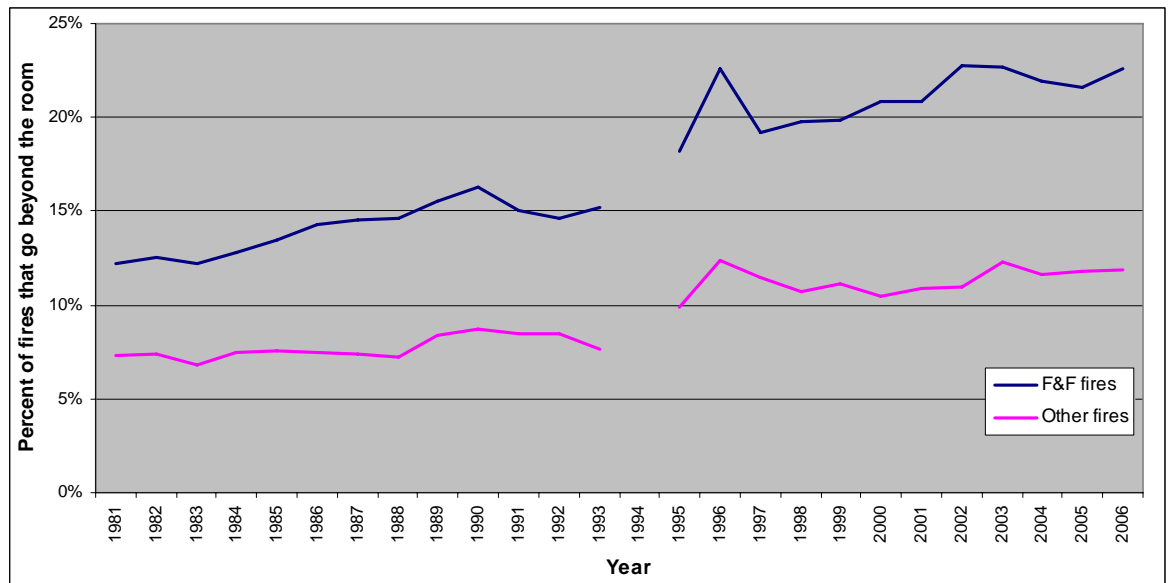
- F&F fires were nearly twice as likely to spread beyond the room of origin than Other Fires before 1988;
- Both F&F and Other Fires that spread beyond the room of origin have nearly doubled between 1988 and 2006; and
- F&F fires remained nearly twice as likely to spread beyond the room of origin than Other Fires after the FFRs were introduced.

Thus:

- F&F fires were and remain more likely to spread further than Other Fires; but
- Whilst the lethality of fires has decreased, there is less evidence of an impact on fire spread.

Indeed, the number of F&F fires that spread beyond the room of origin rose between 1981 and 1990, and did not clearly fall until 2005. F&F fires that were confined to the "item of origin" and "room of origin" both declined after 1990.

Figure 6: Extent of fire spread



Impairment of victims

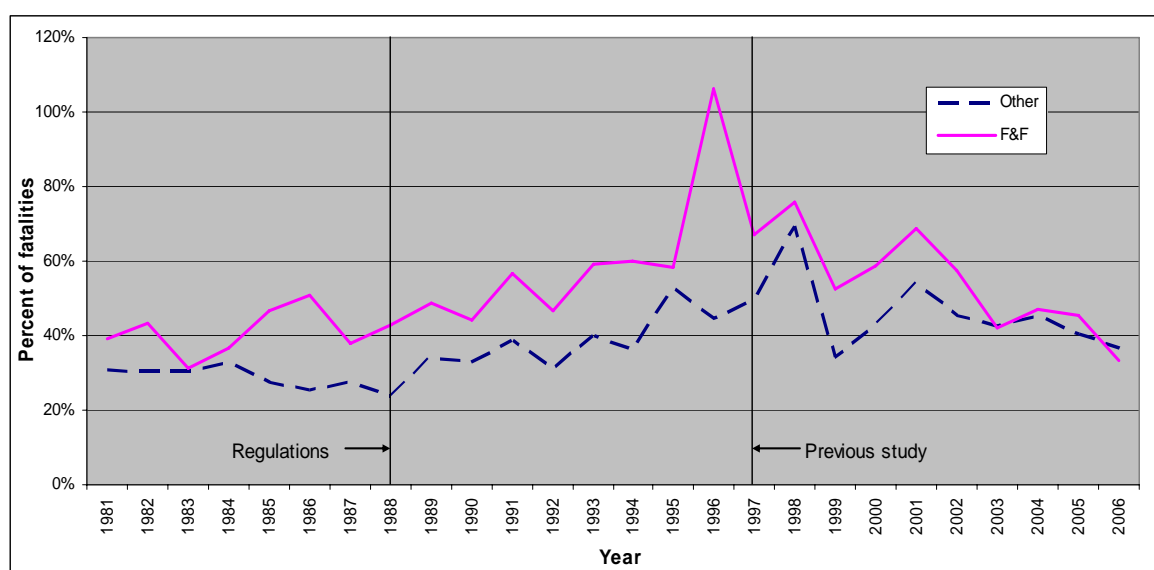
It was suggested that people may be impaired by alcohol or by being asleep and so need time to escape from a F&F fire, especially if they are intimate with the source of the fire (i.e. sitting on the furniture that has been ignited). Therefore, the proportion of casualties that were impaired was examined to see if impairment was and remains a particular feature of F&F fires.

Figure 7 shows the percentage of F&F and Other Fire fatalities between 1981 and 2006 where the victim was asleep or impaired by alcohol. It can be noted that:

- A greater percentage of F&F fire fatalities (i.e. 39%) occurred when people were impaired by sleep or alcohol than with Other Fires (i.e. 31%) before 1988;
- These both increased until 1997 when they both began to decrease; and
- F&F fire fatalities where people were impaired by sleep or alcohol remained higher than Other Fire fatalities until 2006.

Thus, there was some evidence that impairment was a greater factor in the case of F&F fires than Other Fires, and that this remained the case until 2003.

Figure 7: Alcohol and sleep impairment for fatalities – 1981 to 2006



It is clear that:

- The three F&F test requirements matched the main sources of ignition and the high lethality of F&F fires before 1988 and still match them;
- Cigarettes and matches remain the main sources of ignition, although some others have now increased in frequency;
- F&F fires remain more lethal than Other Fires;
- The number of F&F fires, deaths and casualties has declined, as has the lethality of F&F fires, and
- The specific sources of ignition targeted by the regulations have declined (e.g. cigarettes), whilst some "new" sources of ignition have increased.

The next section of this report explores statistical evidence regarding the extent to which the reduction in F&F fires and deaths can be attributed to the specific requirements of the FFRs.

3.4 Impact of the FFRs

3.4.1 Trends in the number of fires, deaths and casualties

The aim was to assess whether:

- There was a clear change in the F&F fires trend before and after the introduction of the FFRs, and
- The trend in the number of F&F fires was different to trends in Other Fires.

It can be noted that:

- The number of F&F fires rose before the introduction of the FFRs and declined afterwards;
- The trend in the number of F&F fires and fatalities was not significantly different to the trend in Other Fires; and
- The trend in F&F non-fatal casualties was significantly different to the trend in Other Fires, with F&F casualties falling and Other Fires casualties initially rising.
- Whilst F&F and Other Fires increased at the same rate before the introduction of the FFRs, F&F fires fell at a different rate afterwards, initially rising faster and then declining faster than Other Fires.
- The number of F&F fires fell by 38% compared to 12% for Other Fires;
- The number of F&F fatalities was rising before 1988, after which they fell, whilst Other Fire deaths were tending to fall across the entire period of 1981 to 2006 (as shown in Figure 8); and
- The trend in F&F non-fatal casualties was significantly different to the trend in Other Fires, with F&F casualties falling and Other Fires casualties initially rising (as shown in Figure 9).

Figure 8: Trend in F&F and Other Fires deaths

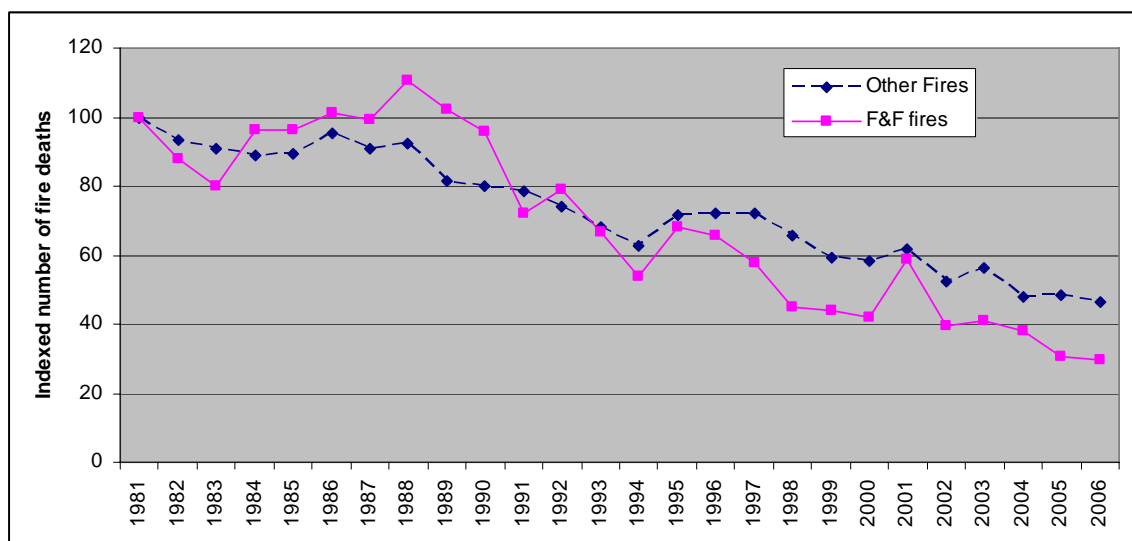
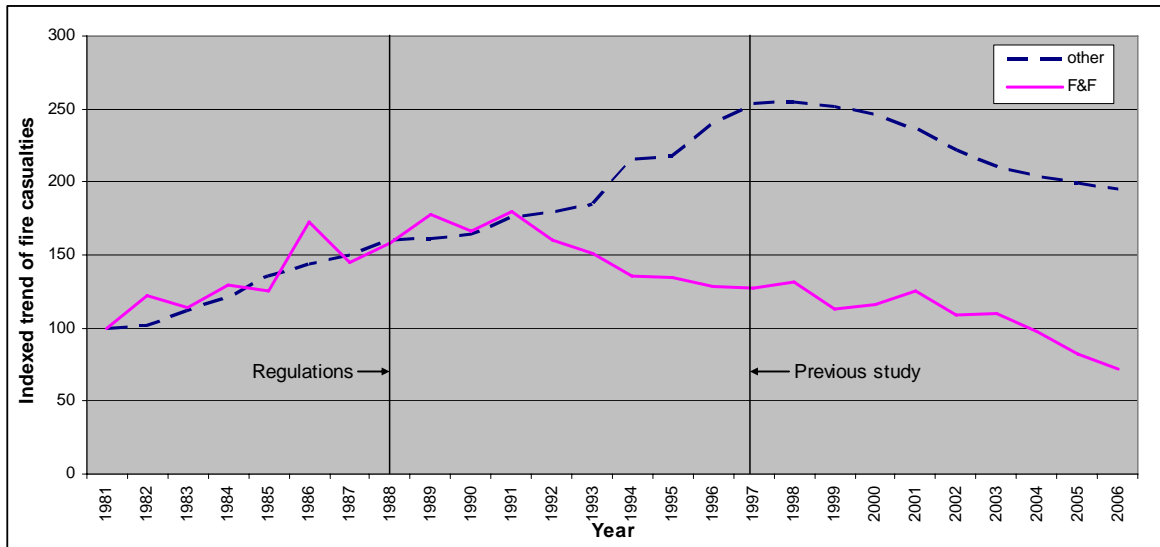


Figure 9: Trends in F&F and Other Fires non fatal casualties



Thus, there was a clear difference in the trends for F&F versus Other Fires. The next stages of analysis aimed to assess the reasons for these differences, as far as data permitted. Section 9.1 elaborates this part of the analysis.

3.4.2 Sources of ignition

The aim was to explore if those Sources of Ignition (SOI) targeted by the FFRs (cigarettes, matches and other stronger SOI) had declined overall and relative to other SOI. If the targeted SOI had declined more than other SOI this might indicate a specific impact of the regulations. As elaborated below, the SOI targeted by the FFRs did fall after their introduction, whilst other causes rose.

Figure 10 shows the average number of F&F fires caused by different SOI. The data have been presented for periods of five years, such as 1981 to 1985, to enable a clear presentation of trends.

Figure 10: Causes of F&F fires

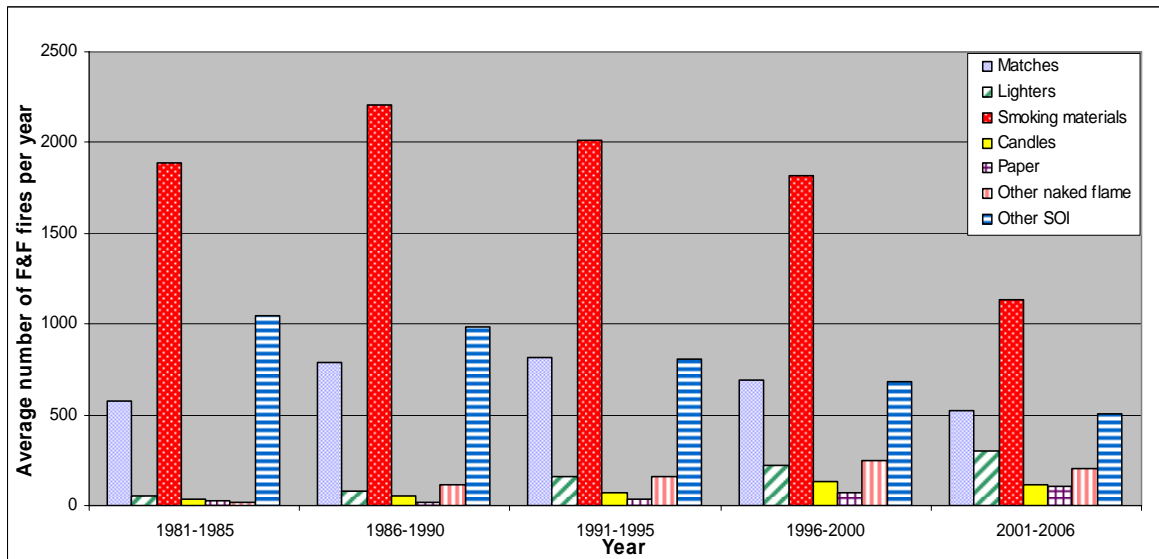


Figure 10 indicates that:

- The average number of F&F fires caused by smokers' materials increased in the years before the FFRs were introduced but started to decrease after;
- The average number of F&F fires caused by matches also increased before the FFRs but decreased after;
- The average number of F&F fires caused by other SOI steadily decreased between 1981 and 2006;
- The average number of F&F fires caused by lighters continued to increase between 1981 and 2006; and
- The average number of F&F fires caused by paper, candles and other naked flames generally increased over the years after the FFRs were introduced.

A similar result was found for F&F fire deaths and casualties.

Thus, the sources targeted by the FFRs (cigarettes, matches and other stronger sources) declined, whilst some other SOI rose. Care must be taken in interpreting this finding, as some of these trends could reflect societal change. For example, the increase in fires caused by lighters and candles might reflect their increased usage. Also, there has been a decline in the number of adult cigarette smokers in this period.

Section 9.2 elaborates this part of the analysis.

3.4.3 Material first ignited vs. material mainly responsible

The Crib 5 test guards against stronger ignition sources, such as where a fire spreads from one item to the F&F. Fire data is also available regarding which material was "Mainly Responsible" for a fire. For example, a match may ignite paper in a rubbish bin which spreads to a sofa. If burning of the sofa causes more damage than the bin fire, the sofa would be the item "Mainly Responsible" for the fire, whilst the paper in the bin would be the "Item First Ignited". It is possible for the Item First Ignited to also be the item Mainly Responsible for the fire, such as a sofa being ignited by matches and causing most of the fire damage. Therefore, this offers another way of assessing trends in the causes of F&F fires, and whether certain causes of fire targeted by the FFRs had changed more than other causes.

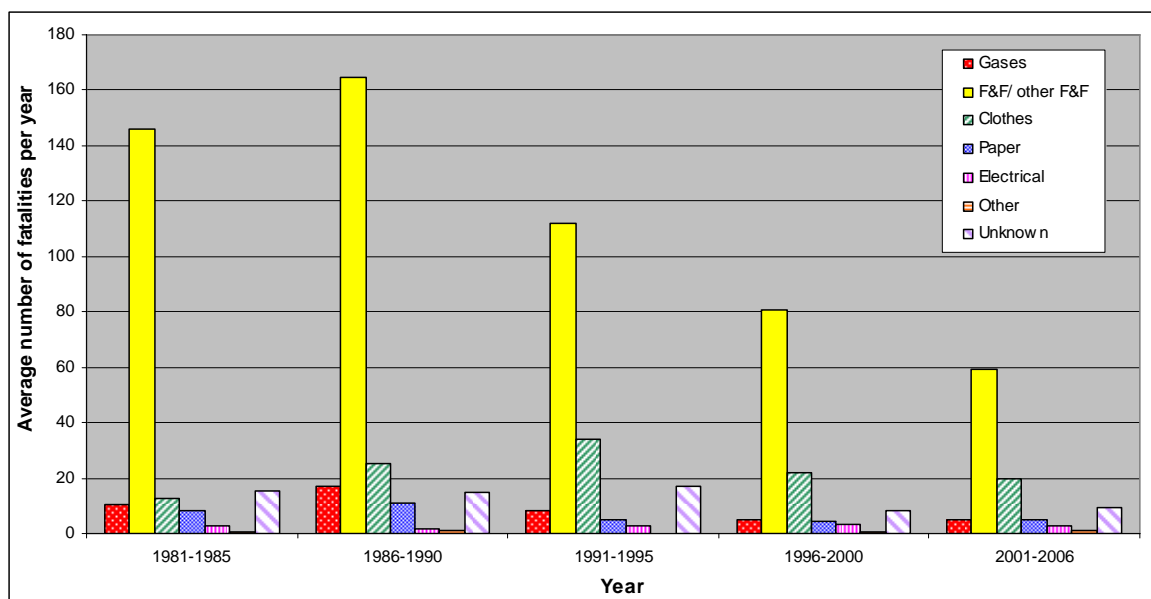
Figure 11 shows the average number of fatalities in F&F fires with differing materials first ignited.

Figure 11 It also shows that in most cases F&F was the Item First Ignited and the item Mainly Responsible for the fire. These increased in the years before the FFRs were introduced, but then decreased after they were in place. For example, the average number of fatalities in the periods 1981 to 1985 and 1985 to 1990 increased by 13%. By the period 2001 to 2006 this had decreased by 64%.

The changes in the profile of causes are consistent with the trends in the SOI for F&F fires.

Section 9.2.6 elaborates this part of the analysis.

Figure 11: F&F fire fatalities with material first ignited – 1981 to 2006



An analysis (see section 9.3.2) of the 'behaviours' associated with fires further supported these trends. That is, there was a clear fall in the role of 'careless handling' causing F&F fires. Moreover, the decline in 'careless handling' for F&F fire deaths exceeded the decline in 'careless handling' as a cause of Other Fire deaths.

3.4.4 Fewer adult smokers

Introduction

The number of F&F fires caused by smokers' materials declined after the FFRs were introduced. However, the number of adult smokers has also declined over the years. Therefore, analysis aimed at identifying whether the reduction in F&F fires caused by smokers' materials was attributable to the decline in adult smokers. This was done through:

- A trend comparison of smokers' related F&F fires and number of adult smokers;
- Identifying the rate of smokers' related F&F fires per million smokers; and
- Comparing the trend in F&F smokers' materials fires per million smokers with the same measure for Other Fires.

The latter analysis aimed to assess if the decline in smokers' materials fires per million smokers was greater for F&F than for Other Fires.

First, it can be noted from Table 1 that the rate of F&F smokers' materials fires fell by 6% more than the number of smokers.

Table 1: Change in number of smokers and rate of F&F smokers' materials fires per million smokers

	Average for 1982-1988	Average for 2004-2006	Change between 1982-88 and 2004-06
Number of adult smokers	18,251,434	13,841,096	-24%
Smoking F&F fires per million smokers	150.88	105.90	-30%

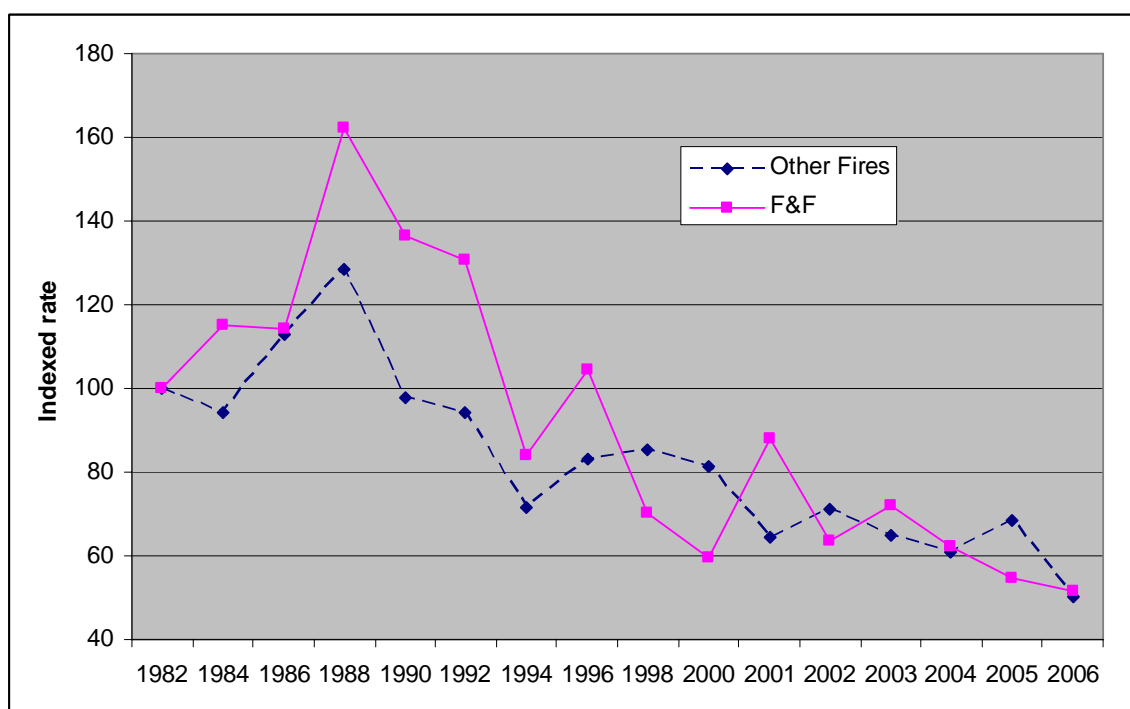
The number of adult smokers declined steadily across the study period. Figure 12 shows the indexed rate of fires involving matches or smokers' materials per million adult smokers for F&F and Other Fires. It was clear that:

- Before 1990 the number of fire deaths was rising despite a fall in the number of adult smokers; and
- After 1988 the number of fire deaths fell at about the same rate as the number of smokers.

Whilst the trends for F&F and Other Fires look similar, F&F fire deaths fell more than Other Fire deaths between 1982-88 and 2002-06. Overall, the rate of fire deaths per million smokers fell by 52% for F&F fires and 42% for Other Fires.

Thus, whilst the reduction in adult smokers was closely related to the fall in F&F fires, there was some evidence of a more marked decline in F&F fires than in Other Fires, and the decline in adult smokers was less than the decline in F&F fires and deaths. Therefore, the decline in adult smokers accounted for some but not all of the decline in F&F fires and deaths.

Figure 12: Indexed rate of smokers' materials fire deaths per million smokers for F&F and Other Fires



Section 9.3.3 elaborates this part of the analysis.

3.4.5 Furniture sales

The cost of furniture sales was analysed to determine if the value of furniture sold had changed since the FFRs were introduced and whether this had an impact on the number of F&F fires. The furniture sales were adjusted for inflation over the years. The sales were based on UK production for the UK and on imports. It was found that whilst F&F fires initially rose in line with increasing furniture sales, the number of fires after 1989 fell against a background of rising furniture sales.

Section 9.3.4 elaborates this part of the analysis.

3.4.6 Relative trends in deaths per fire

The potential impact of the Crib 5 test would be reflected by trends in the lethality of fires. Therefore, analysis was conducted to identify whether the reduction in the lethality of F&F fires between 1981 and 2006 exceeded that of Other Fires.

The trend in F&F fire deaths was volatile. This made it difficult to compare trends. Therefore, Table 2 shows the lethality rate for bands of years, and the amount of reduction in lethality over the review period. It was noted that:

- The lethality of F&F fires was steady or rising before 1988, after which lethality fell;
- The lethality of Other Fires declined at a steady rate between 1981 and 2006;
- The lethality for F&F fires declined at a greater rate than Other Fires. Taking the study period as a whole, the lethality of F&F fires fell by 48% compared to a 39% fall for Other Fires; and
- The lethality of F&F fires remains reasonably level after 1998. This is consistent with the view that a 10% replacement rate of furniture would mean that most non-compliant furniture might be scrapped by 1998, and so the decline in lethality might slacken off.

Table 2: Lethality of fires

	1981-88	1989-1993	1994-1997	1998-2001	2002-2006	Reduction between 1981-88 and 2002-2007
Deaths per Other Fire	0.0093	0.0070	0.0067	0.0059	0.0057	38%
Rate of change		0.76	0.95	0.88	0.97	
Deaths per F&F fire	0.0443	0.0331	0.0266	0.0225	0.0231	48%
Rate of change		0.75	0.80	0.85	1.03	

This provides some contextual support for the suggestion that the decline in lethality of F&F fires between 1988 and 1998 was associated with the FFRs, particularly the fire resistance requirements arising from the Crib 5 test.

An analysis of the proportion of people impaired by sleep or alcohol found that the reduction in lethality cannot be attributed to a decline in the involvement of impaired persons.

The next section explores the role of smoke alarms.

Section 9.4 elaborates this part of the analysis.

3.4.7 Role of smoke alarms in reducing lethality

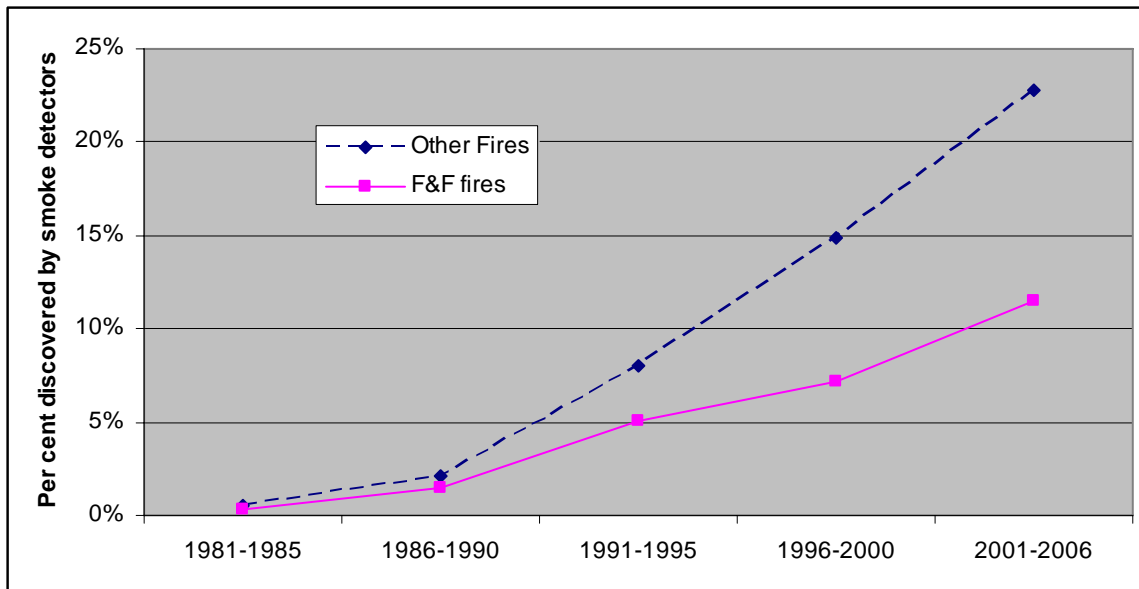
There was a continued and sustained increase in the installation of smoke alarms from the late 1980s to the early 2000s. This trend coincided with a Home Office mass media campaign promoting the purchase of smoke alarms. The aim here was to explore to what extent the increase in the installation and use of smoke alarms may be a reason why the number of F&F fatalities fell.

As a first step, analysis was conducted to identify if smoke alarms detected a significant amount of F&F fires. Figure 13 shows the proportion of fires discovered by alarms. It can be noted that:

- Whilst the proportion of fires discovered by smoke detectors rose for F&F and Other Fires, the vast majority of fires were discovered by people in both cases; and
- A far greater proportion of Other Fires were discovered by smoke detectors than F&F fires.

This therefore casts some doubt on whether the particular reduction in the lethality of F&F fires could be attributed to smoke detectors.

Figure 13: Comparison of trends in F&F and Other fires discovered by smoke detectors



As a second step the analysis estimated the number of lives saved by smoke alarms for F&F fires and for Other Fires. The lives saved by smoke alarms was estimated by calculating the fatality rate in F&F fires discovered by smoke alarms and for F&F fires discovered by people. The difference between these two rates equates to the reduction per fire in the fatality rate associated with smoke alarms. The calculation was repeated for Other Fires to give the following:

- Proportion of fall in deaths for F&F fires associated with smoke alarms = 3.3%
- Proportion of fall in deaths for Other Fires associated with smoke alarms = 17%

The lethality rate of fires fell by:

- For F&F fires - 48% in this period.
- For Other Fires - 41% in this period.

Thus, smoke alarms account for a small fraction of the fall in lethality of F&F fires and a larger proportion of the reduction in lethality of Other Fires.

Section 9.4.4 elaborates this part of the analysis.

3.4.8 Type of injury

Furniture and furnishings were thought to be more lethal and cause more injuries due to the production of toxic smoke associated with foam fillings and a greater spread of fire. This results in a greater proportion of deaths due to smoke. Therefore, the types of injury that caused fatalities and casualties in F&F fires and Other Fires were analysed to determine if the FFRs had an impact on the injury type in fires.

It was found that:

- The proportion of F&F fire deaths involving smoke fell by nearly the same amount as for burns, i.e. 65% for smoke and 67% for burns, between 1981-85 and 2001-06. Thus, there was no apparent additional fall in smoke-related fire deaths; and
- There was no significant difference between the trends in the number of F&F fires and Other Fire deaths due to smoke.

Thus, in the case of fire deaths, there was no clear evidence of a particular impact on smoke-related deaths.

However, in the case of casualties, there were clear differences, including:

- Precautionary checks rose for Other Fires remained higher, but remained level and then fell for F&F fires;
- Smoke injuries rose for Other Fires, but far less so for F&F fires, and F&F smoke injuries started to fall earlier than Other Fire smoke injuries; and
- F&F, other, burns and smoke types of injuries appear to follow similar trends.

Thus, the fact that the number of Other Fire injuries rose over the study period appears to be related to an increase in precautionary checks that is not apparent in the case of F&F fires. There was less evidence of an additional decline in F&F smoke injuries over and above burn or other types of F&F injuries, although there was some evidence of an earlier decrease in F&F than Other Fire smoke injuries.

Section 9.5 elaborates this part of the analysis.

3.4.9 Incidents averted

An assessment was completed of the reduction in fire deaths, casualties and fires that could be associated with the FFRs.

In particular, an estimate was made of the difference between the trends in the number of deaths, fires and non-fatal casualties for F&F fires versus Other Fires. It should be noted that:

- Whilst the trends in fatalities and fires were similar, the rate of F&F fatalities and fires did fall more than Other Fires between the periods 1981-85 and 2003-07. Also, smoke detectors accounted for a large part of the fall in Other Fire deaths but were a smaller part of the fall in F&F fire deaths;
- In addition, the number of non-fatal casualties for Other Fires was higher in 2003-07 than 1985-88, whilst the number of non-fatal casualties in F&F fires was less; and
- The number of F&F fires fell at a faster rate than Other Fires.

Therefore, this assessment was based on the assumptions that:

- Both F&F fires and Other Fires fell due to non-specific other factors, such as general improvement in residential fire safety; but the difference in the decline in fires between F&F fires and Other Fires could potentially be associated with the FFRs;
- The reduction in deaths per fire was mostly due to the FFRs in the case of F&F fires, but alarms had a major impact on Other Fire deaths. This was taken into account in this part of the assessment; and
- The decline in F&F casualties was associated with the FFRs, whilst Other Fire casualties rose due to factors unspecified in this analysis.

Overall result

The table below shows the reduction in the number of incidents per year and their value. Each incident was valued⁸ at:

- £1,375,000 per fatality;
- £72,689.83 per non-fatal casualty; and
- £8,507 per fire.

⁸ These values are taken from the Department for Communities and Local Government toolkit for FRS, "Local Target Setting: the development of a risk based model and toolkit for the fire and rescue service - Fire Research Series 4/2008" at: <http://www.communities.gov.uk/publications/fire/localtargetsetting>

Thus, the total value of averted incidents per year, as of 2002-2007, was £140,722,000. As with all benefit estimates this should be treated as an approximate and not an exact value.

Table 3: Reduction in incidents per year (as of 2002-07) associated with the FFRs

	Estimated reduction per year	Value (£) per year
Fewer fatalities	54	£75,000,179
Fewer casualties	780	£56,711,875
Fewer fires	1065	£9,059,961
Total		£140,772,016

The calculation of these values is shown in the Appendix at section 9.6.

The sub-division of these values between test 0, 1 and Crib 5 was estimated as:

- IS 0 (cigarettes): smokers' materials were 65% of deaths, 62% of fires and 62% casualties in 1985-88, which equates to:
 - 65% of the 31.5 reduction in F&F deaths attributed to fewer fires = 20.5 fewer deaths;
 - 62% of the reduction in casualties = 483 fewer casualties;
 - 62% of the reduction in fires = 660 fewer fires.

This equates to a value of £69m per year.

- IS 1 (matches): matches were 11% of F&F fire deaths, 15% of casualties and 14.5% of fires in 1985-88, which equates to:
 - 11% of the 31.5 reduction in F&F deaths attributed to fewer fires = 3.5 fewer deaths;
 - 15% of the reduction in casualties = 117 fewer casualties;
 - 14.5% of the reduction in fires = 154 fewer fires.

This equates to a value of £14.6m per year.

- Crib 5: the estimate is based on the reduction in lethality per fire and the reduction in fires involving other SOI:
 - Reduction in lethality: 22 of the averted deaths related to the reduction in lethality and 21% of the total value of averted incidents.
 - Reduction in other SOI were 24% of deaths, 23% of casualties and 24% of fires, which equates to:
 - 24% of the 31.5 related to the reduction in the number of F&F fires = 7.6 fewer F&F deaths;
 - 23% of the reduction in casualties = 179 fewer casualties;
 - 24% of the reduction in fires = 255 fewer fires.

This equates to a value of £56m per year.

These estimates assumed that the Crib 5 test made no contribution to the reduction in match and cigarette fires, and that all Other Fires (excluding matches and smokers' materials) were impacted solely by Crib 5. These assumptions may be simplistic and so the estimates should be treated as approximations only.

4 CONCLUSIONS

The main conclusions are that:

- The match, cigarette and Crib 5 tests match the features of F&F fires in that:
 - Matches and cigarettes are the main SOI for F&F fires –as covered by test 0 (match) and 1 (cigarette);
 - Other sources such as paper, candles and lighters also cause a significant proportion of F&F fires (as covered by the Crib 5 test); and
 - F&F fires are more lethal and more likely to spread further than Other Fires, noting that Crib 5 is intended to test for fire resistance and fire growth.
- Whilst the frequency and lethality of F&F fires have fallen, they remain more lethal than Other Fires, and matches/cigarettes remain the main SOI. Indeed, a number of SOI have risen, such as lighters and candles, suggesting that some risk factors are rising rather than falling.
- There are differences in the F&F fires, deaths and casualties trends when compared to Other Fires, which may indicate an impact of the FFRs over and above other factors.
- Only a small part of the reduction in lethality can be attributed to smoke alarms in the case of F&F fires, with a larger proportion attributed to alarms in case of Other Fires.
- There was a particular fall in the lethality of F&F fires, which may relate to the impact of the Crib 5 test on restricting fire growth.

Overall, in the period 2002-07, the analysis suggests that the FFRs account for:

- 54 fewer deaths per year;
- 780 fewer non-fatal casualties per year ,and
- 1,065 fewer fires each year.

This was valued⁹ at about £140m per year.

Of this:

- 50% was attributed to the cigarette test;
- 10% to the match test; and
- 40% to the Crib 5 test.

These estimates are approximations and should not be treated as literal or exact values.

⁹ These values are taken from the Department for Communities and Local Government toolkit for FRS, "Local Target Setting: the development of a risk based model and toolkit for the fire and rescue service - Fire Research Series 4/2008" at: <http://www.communities.gov.uk/publications/fire/localtargetsetting>

5 APPENDIX A – SUMMARY OF STAKEHOLDER CONSULTATION

5.1 Introduction

This summary includes a variety of opinions from the stakeholders. It does not necessarily represent the opinion of each stakeholder and does not attempt to quantify the level of agreement.

5.2 Current effectiveness of the ignition tests

There were mixed views regarding the current effectiveness of the ignition tests. A few stakeholders felt that the tests were out of date and needed to be updated. This was because some of the tests cannot be replicated properly anymore. It was felt that some modern materials and products do challenge the tests as not being suitable for the test methods (for example, air-filled furniture). Also, one stakeholder noted that at present there is a lot of detail in the FFRs, where instead the regulations should refer people to a particular standard. Over time, the standards can be updated as needed rather than changing the whole regulations. Some felt that the FFRs need to be more performance- or goal-based.

One stakeholder also noted that the tests were robust as they test for worst case scenarios.

One stakeholder felt that whilst the match tests and the cigarette tests are effective ways of measuring fire resistance, these were not thought to be the most important tests. The Crib 5 test was the most important test as it identified the behaviour the filling would have post-ignition.

Overall, it was felt that the ignition tests were effective and that they have saved many lives over the years since the FFRs were introduced.

5.3 The Crib 5 test

5.3.1 What fire scenarios does the Crib 5 test replicate?

There were mixed views on what fire scenarios the Crib 5 test replicates, these included:

- A fire caused by matches and cigarettes on fabric including mattresses and bed covers;
- A fire, not necessarily the item first ignited but may become involved as a fire develops;
- Ignited newspaper, clothing, cardboard, non-flame retardant waste bin or heater on or very near the furniture product, producing much more heat than a match or a cigarette;
- Approximately two sheets of full sized newspaper;
- Not a specific fire scenario, however, is meant to be a more intense ignition source than a flame or a cigarette; and
- Burns from cigarettes.

5.3.2 Is the Crib 5 test a valid method?

The stakeholders were asked if they felt the Crib 5 test was a valid method for assessing whether the product protects against the fire scenarios. Views were mixed, including:

- The test does not effectively replicate a fire scenario but is effective in ensuring that a material is fire retardant;
- One stakeholder felt that the tests were not valid, because the only way to prove if a product is compliant is to destroy it, i.e. it's the method of the test that is the problem, not the test itself;
- Others felt that the test was very reasonable and that there are better quality products around as a result. One stakeholder felt that they would "rather be safe than sorry";
- One stakeholder felt that the tests were not representative but compensated for this because the tests were very consistent across the UK and therefore comparisons can be made between different areas and different people; and
- The Crib 5 test was thought to be a good rough indicator. However, it was also felt that the Crib 5 test could be simplified by removing some of the complications and burdens on the furniture industry. One suggestion was to ensure that manufacturers provide covering materials to relevant fire resistant standards and filling materials with appropriate post-fire behaviour. This would mean that the furniture industry would be able to change designs as long as all the materials used are to a certain standard.

5.3.3 Justification of the Crib 5 test

It was felt that the Crib 5 test is perfectly justified and that the safety of UK furniture outclasses furniture in the rest of Europe.

One stakeholder noted that the justification of the Crib 5 test is that the UK has a better fire safety record than the rest of Europe. Another stakeholder felt that the Crib 5 test was the most important test because the cover fabric of furniture is not the most critical factor with regard to the impact foam-filled furniture has on fire growth, heat release and products of combustion.

However, others were not so sure if the Crib 5 test was needed. One stakeholder questioned why the UK sets higher standards than Europe; that the UK needs to justify these extra regulations. However, another stakeholder thought that Europe should pay for a review to disprove the effectiveness of the Crib 5 test, rather than the UK pay for a review to prove the effectiveness of them.

Finally, one stakeholder felt that removing the Crib 5 test would be a backwards step in terms of fire safety.

5.3.4 What measures should this study be looking at?

Stakeholders' suggestions included:

- Looking at the number of fires and fatal fires to see if the furniture was/wasn't compliant with the FFRs over a period of time;
- Analysing fire statistics and comparing them against statistics from other countries that do not have the Crib 5 test;

- Comparing the rate of fire development vs. the rate of fire injuries;
- Reviewing other research;
- Looking at the extent of fire and smoke/damage spread using FDR1 data;
- Looking at fire-fighter injury and death statistics; and
- Assessing the number of fires in the UK where multiple occupants have been killed due to rapid fire and smoke spread.

5.4 Changes in fires and casualties

5.4.1 Role of the FFRs in the reduction of F&F fires and fire fatalities

It was felt that the FFRs do have a continuing role in reducing the number of F&F fires and fire fatalities. Also, that although they will continue to reduce fires, fires will never be completely stopped because curtains do not have to comply.

One stakeholder felt that evidence from other research and their organisations' own experiences suggest that the FFRs continue to have a significant role in reducing fires involving F&F.

One stakeholder felt that the FFRs are out of date and need reviewing, and there is an assumption that everyone is complying with them.

5.4.2 Additional factors contributing to changes in fire trends

There were several suggestions of what may have contributed to changes in fire trends, including:

- People are less safety-conscious because they now think everything in the home is safe;
- People drink more alcohol at home;
- People smoke less;
- People smoke less indoors due to cultural change;
- There are fewer open fires;
- There are more smoke detectors;
- People are more educated on the risks of fires in the home due to National Fire Safety adverts for example;
- The strength of cigarettes has reduced;
- There are more Home Fire Risk Checks;
- The introduction of child-safe lighters;
- The increasing use of candles;
- Changes in domestic heating;
- Improvements in the design of electrical products and wiring;
- Greater migrant populations; and

- An aging population.

5.5 Any comments on the proposed method

Generally, stakeholders did not have any comments on the proposed method for this study, although one stakeholder thought it was good.

One stakeholder felt that the findings should be interesting but had concerns over the validity of them due to the use of FDR1 data, in that it may prove difficult to attribute cause and effect, specifically to individual factors applied over time in conjunction with each other.

As noted previously, it was suggested that this study should consider comparisons with other countries that do not have similar legislation for Crib 5 tests. The same stakeholder also suggested looking at other research that has been carried out and comparing the findings from this study to them.

One stakeholder suggested that the following be taken into consideration in the method:

- How long it would have taken PU furniture to be replaced with combustion modified furniture after the regulations were introduced in 1988;
- Data prior to 1988 and when PU foam furniture ownership would have increased;
- Trends in dwelling fire reductions (for example, less damage, less reported small fires);
- Average speed of fire development over time since 1980; and
- Toxic smoke and fumes as well as fire spread.

6 APPENDIX B – F&F FIRE FATALITY CASE STUDIES

6.1 Case study 1

The following case study is of an F&F fire fatality taken from a Fire Investigation Report by Hertfordshire FRS in 2002.

Details of victim

The victim was a 62 year old male who had lived alone for a number of years - a heavy drinker, often under the influence of alcohol for several days at a time; also a heavy smoker. When under the influence of alcohol, he was known to use a wheelchair for support. He was under daily care with the Adult Care Centre and received daily visits from Meals on Wheels.

Details of dwelling

The dwelling was a single storey detached bungalow in a state of disrepair with long term disruption to basic services such as lighting, heating and sanitation. Electric lighting to the lounge and hallway were known to have been faulty for some months.

The lounge was the room mainly occupied, where torches and candles were used for lighting.

Details of fire

The area of origin of the fire was the left-hand seating of a two-seater settee, between the arm and the back. There were many potential sources of ignition of the fire such as roll up cigarettes, electrical faults and candles.

Extensive burning was found to the back and inside the arm of the left hand side of the settee, as well as to the horizontal surface of the seat. These burning patterns indicated a slow smouldering fire spreading along the vertical back of the settee and arms, across a horse blanket laid between the settee and chair and to the vertical surfaces of an easy chair. Heavy soot deposits were found on all horizontal surfaces, indicative of a fire with low heat release.

The fire was confined to the room of origin at ground floor level, with the lounge being heavily damaged by smoke. The hallway and kitchen showed signs of smoke damage but to a lesser degree.

Details of furniture and furnishings

The construction of the easy chairs and settee was the standard timber framework with metal strutting for seat support. They had polystyrene foam seating with loose cotton covers believed to be prior to the FFRs.

Fire discovery

It was believed that on discovering the room had been heavily smoke-logged, the victim rose from the settee into the smoke layer, stumbled one or two steps using the wheelchair for support, then reached for the door handle and fell backwards and sideways colliding with the wheelchair and on to the ground. The victim was found at the doorway of the room of origin (lounge).

The incident was discovered by a care worker on her routine visit.

Injury details

The victim was found deceased and had suffered no physical burns to the body. There was however, evidence of smoke inhalation.

6.2 Case study 2

The following case study is of an F&F fire fatality was taken from a Fire Investigation Report by London FRS in 2002.

Details of victim

The victim was a 74 year old male reported to live in the dwelling with his daughter. A toxicology report indicated the presence of a very high alcohol level in the blood of the victim. The victim was not believed to have smoked; however, his partner did smoke.

Details of dwelling

The dwelling was a five room maisonette, located on the second and third floor in a medium risk block of purpose built flats consisting of four floors, 200 metres by 40 metres, built around 1980.

Gas central heating was present in the maisonette in the form of radiators. There was also a small wall-mounted electric fire situated in the second floor lounge area.

Details of fire

The area of origin of the fire was the right hand side of a settee located in the lounge on the second floor. It is believed that the source of ignition was the application of a naked flame to the upholstery of the settee. All the fabric and polyurethane foam of the settee was consumed by the fire.

There was an arc of fire damage to the rear of the door of the lounge which indicated that the fire started at a relatively low level. However, the fire developed into a fast flaming fire.

The fire was confined to the room of origin and this was severely damaged by the fire. There was evidence of heat and smoke damage to the bedroom on the third floor.

Fire discovery

Office workers noticed a smell in their building and later saw smoke coming from a flat in the block. They contacted the fire brigade. Several members of the public also noticed smoke coming from a flat in the building and called the fire brigade.

Two smoke alarms had been recently fitted in the property. These were mains alarms and believed to be fully operational. A site contractor working on an adjacent block heard the smoke alarm sounding.

The fire crew found the victim slumped in his bed on the third floor. He was rescued from the flat by the crew, who proceeded to perform CPR until the Ambulance crew arrived. It was believed that the high blood alcohol level of the victim was the reason of his lack of response to the smell of smoke and noise of the smoke alarms in the property.

6.3 Case study 3

The following case study is of an F&F fire fatality taken from a fire investigation report by London FRS in 2004.

Details of victim

The victim was a 61 year old male, a heavy smoker who also suffered from asthma, angina, diabetes, depression and who required walking sticks. He spent most of his time in his armchair, within the lounge, smoking. He always took medication between the hours of 21.30 and 23.30 which made him drowsy.

Details of dwelling

The dwelling was a four room ground floor flat within a semi-detached two-storey maisonette. The building was of brick construction, built around 1940.

The room of origin contained various items of furniture and was carpeted throughout. It was in a state of untidiness with papers, books, clothing and other items on all flat surfaces. Cigarettes and matches were lying around and a full ashtray was on the floor.

Details of fire

The main area of fire damage was contained within a two-seater settee with a slight spread to papers to the left of the adjacent armchair. Accidental ignition by a cigarette appeared to be the most likely cause.

The backrest cushion of the chair was completely destroyed, down to the supporting timbers at floor level. The fire had begun to melt the plastic base covering underneath, towards the front of the furniture. The ceiling and high levels in the room were heavily deposited and severely damaged by heat, including the net curtains on the far side of the lounge which had melted and fallen.

Due to the supporting timbers of the settee remaining relatively intact, it was suggested that the fire was a free-burning flaming fire within the furniture.

Details of furniture and furnishings

The settee and armrest of the settee were constructed from fabric covered by solid PVC foam. No labelling was apparent on the furniture to enable identification of the fire resistance of the materials.

Fire discovery

A neighbour of the victim heard a smoke alarm and later saw smoke issuing from a vent in the property. She contacted the fire brigade. The upstairs occupant also heard a loud bang and saw smoke rising from the victim's floor. He rang Emergency Services who also contacted the fire brigade.

The fire crew found a fire within the lounge area and then located a man lying unconscious in the kitchen. It is believed that the victim took his medication and dozed in his armchair smoking a cigarette. He then awoke perhaps due to the activation of his smoke alarm and found himself in heavy smoke, suffering from the effects of his medication and lack of oxygen. In an effort to escape he exited the room but in confusion turned into the kitchen instead of turning to the front door. He then collapsed in the kitchen due to the effects of smoke inhalation.

Injury details

The victim was rescued and removed from the fire scene. CPR was then carried out until the Ambulance Service arrived and took him to hospital. He later died as a result of damage to his lungs due to smoke inhalation.

6.4 Case study 4

The following case study is of an F&F fire fatality taken from a fire investigation report by Greater Manchester FRS in 2004.

Details of victim

The victims of the fire were a 21 year old female, her two children (a 3 year old boy and a 1 year old girl) and a 4 year old boy who was the son of the registered tenant. A fourth child (a 10 year old boy) was also in the property at the time of the fire but escaped.

Three adults lived in the property and all shared responsibility for the four children also living there. Social services and the police had been involved with the family due to domestic disturbances. The children also exhibited considerable fire play behaviour, such as lighting toilet paper, singeing dolls' hair, igniting paper with a magnifying glass and igniting items of furniture and bedding. A fire incident took place a week before the fire in question but was extinguished by the family and not reported at the time to the fire service.

Details of dwelling

The dwelling was a semi-detached house owned by the council. The house was cluttered due to extra residents and general untidiness. Children's bicycles were in the hallway/porch making it a 'tight squeeze'. There was no smoke alarm in the property.

Due to the arrangement of the properties as a small square, fire appliances were not able to park at the front or the rear of the property. As a result, hose reel equipment had to be extended from the end terrace location.

Details of fire

The fire originated in the lounge/dining area close to or underneath a pine table. It is believed that the source of ignition was a child playing with matches.

The fire developed quickly due to a plentiful supply of oxygen provided by open windows, the door from the lounge to the kitchen also being open and the door from the lounge to the hallway having been removed. Cross-ventilation also took place due to front door being left open.

The hot gases and smoke vented from the lounge into the kitchen and hallway, up the stairwell to the first floor, igniting all combustible materials in these areas.

Details of furniture and furnishings

The pine table had slight scorching to its top surface with areas that had been protected by crockery, indicating that the table was upright. The underneath of the table had deep charring. Carpet covering the floor close to the pine table was destroyed, and the fire spread from the table to an armchair and small slatted table.

Fire discovery

One adult and four children were in the property at the time of the fire. All were upstairs apart from the child who started the fire in the downstairs lounge. The others became aware that a fire had occurred in the lounge and went downstairs to investigate. On discovery of the fire they escaped via the front door, leaving the doors open. They alerted neighbours about the fire who then rang the fire brigade.

The adult re-entered the property in attempt to rescue the children and gained access to the first floor. However, due to the rapid development of the fire she was then trapped.

Fire crew later found the bodies of one adult and two children in the bedroom. The body of the fourth child was found in the bathroom at the head of the landing.

6.5 Case study 5

The following case study is of an F&F fire fatality taken from a fire investigation report by greater Lancashire FRS in 2002.

Details of victim

The victim was a 44 year old man. A 53 year old woman was also in the property at the time of the fire but survived, despite suffering from smoke inhalation.

Both occupants were smokers and in an intoxicated state at the time if the fire.

Details of dwelling

The dwelling was a mid terrace private house built around 1900, constructed of stone walls with slated and battened roof, with part-stone part-timber floors.

Upholstered furniture was present, rubbish was strewn on the floor and the doors were left open. No domestic smoke alarm was fitted in the property.

Details of fire

The area of origin of the fire was the ground floor front living room. The source of ignition was believed to be an inspection lamp without a protective cage that was used as a temporary or extra light, placed on an upholstered chair. Due to being left unattended or due to the intoxicated state of the occupants, the chair was ignited and quickly developed. The open doors and rubbish on the floor allowed the fire to reach severe proportions and spread heat and smoke throughout the premises.

Details of furniture and furnishings

The chairs in the room of origin contained non-modified PU foam and were covered in non-flame retardant upholstery.

Fire discovery

Smoke was seen issuing from the building by a neighbour who then called emergency services. Several other calls regarding the incident were also made by other neighbours. On arrival of the fire service, one occupant was being led from the building by two neighbours. The deceased victim was later found by the fire crew in the downstairs living room.

6.6 Case study 6

The following case study is of an F&F fire fatality taken from a fire investigation report by Suffolk FRS in 2003.

Details of victim

The victim was a 2 year old boy. His mother (23), father (33) and 3 year old brother were also in the property at the time of the fire but escaped.

The mother was known to be on anti-depressants and other medication, and was known to Social Services who had visited the property the day before the fire. Evidence of drug use was also found at the property.

The 3 year old boy had previously been involved in 'fire play' with smokers' materials.

Details of dwelling

The dwelling was a local authority-owned two storey, two bedroom terrace house. It was modern style, constructed of brick and tile and built around 1970. The general housekeeping was of a very poor standard and there was a battery-operated smoke detector in the ground floor hallway disabled due to a disconnected terminal.

Smokers' materials were found throughout the property, including in the children's bedrooms.

Details of fire

The room of origin was the children's bedroom at the front of the property at first floor level. Struck and live matches were found in the room and a matchbox was found in the hallway at first floor level.

It is believed that the fire started due to unattended children playing with matches. The area of greatest and most prolonged burning was in a mattress, suitcase and contents at floor level. The fire could have started in the mattress, foam pillow or suitcase and contents. It then spread from the floor level mattress to the adjacent mattress supported by the bed frame. A further seat of fire was located on a futon, on the top surface of the fabric.

The colour and nature of the smoke damage of the room suggested that the fire was burning rich. The development of the fire appeared to be relatively slow and smouldering, with evolving toxic fumes smoke fumes and gas.

Details of furniture and furnishings

The futon was modern enough to be fire retardant and an attached label confirmed this to be the case. This may explain why the item did not become fully involved in the fire.

Fire discovery

Both parents were asleep in bed at the time the fire started. They were alerted to the situation by the older son but by then it was too late to control.

The older son attempted to reach the victim but was unsuccessful and evacuated the property via the staircase and front door. The parents evacuated the property via the casement window in the parents' bedroom. The victim was later found by fire crew on the futon in the room of origin.

Injury details

All survivors were suffering from the effects of smoke inhalation. The victim suffered up to 70% burns and severe smoke inhalation.

6.7 Case study 7

The following case study is of an F&F fire fatality taken from a fire investigation report by London FRS in 2002.

Details of victim

The victim was an adult male.

Details of dwelling

The dwelling was a mid-terrace three bedroom house on two floors, constructed of brick walls with a pitched tile on timber roof, built around 1900.

There was evidence of excessive hoarding throughout the house. The downstairs living room was piled so high with items that only half of the window was visible. There was no access to the back of the room because of the stored items.

There was evidence of smoking inside the room of origin, i.e. cigarette packs and disposable lighters, as well as beer cans on the floor and bed. The floor was also covered with newspaper.

There was a smoke alarm present in the front bedroom on the first floor; however, the battery had been removed.

Details of fire

The fire originated in the back bedroom on the first floor. It appeared to originate under the window, near the head of the bed. From there the fire spread from a low level to involve the bed on one side of the room and the fitted wardrobe on the other side. It was mainly confined to the room, however there was some damage to the roof area as a result of the fire spreading through the bedroom window, up the outside of the building. There was smoke damage to the landing of the first floor and to the bathroom. The other bedrooms were not badly affected by smoke damage due to the doors to those rooms being closed.

It was believed that the source of the fire was careless discarding of cigarettes or use of ignition sources. This may have happened as a result of the victim falling asleep after drinking and smoking.

Details of furniture and furnishings

The room was furnished with a pine bunk bed, a chest of drawers, a fitted wardrobe and a wooden unit with sliding doors.

Fire discovery

Multiple calls were received by the fire service notifying them of the fires. No information was provided regarding who made these calls.

The victim was found by fire crew slumped behind the door to the room of origin.

Injury details

The victim was reported to have suffered from severe smoke inhalation.

6.8 Case study 8

The following case study is of an F&F fire fatality taken from a fire investigation report by Greater Manchester FRS in 2005.

Details of victim

The victim was an 87 year old female who lived alone. She suffered from dementia and took tablets for a thyroid problem. She had suffered two falls after which her health had declined more noticeably. She drank around a bottle of whisky a week and smoked 10-20 cigarettes a day.

Her niece and her husband visited the victim on a daily basis. One week before the fire a burn was discovered in an armchair.

Details of dwelling

The property was a purpose built flat in a private three storey building. Cigarette ash was often seen on the floor of the lounge near the armchairs.

Details of fire

The origin of the fire was in the lounge. It is thought that the victim fell asleep in an armchair and her lit cigarette dropped onto the seat cushion.

The main area of burning was the armchair with around one third of the seat cushion burnt through, penetrating the base with burning extending up the left arm and back of the chair. There were four feather-filled cushions on the armchair which the fabric had burned away exposing the feathers. Another armchair also suffered damage to the front and base. The seat cushion upholstery had burned away exposing the foam filling.

The fire developed in the form of a slow smouldering fire. Once flaming occurred the fire spread up the victim's clothing and the arm and back of the chair. Toxic fumes and smoke were generated.

On arrival, fire crew discovered light smoke in the hallway and the room of origin was heavily smoke logged.

Details of furniture and furnishings

The armchair was part of a three piece suite purchased in 1985, therefore it did not comply with the current FFRs.

Fire discovery

The victim became aware of the fire when her clothes started to burn. She attempted to escape but was unable to and collapsed. A neighbour heard the smoke alarm and rang the fire brigade.

6.9 Case study 9

The following case study is of an F&F fire fatality taken from a fire investigation report by Staffordshire FRS in 2003.

Details of victim

The victim was a 57 year old man who lived alone. He had failing health and until recently had been looked after by his brother. He had attended a residential course on 'personal skills' run by a local mental health care unit. He was also known to smoke and drink.

Details of dwelling

The dwelling was a mid-terrace house of traditional construction. Candles were used for lighting throughout the property and empty cider bottles and evidence of smokers' materials were found in the premises. The living room contained various items of furniture and fittings, together with plastic bags containing waste.

Details of fire

It was believed that the fire was caused by accidental ignition due to the victim leaving a lighted candle on the floor adjacent to the sofa. Materials covering the sofa and combustible materials stored in a small base unit at the side of the sofa would have then become involved in the fire. This area was adjacent to the door leading to the stairs, where significant burning occurred.

The sofa was ignited at a low level, with the fire spreading upwards and involving the victim.

Fire discovery

The victim's ability to recognise and respond to the developing fire may have been impeded due to medication and or alcohol.

Fire crews forced their way into the building, finding a ground floor living room involved in a fire.

Details of furniture and furnishings

The sofa's wooden frame at floor level was found charred.

Injury details

The victim was found lying on the sofa, suffering approximately 80% burns.

6.10 Case study 10

The following case study is of an F&F fire fatality taken from a fire investigation report by Leicestershire FRS in 2002.

Details of victim

The victim was a 79 year old female who lived alone.

Details of dwelling

The dwelling was a two-storey private house. It was built around 1960 and constructed of brick walls, concrete and timber floor and timber and tile roof.

The house was fitted with a domestic smoke alarm.

Details of fire

The fire originated in or close to the hearth in the lounge. The victim fed the open fire in the hearth with a length of timber from a broken up window frame. Due to the length of the timber (1 to 2 metres) it was not possible to put it completely in the fire and a part-burned piece was found sticking out of the grate. The paint on the timber had ignited and spread to ignite the fabric and fillings of a nearby armchair. The chair cushions and adjacent ironing board were badly damaged and the resulting heat and smoke filled the room.

The fire was confined to the room of origin, as the fire brigade were called early and managed to prevent the development of the fire. Burn patterns were found to the wall and ceiling and the rest of the room was severely damaged by flames and heat at a high level and by smoke at a lower level.

Fire discovery

The domestic smoke alarm fitted in the house failed to operate.

Neighbours noticed smoke coming from the house and a fire in the ground floor front room. They then called the fire brigade.

The victim was immediately located alive in the hallway of the property and rescued by fire crew.

Injury details

The victim suffered the effects of smoke inhalation and burns to her hands and arms. She was given oxygen and taken by ambulance to hospital where she later died.

7 APPENDIX C: A RETROSPECTIVE OF F&F FIRES BEFORE 1988

7.1 Introduction

This appendix re-examines UK fire data for the period 1981 to 1987, in order to explore the extent to which the FFRs matched the causes and factors associated with F&F fires, and whether F&F fires were more lethal than Other Fires.

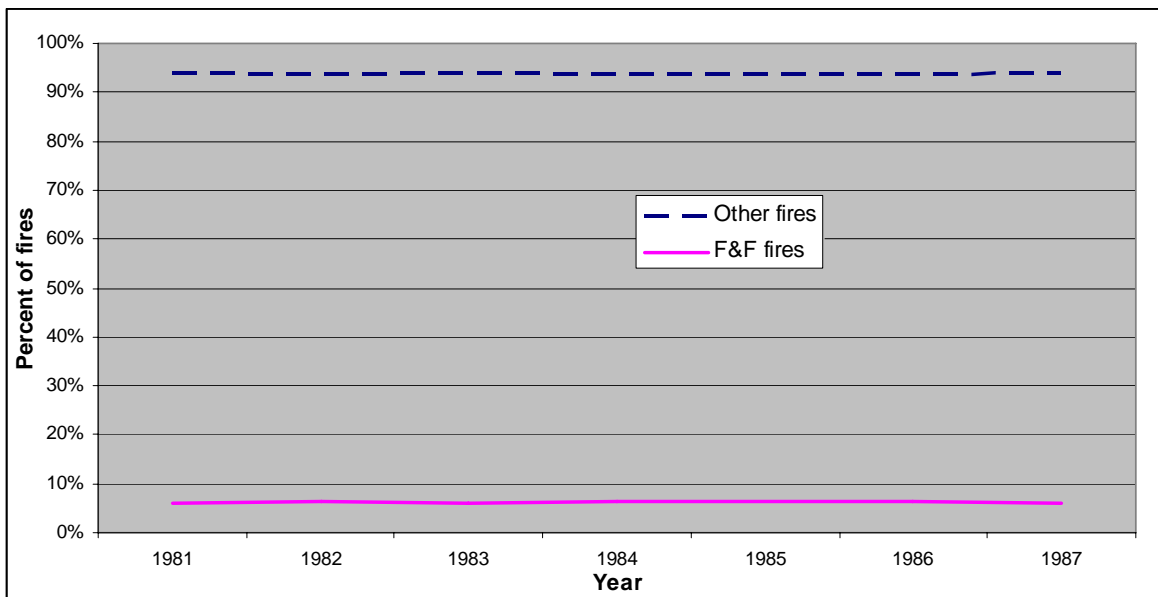
7.2 Number of furniture and furnishings fires, deaths and casualties

Analysis was conducted to determine if F&F fires were a risk. Data was analysed to identify whether a significant amount of fires, fire deaths and fire casualties occurred where the items first ignited were furniture and furnishings.

Fires

Figure 14 shows the percentage of F&F fires and Other Fires that occurred in the years before the FFRs were introduced.

Figure 14: Percentage of F&F and Other Fires

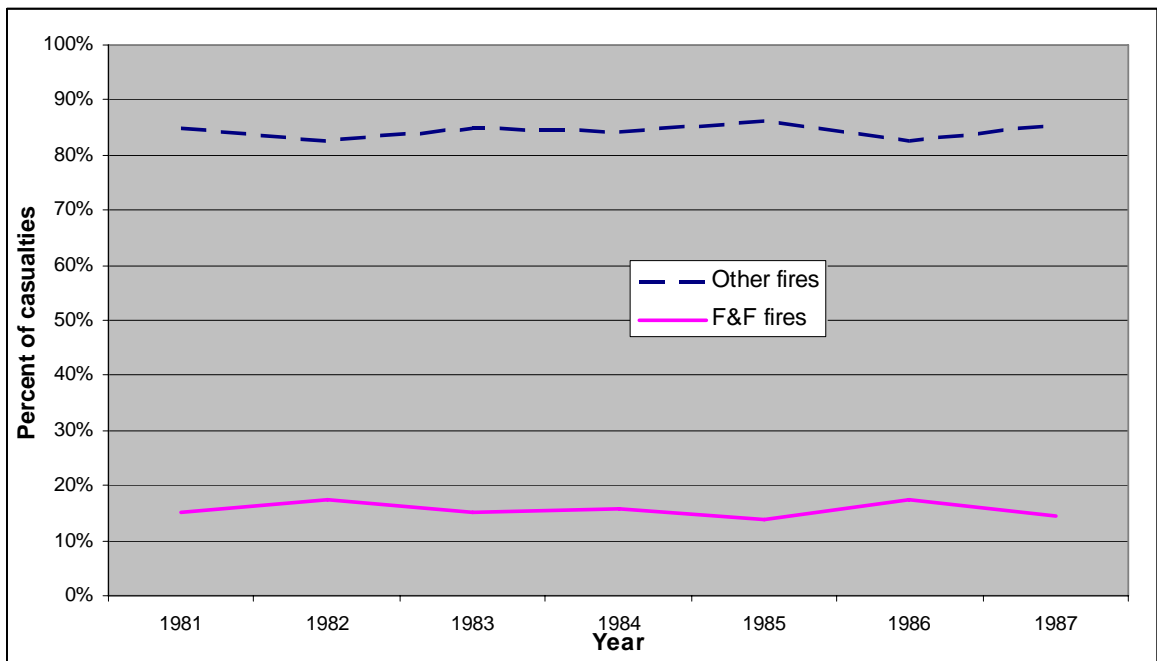


It can be seen from Figure 14 that between 1981 and 1987 there was a much larger percentage of Other Fires than F&F fires: around 93% of Other Fires, whereas there were around 6% of F&F fires.

Casualties

Figure 15 shows the percentage of F&F and Other Fire casualties that occurred before the FFRs were introduced.

Figure 15: Percentage of F&F and Other Fire casualties

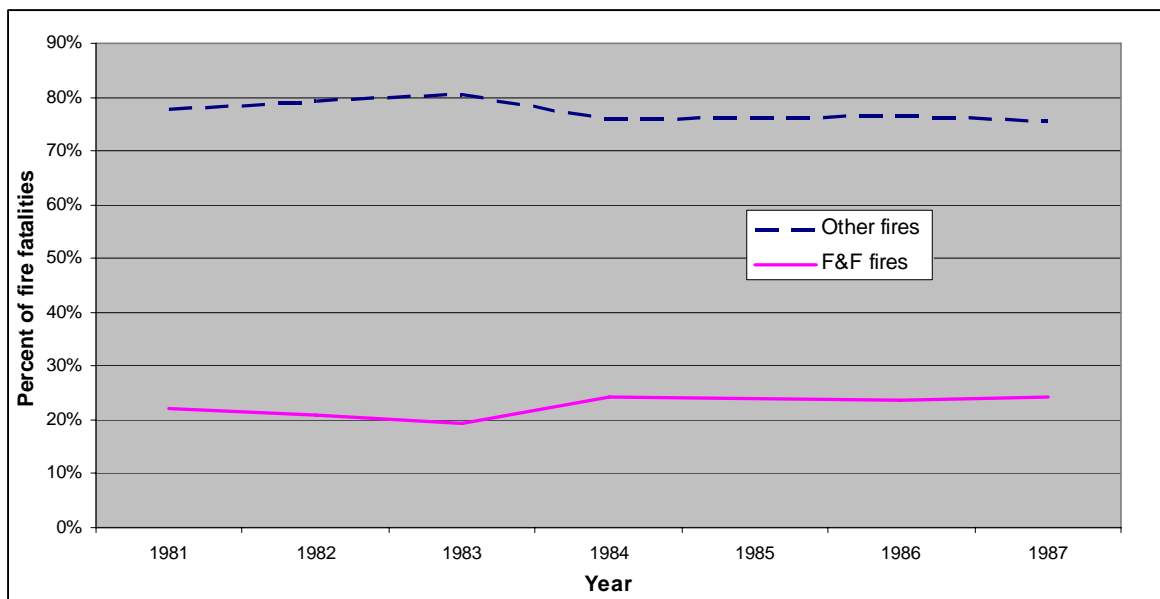


It can be seen from Figure 15 that there were many more Other Fire casualties and F&F fire casualties between 1981 and 1987: approximately 85% of Other Fire casualties and 15% of F&F fire casualties. However, there were more F&F fire casualties than F&F fires.

Fatalities

Figure 16 shows the percentage of F&F and Other Fire fatalities that occurred before the FFRs were introduced.

Figure 16: Percentage of F&F and Other Fire fatalities



It can be seen from Figure 16 that there were more Other Fire fatalities than F&F fire fatalities between 1981 and 1987. For example, in 1984 there were 76% of Other Fire fatalities and 24% of F&F fire fatalities. However, this percentage of F&F fire fatalities is again greater than F&F fires and F&F fire casualties.

Thus:

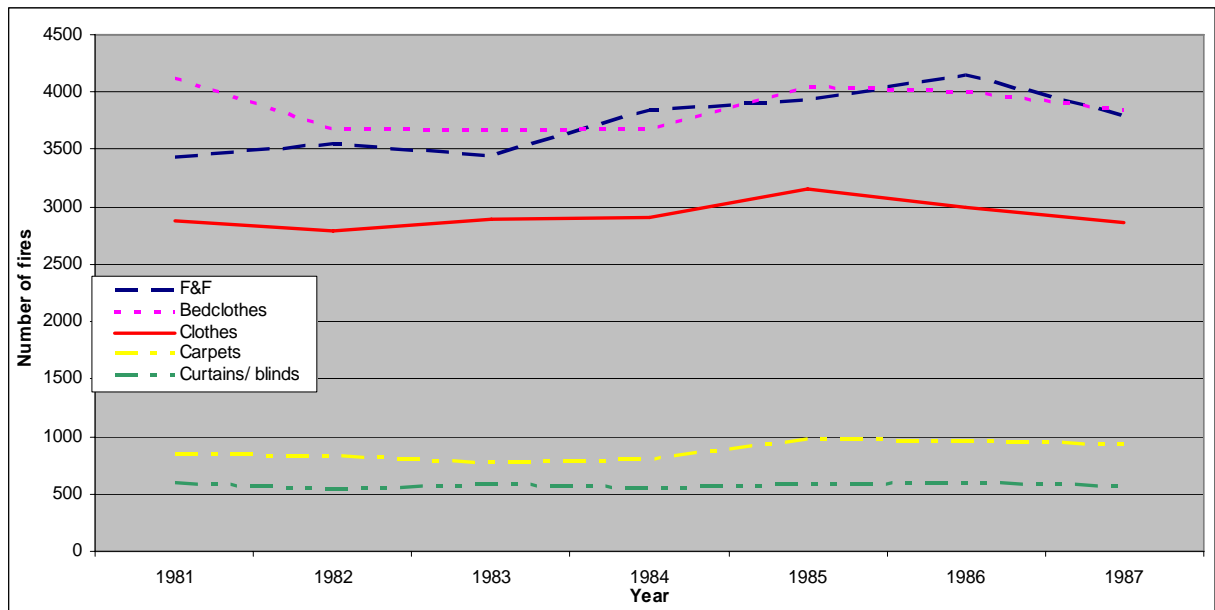
There were many more Other Fires than F&F fires before the FFRs were introduced. However, the gap between the two types of fire decreases for casualties and fatalities where there were more F&F casualties and fatalities and less Other Fire casualties and fatalities.

The amounts of F&F fires, fire deaths and fire casualties were also compared to fires, fire deaths and fire casualties where the items first ignited were other household items such as bedclothes, clothes, carpets, and curtains/blinds.

Fires

Figure 17 shows the number of fires with differing items first ignited between 1981 and 1987 before the FFRs were introduced.

Figure 17: Number of dwelling fires by item first ignited – before the FFRs



It can be seen from Figure 17 that the number of fires first ignited by furniture and furnishings increased in the years before the FFRs were introduced. For example, in 1981 the number of fires first ignited by furniture and furnishings was 3436. This increased to 3804 in 1987.

Casualties

Figure 18 shows the number of casualties in fires with differing items first ignited between 1981 and 1987 before the FFRs were introduced.

Figure 18: Number of dwelling fire casualties by item first ignited – before the FFRs

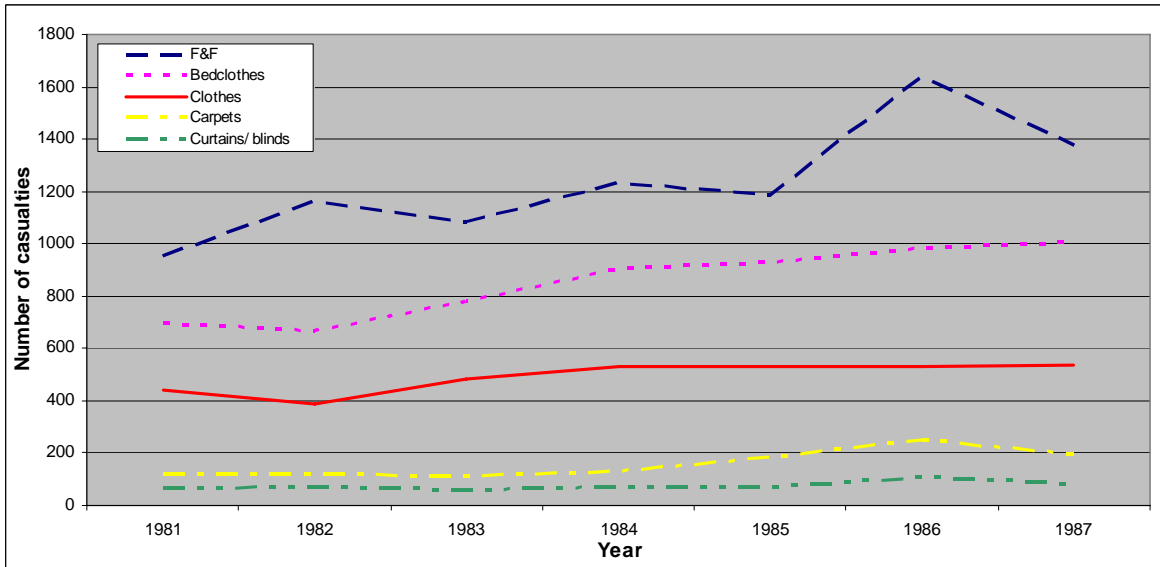


Figure 18 shows that more casualties occurred in fires where furniture and furnishings were the item first ignited. These increased in the years before the FFRs. For example, in 1981, 951 casualties occurred in fires where furniture and furnishings were the item first ignited; this increased to 1376 in 1987.

Fatalities

Figure 19 shows the number of fatalities in fires with differing items first ignited between 1981 and 1987 before the FFRs were introduced.

Figure 19: Number of dwelling fire fatalities by item first ignited – before the FFRs

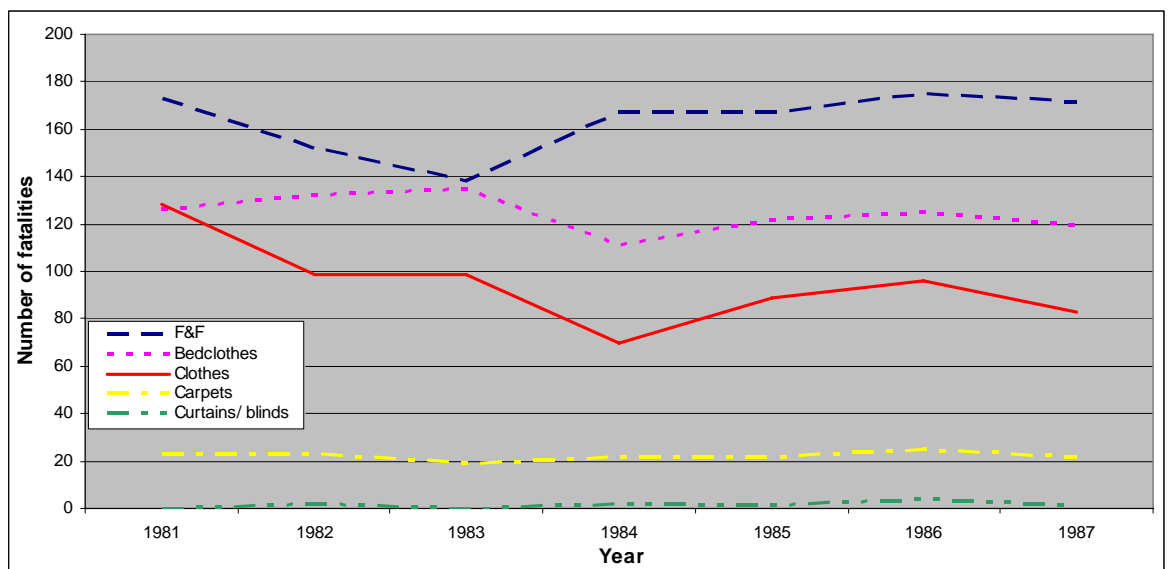


Figure 19 shows that more fatalities occurred in fires where furniture and furnishings were the item first ignited. The number of fatalities in these fires increased between 1983 and 1987. For example, in 1983 138 fatalities occurred in fires where furniture and furnishings were the item first ignited. This increased to 172 in 1987.

Thus:

- There was a high number of F&F fire deaths (about 170 where F&F was the item first ignited);
- The number of F&F deaths was not declining; and
- F&F fire deaths were a significant percentage (around 24%) of all dwelling fire deaths.

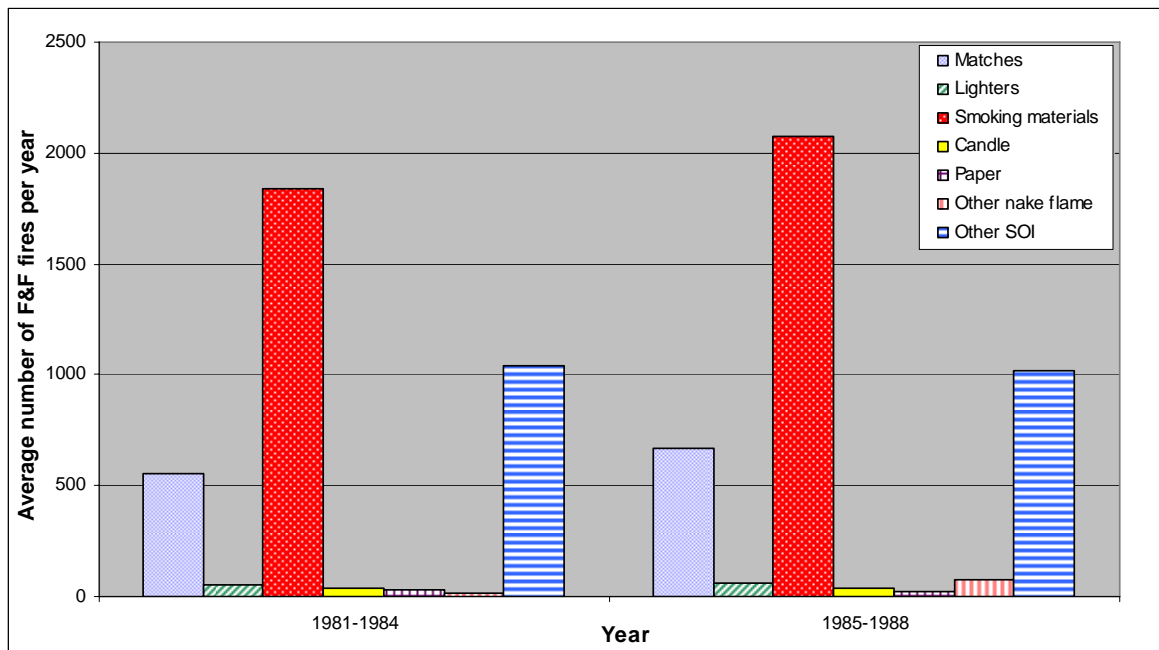
7.3 Sources of ignition of F&F fires

The FFRs have specific requirements for preventing fires caused by matches, cigarettes and other (unspecified) stronger SOI. Therefore, F&F fires were split according to cause in order to identify if there was a significant amount of fires caused by matches, smokers' materials and other stronger SOI.

Fires

Figure 20 shows the average number of F&F fires caused by different SOI. This is an average of four-yearly periods before the FFRs were introduced.

Figure 20: Sources of ignition of F&F fires – before the FFRs



It can be seen from Figure 20 that:

- More F&F fires were caused by smokers' materials. The average number of F&F fires caused by smokers' materials increased before the FFRs were introduced, from 1,698 between 1981 and 1984 to 1,888 between 1985 and 1988, i.e. an 11% increase;
- Matches were a prominent cause of F&F fires. The average number of F&F fires caused by matches increased from 511 between 1981 and 1984 to 602 between 1985 and 1988 before the regulations were introduced, i.e. an 18% increase;
- Other SOI were also a major source of F&F fires. The average number of F&F fires caused by other SOI remained at approximately 1000 between 1981 to 1984 and 1985 to 1988; and
- There were very few F&F fires caused by paper, candles, lighters and other naked flames.

Fire Casualties

Figure 21 shows the average number of F&F fire casualties caused by different SOI. This is an average of four-yearly periods before the FFRs were introduced.

Figure 21: Causes of F&F fire casualties – before the FFRs

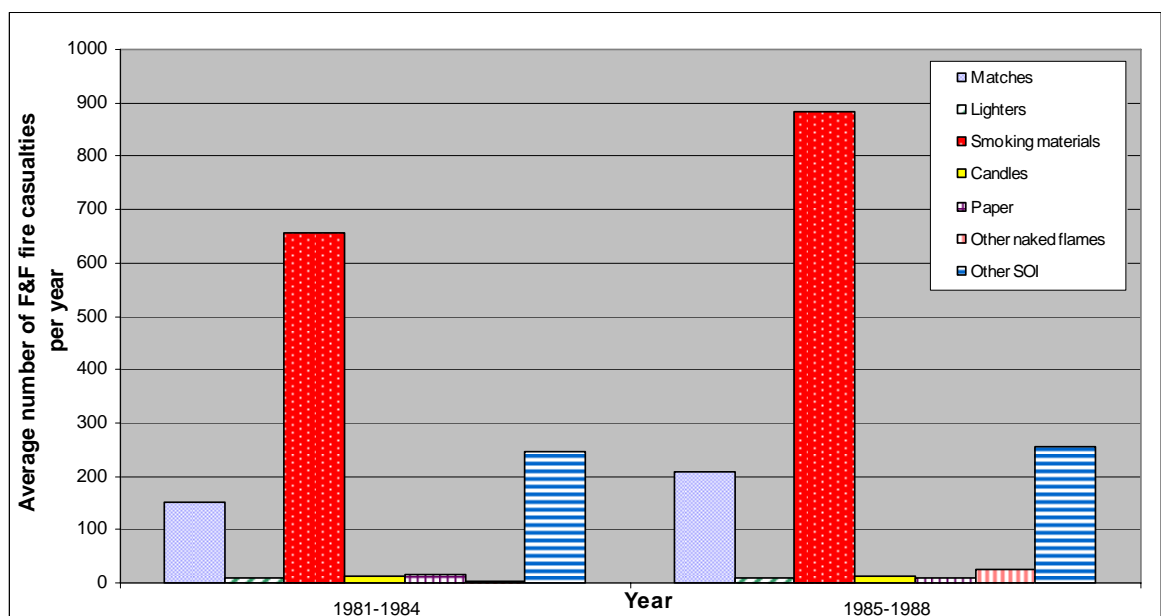


Figure 21 identifies that:

- Most of the F&F fire casualties were caused by smokers' materials. The average number of F&F fire casualties caused by smokers' materials increased before the FFRs were introduced. For example, they increased from 657 between 1891 and 1984 to 885 between 1985 and 1988, i.e. a 35% increase;
- Other SOI were the other prominent causes of F&F fire casualties. The average number of F&F fire casualties caused by other SOI increased slightly in the years before the FFRs were introduced;
- The average number of F&F fire casualties caused by matches also increased in the years before the FFRs were in place. For example, they increased from 151 between 1891 and 1984 to 208 between 1985 and 1988, i.e. a 38% increase; and

- The average number of F&F fire casualties caused by other naked flames also increased before the regulations were introduced. For example, these increased from 4 between 1981-1984 to 25 between 1985 and 1988.

Fire Fatalities

Figure 22 shows the average number of F&F fire fatalities caused by different SOI. This is an average of four year periods before the FFRs were introduced.

Figure 22: Causes of F&F fire fatalities – before the FFRs

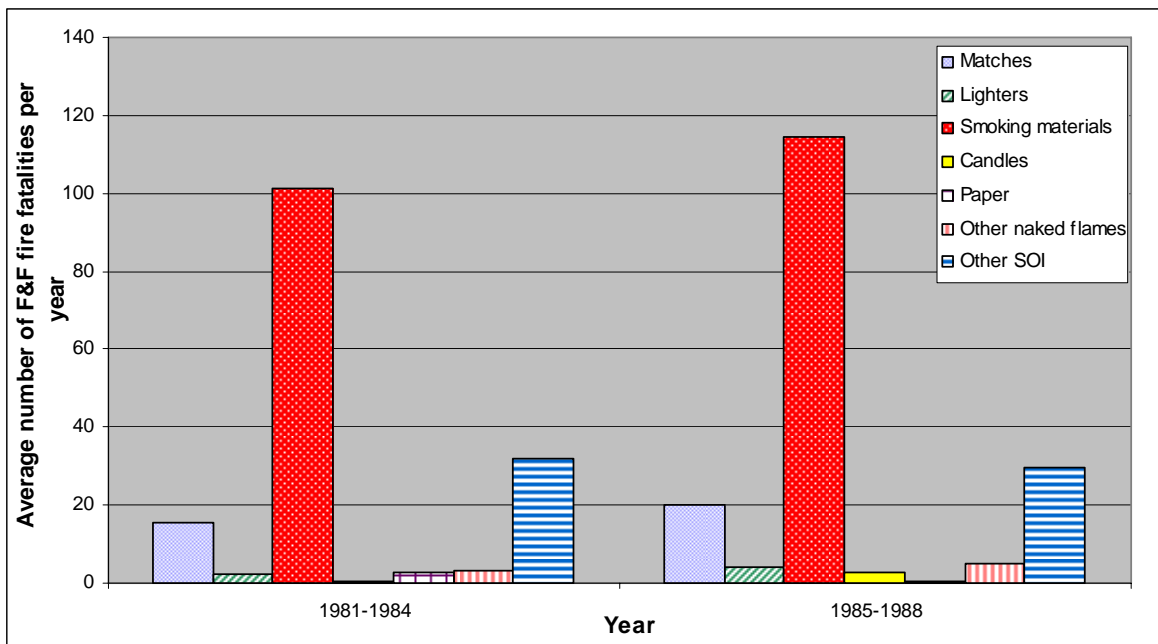


Figure 22 indicates that:

- Smokers' materials were the main cause of F&F fire fatalities. The number of F&F fire fatalities caused by smokers' materials also increased in the years before the FFRs were introduced;
- Other SOI were the second largest cause of F&F fire fatalities. These remained at an average of around 30 between 1981 to 1984 and 1985 to 1988. Other SOI include a mixture of items such as open fires. However, the majority (61%) of items in this category are open fires and radiant heaters;
- The average number of F&F fire fatalities caused by matches increased from 16 between 1981 and 1984 to 20 between 1985 and 1988 before the FFRs were introduced, i.e. a 29% increase;
- The average number of F&F fire fatalities caused by paper was very low and decreased in the years before the FFRs were introduced; and
- The average number of F&F fire fatalities caused by candles increased before the FFRs were introduced.

Thus:

- Smokers' materials was the main source of ignition of F&F fires;
- Matches were the second main source of ignition; and
- Other sources were also important, particularly open fires.

7.4 Behaviours associated with fires

7.4.1 Children playing with fire

The role of children playing with fire was analysed to determine if it was a major cause of F&F and Other Fires. (One of the tests aims to reduce ignition by matches.)

Figure 23 shows the percentage of fatalities in F&F and Other Fires that were caused by children playing with fire between 1981 and 1987, before the FFRs were in place.

Figure 23: Fatalities in fires caused by children playing with fire

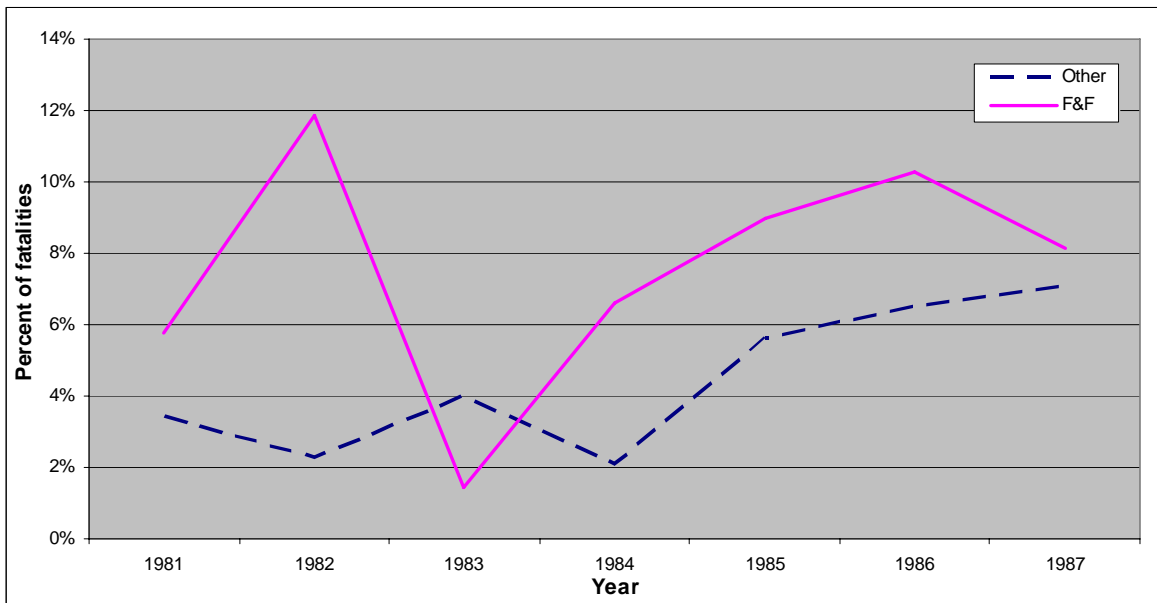
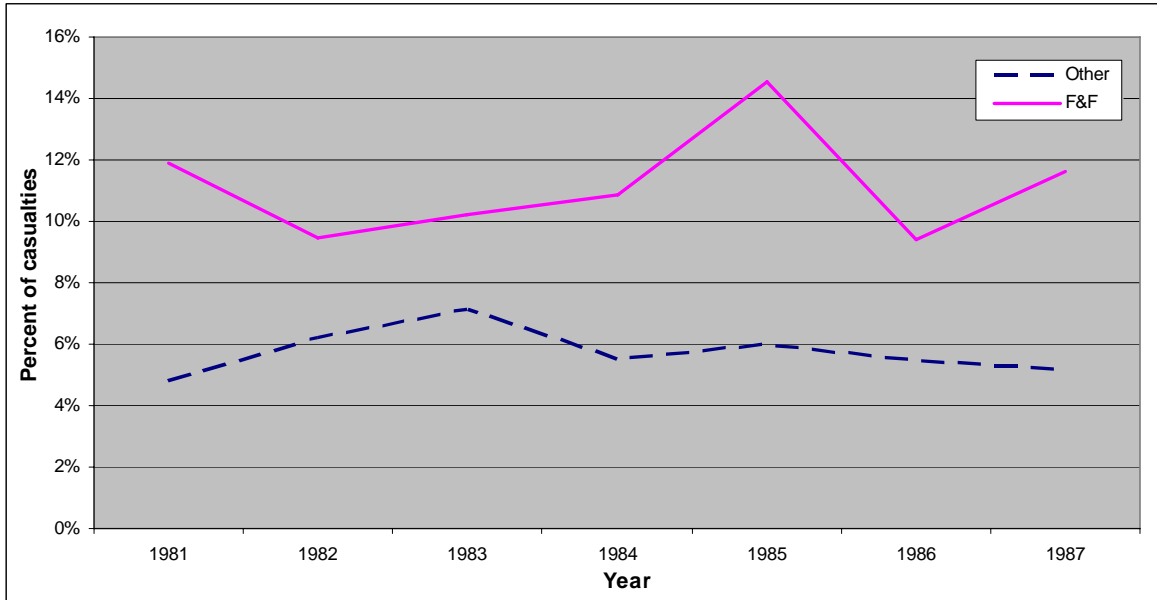


Figure 24 shows the percentage of F&F and Other Fire casualties that were caused by children playing with fire between 1981 and 1987, before the FFRs were introduced.

Figure 24: Casualties in fires caused by children playing with fire – before the FFRs

Figure 23 and Figure 24 show that:



- A greater proportion of F&F fatalities were caused by children playing with fire than Other Fires;
- The percentage of casualties in F&F fires caused by children playing with fire was over double that of Other Fires in most years; and
- The percentage of F&F and Other Fire fatalities, as well as the percentage of F&F and Other Fire casualties follow similar trends.

Thus:

- Children playing with fire was a significant cause of F&F fires, more so than Other Fires.

7.4.2 Contributing factors

Contributing factors to the causes of F&F and Other Fires (i.e. all fires excluding those involving F&F) were explored in more detail from before the FFRs were introduced. This aimed to explore whether the protection against "stronger ignition sources" provided by the Crib 5 test was reflected in the causes of F&F fires.

Fatalities

Figure 25 shows the contributing factors of F&F fire fatalities. This is shown by the average percentage of fatalities between 1981 and 1987, before the FFRs were introduced.

Figure 25: Contributing factors of F&F fire fatalities – before the FFRs

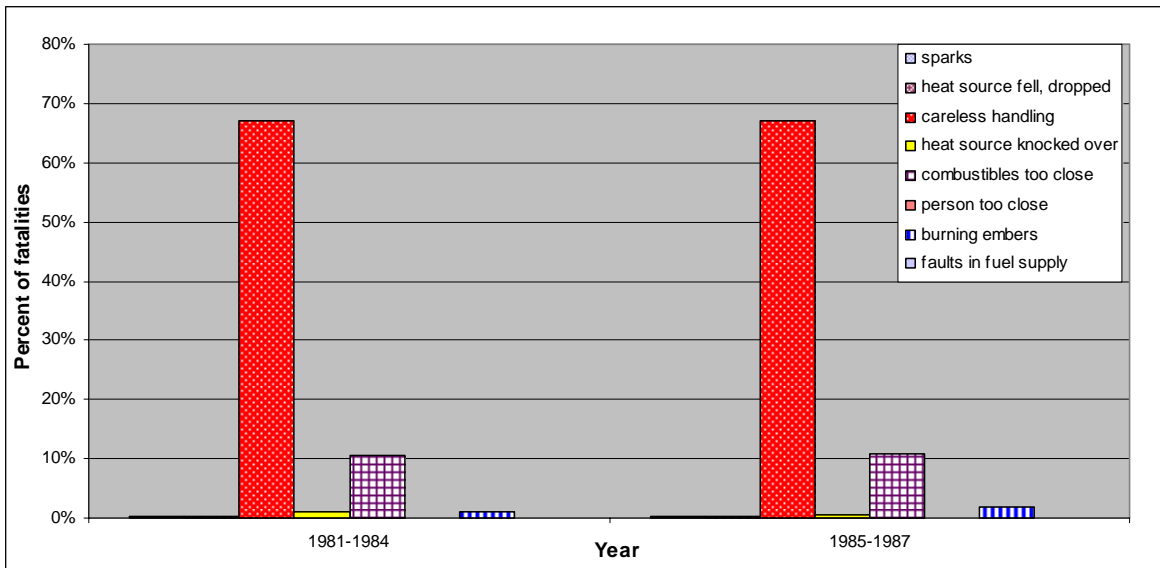


Figure 26 shows the contributing factors of Other Fire fatalities (i.e. fires not involving furniture and furnishings). This is shown by the average percentage of Other Fire fatalities between 1981 and 1987, before the FFRs were introduced.

Figure 26: Contributing factors of Other Fire fatalities – before the FFRs

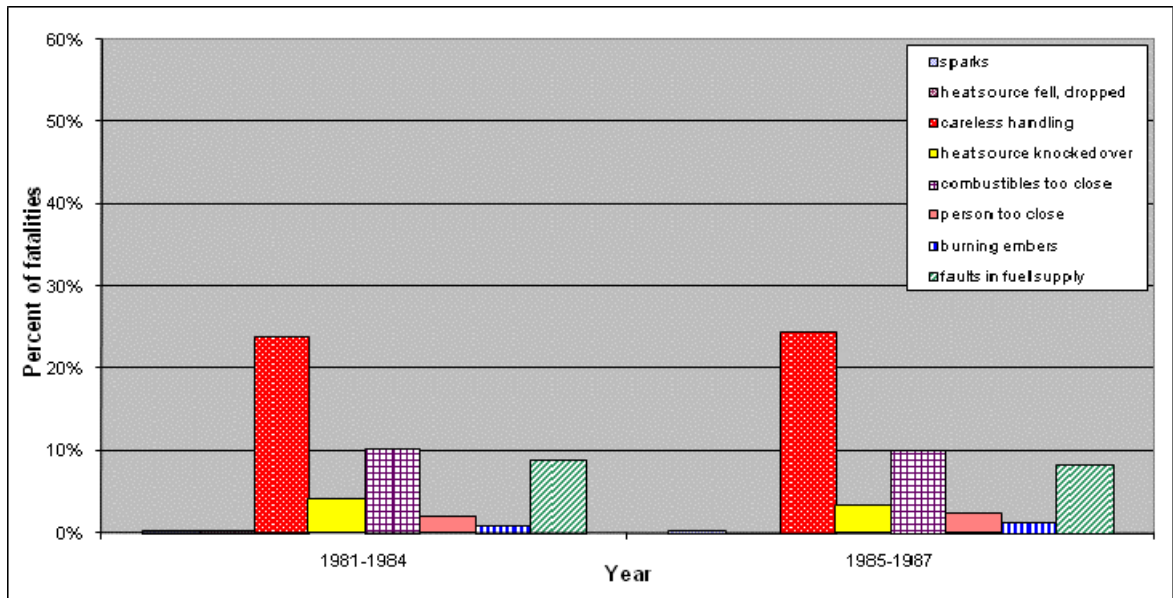


Figure 25 and Figure 26 show that:

- Careless handling was the largest causes of F&F fire and Other Fire fatalities. For example, there was an average of 67% of F&F fire fatalities caused by careless handling between 1981 and 1984 as well as 1985 and 1987. However, for Other Fire fatalities this was a lower percentage of 25%;

- Combustibles too close to the fire were the second largest cause of F&F fire and Other Fire fatalities. These remain at a similar amount for F&F fire and Other Fire fatalities;
- Faults in fuel supplies (e.g. faults in wiring circuits and/or gas or oil pipes; also, faults within appliances, mechanical heat and sparks resulting from equipment defects) were another prominent cause of Other Fire fatalities, causing an average of 8-9% of fatalities. However, this did not cause any F&F fire fatalities; and
- There is a larger percentage of Other Fire fatalities caused by heat sources knocked over, persons too close to the fire and burning embers than F&F fire fatalities.

Casualties

Figure 27 shows the contributing factors to the causes of F&F fire casualties. This is shown by the average number of casualties in F&F fires between 1981 and 1987, before the FFRs were introduced.

Figure 27: Contributing factors of F&F fire casualties – before the FFRs

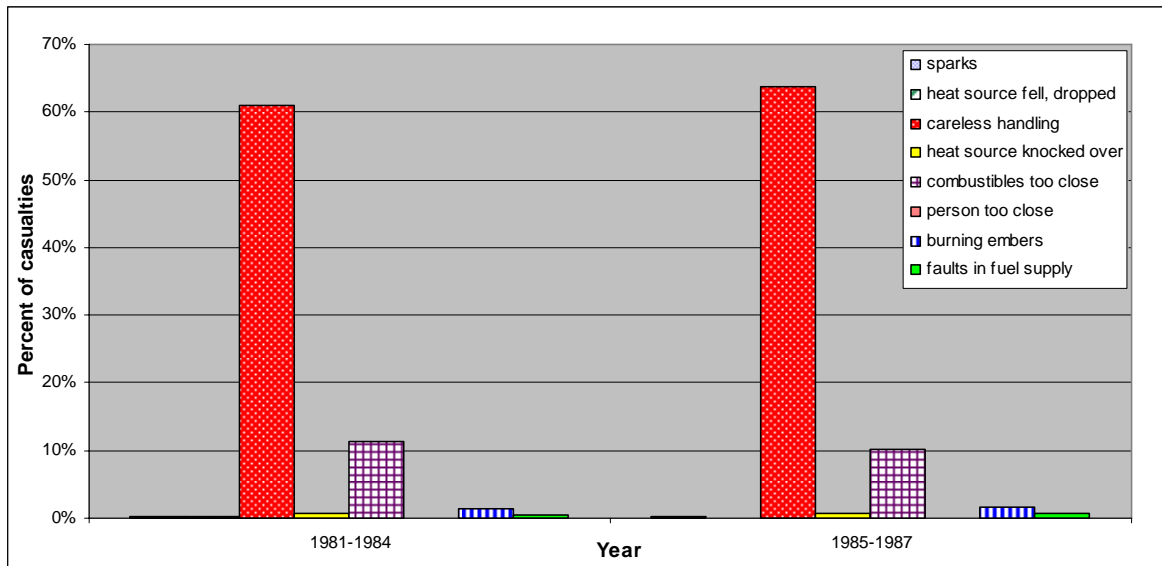


Figure 28 shows the contributing factors to causes of Other Fire casualties. This is shown by the average percentage of other fire casualties between 1981 and 1987, before the FFRs were introduced.

Figure 28: Contributing factors of Other Fire casualties – before the FFRs

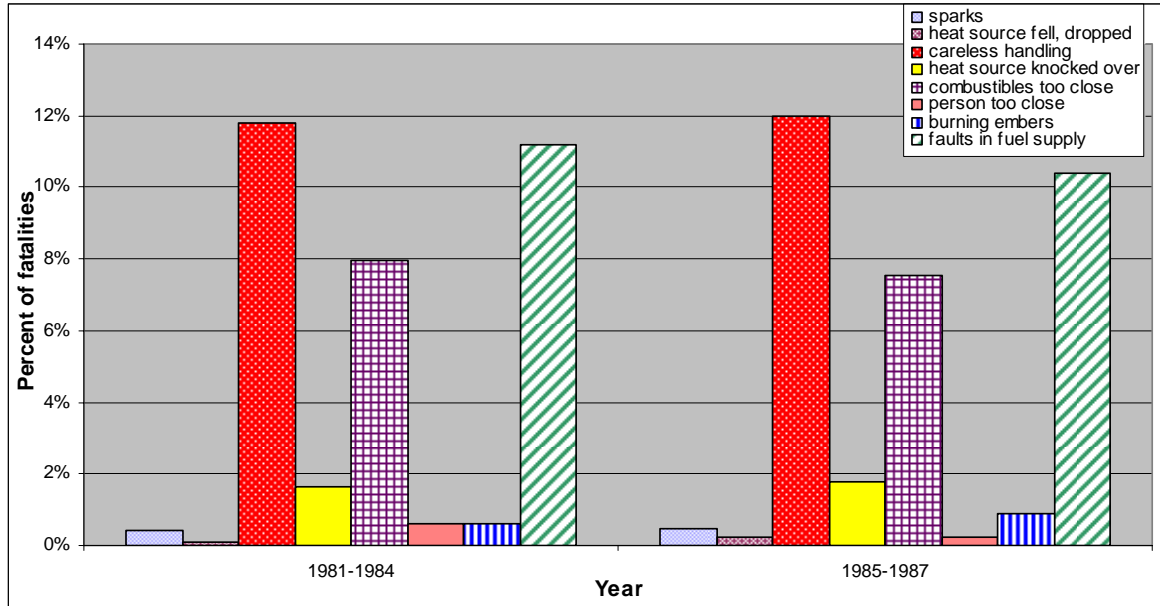


Figure 27 and Figure 28 show that:

- The largest cause of F&F fire and Other Fire casualties is careless handling. However, there is a much larger percentage for F&F fire casualties. For example, between 1985 and 1987 an average of 64% of F&F fire casualties were caused by careless handling whereas 12% of Other Fire casualties were caused by careless handling; and
- Combustibles too close to the fire was the second largest cause of F&F fire casualties. However, faults in the fuel supply was the second largest cause of Other Fire casualties.

Thus:

- Careless handling of fire or the heat source was the main cause of F&F fires; and
- Placing items too close to heat sources (e.g. putting clothes near to fires to dry) and faults in fuel supply were also key causes.

7.4.3 Item first ignited vs. material mainly responsible

The Crib 5 test guards against stronger ignition sources. Another way of examining this is by exploring what was ignited before fire spread to furniture and furnishings, for example a cigarette (source of ignition) igniting newspaper (item first ignited) which then ignited the furniture (material mainly responsible). Therefore, the analysis has identified the patterns of fire fatalities where F&F were the material mainly responsible. This also includes F&F being the item first ignited and the material mainly responsible.

Figure 29 shows the average number of fatalities in F&F fires with differing materials that were first ignited, before the FFRs were introduced.

Figure 29: Material first ignited for F&F fire fatalities – before the FFRs

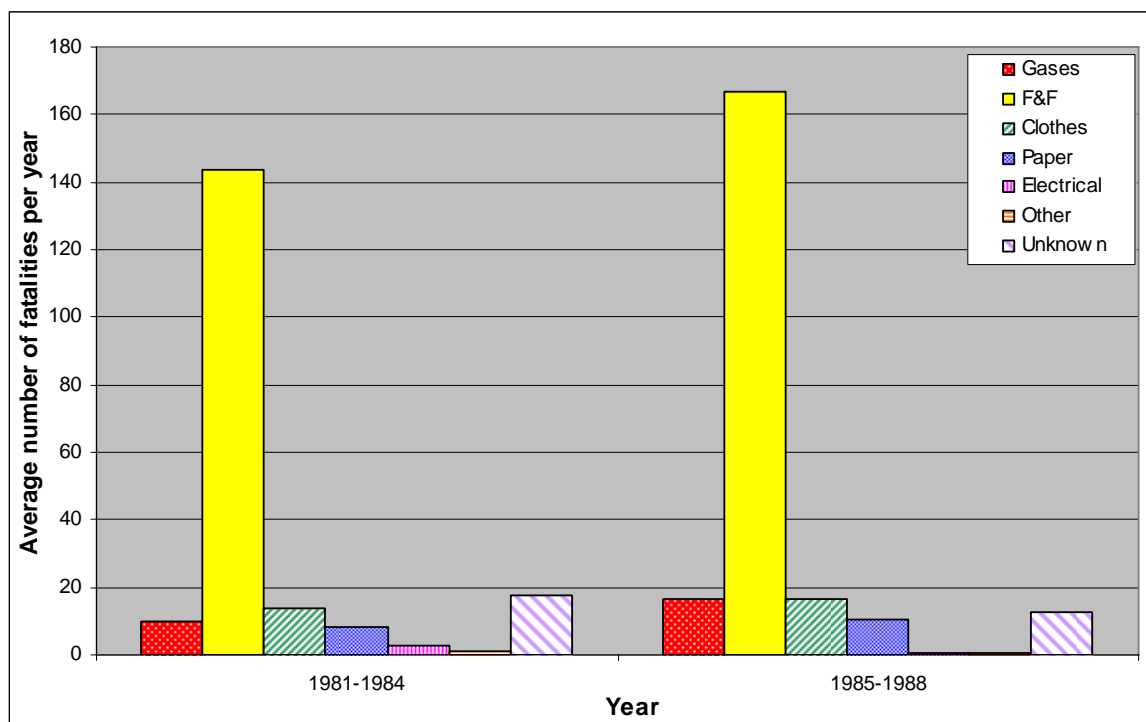


Figure 29 shows that more F&F fire fatalities were caused in fires where furniture and furnishings were the materials first ignited. This also increased before the FFRs were in place. For example, between 1981 and 1984 there were an average of 144 fatalities in F&F fires where furniture and furnishings were the materials first ignited. This increased to an average of 167 between 1985 and 1988.

The average number of fatalities in F&F fires where gases (e.g. dust & powder, fireworks, mains gas, LPG, petrol, paraffin and spirits), clothes and paper were the materials first ignited, also increased in the years before the FFRs were in place.

Thus:

- In most cases, furniture was both the item first ignited and the material mainly responsible for the fire; and
- Other materials comprised a small minority of items first ignited.

7.5 Lethality and spread of fires

7.5.1 Deaths per fire

F&F fires were seen to be lethal before the FFRs were introduced, due to foam fillings when ignited producing toxic smoke and fire spreading very quickly. This concern underpinned the proposal to 1) prevent F&F fires by resisting ignition and 2) reduce the lethality of fires if they do occur. The Crib 5 test is intended, in part, to demonstrate performance in respect of limiting the speed of fire growth and the rate at which toxic smoke is produced. Clearly, by reducing the size and toxicity of fires, they should be less lethal.

Therefore, analysis was conducted to identify if F&F fires were indeed more lethal than Other Fires. This is shown by the number of deaths per F&F and per Other Fires, to determine their lethality.

Figure 30 shows the number of deaths per fire for F&F fires and Other Fires from 1981 to 1987 before the FFRs were introduced.

Figure 30: Lethality of F&F fires and Other Fires – before the FFRs

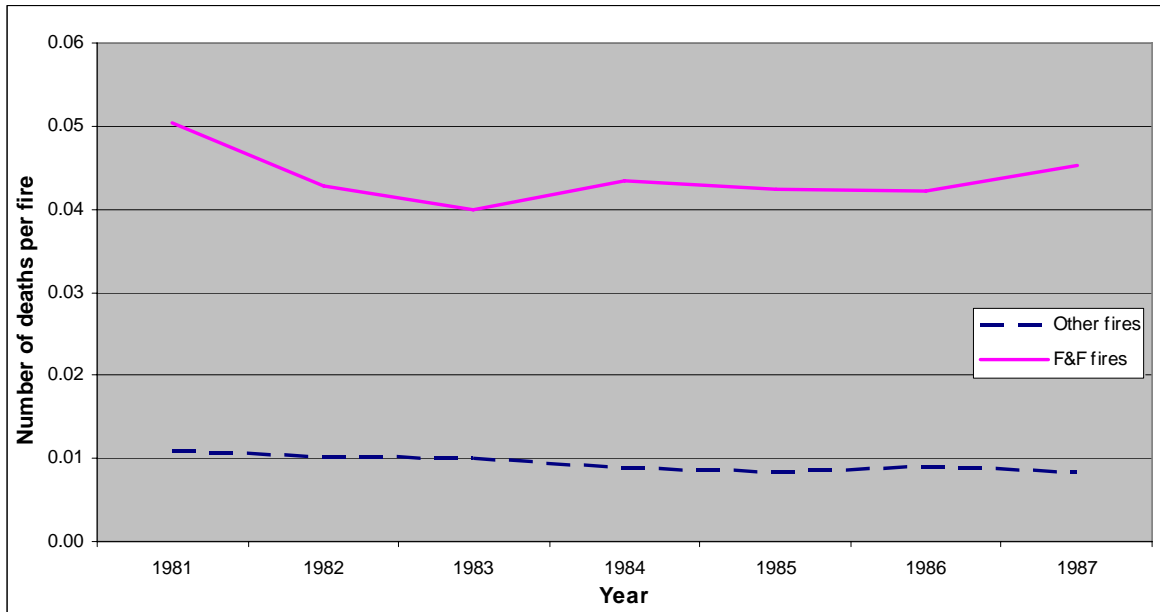


Figure 30 shows that F&F fires were more lethal than Other Fires as they caused more deaths per fire. For example, in 1981 the number of deaths per F&F fire was 4 times greater than that of Other Fires. There were 0.05 deaths per F&F fire, but far fewer for Other Fires (0.011 deaths per fire).

Thus:

- F&F fires were far more lethal than Other Fires, i.e. about 5 times more so.

7.5.2 Impairment of victims

The Crib 5 test aims, in part, to limit the rate of fire growth and production of toxic smoke, so that people have time in which to escape from a burning room. This is particularly important where people are impaired by alcohol or are asleep. Therefore, analysis was conducted to explore in more detail the factors associated with F&F fire deaths.

Alcohol and sleep impairment

The roles of alcohol and sleep impairment were analysed. This aimed to identify impairment associated with F&F fires before the FFRs were introduced.

Figure 31 shows the percentage of F&F fire and Other Fire fatalities in fires where people were impaired due to alcohol or being asleep between 1981 and 1987, before the FFRs were in place.

Figure 31: Alcohol and asleep impairment for fatalities – before the FFRs

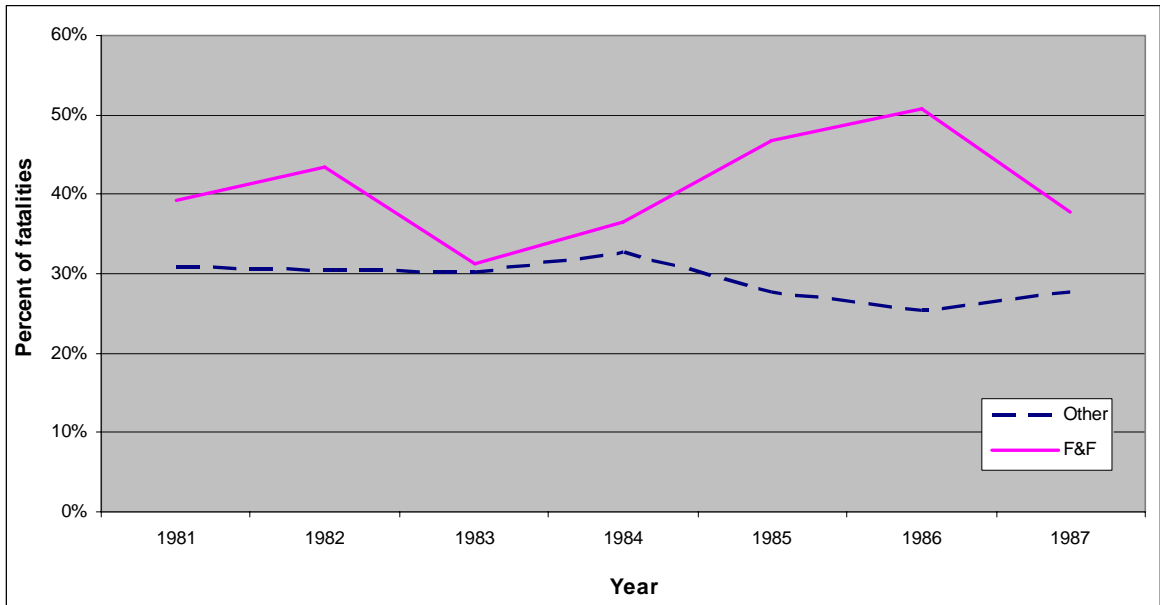


Figure 31 shows that more fatalities occurred in F&F fires where people were impaired by alcohol or asleep. From 1985 these trends began to differ: in 1986 the percentage of F&F fire fatalities where people were impaired by alcohol or being asleep was double that of Other Fire fatalities.

Figure 32 shows the percentage of F&F fire and Other Fire casualties where people were impaired due to alcohol or being asleep between 1981 and 1987, before the FFRs were in place.

Figure 32: Alcohol and sleep impairment for non fatal casualties– before the FFRs

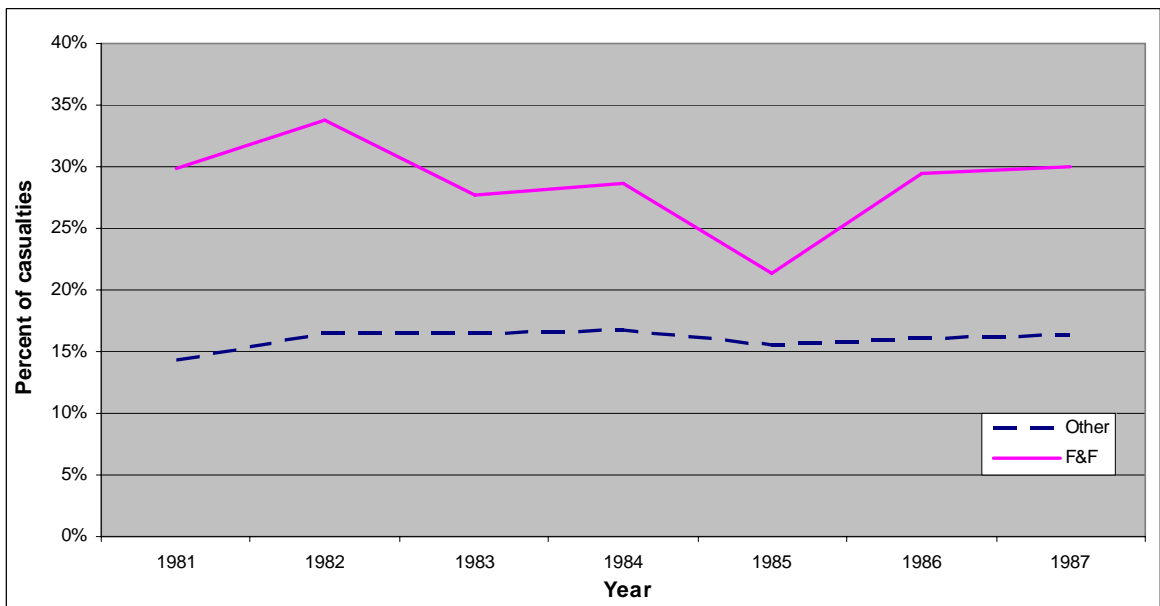


Figure 32 shows that more casualties occurred in F&F fires where people were impaired by alcohol or asleep. For example, in 1987 the percentage of casualties in F&F fires where people were impaired by alcohol or being asleep was nearly double that of Other Fires.

Thus:

- Casualties in F&F fires were more likely to be impaired by alcohol or asleep than victims of Other Fires.

7.5.3 Fire spread

The Crib 5 test also aimed to reduce the speed at which fire grows, inhibit the smoke produced and the spread of the fire. Therefore, analysis was conducted to identify if F&F fires spread further than Other Fires.

Figure 33 shows the percentage of F&F fires and Other Fires that spread beyond the room of origin before the FFRs were introduced.

Figure 33: Percentage of F&F fires and Other Fires spread beyond the room – before the FFRs

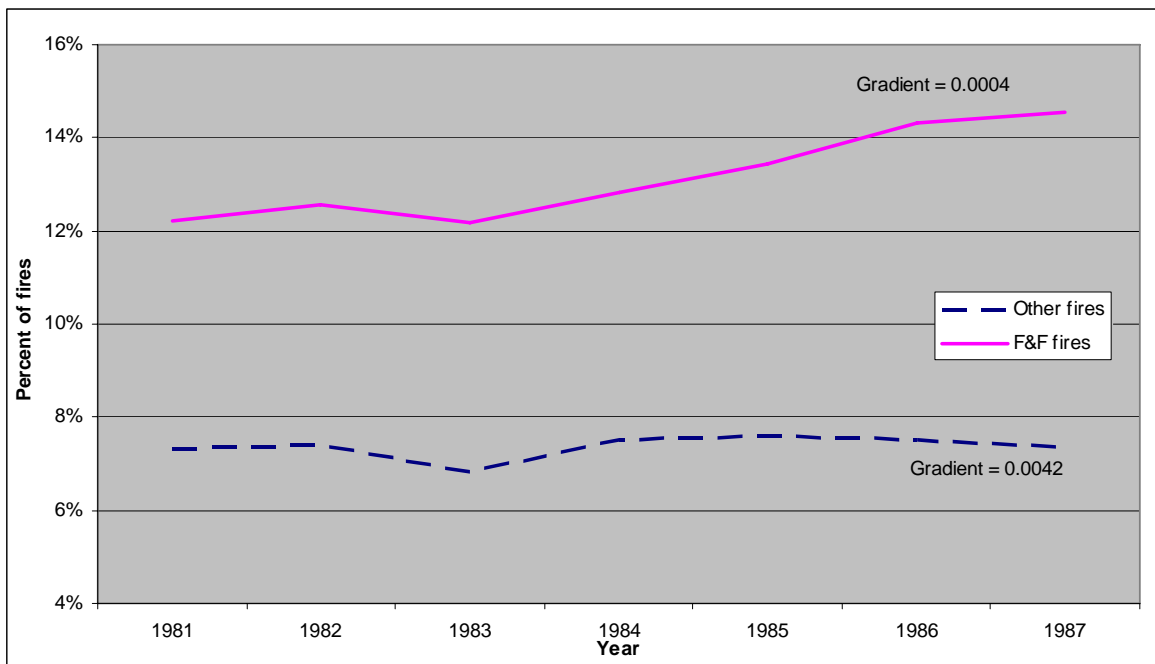


Figure 33 shows that:

- More F&F fires spread 'beyond the room of origin' than Other Fires. For example, the percentage of F&F fires 'spread beyond the room' in 1987 is over two times greater than that of Other Fires; and
- F&F fires that spread beyond the room of origin were increasing over the years before the FFRs were introduced. This increase was steeper than the trend of Other Fires that spread beyond the room of origin. This was shown by a steeper gradient in the trend of F&F fires (0.0042) than that of Other Fires (0.0004).

Figure 34 shows the percentage of F&F fires and Other Fires that were 'confined to the item first ignited', confined to the 'room of origin' and 'spread beyond the room'. This covers the period of 1981 to 1987, before the FFRs were introduced.

Figure 34: F&F and Other Fire spread – before the FFRs

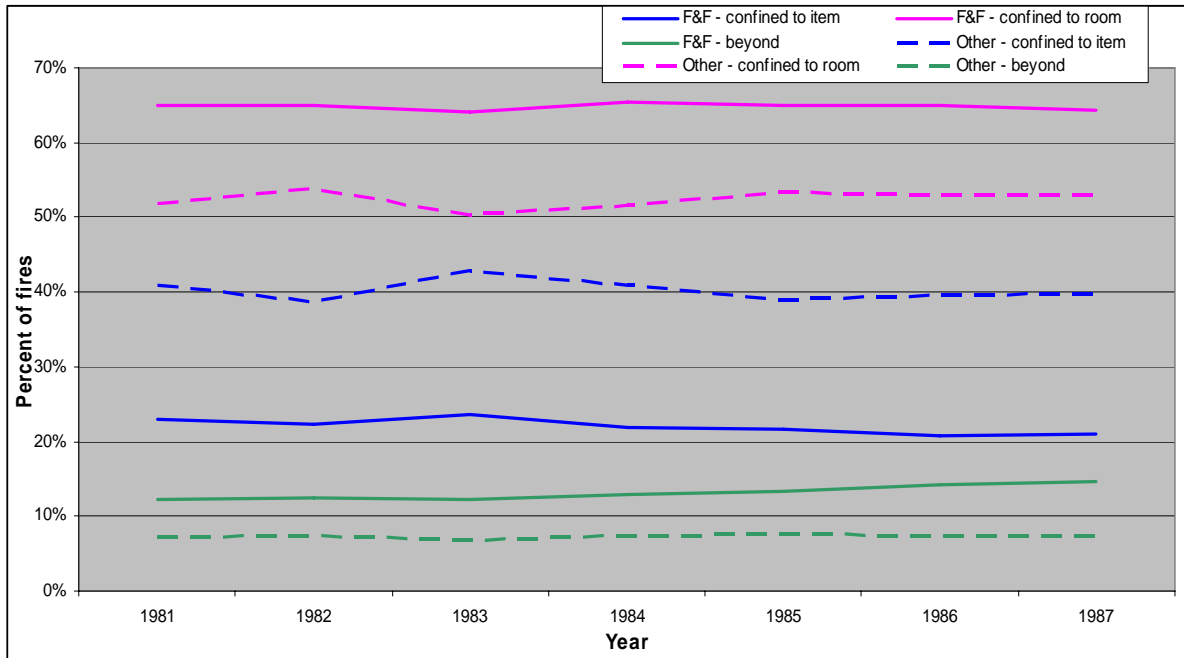


Figure 34 shows that:

- Most F&F and Other Fires were confined to the room of origin with the fewest number of fires spreading beyond the room;
- More F&F than Other Fires spread beyond the room of origin. The trend of the F&F fires that spread beyond the room increased across the years before the FFRs were introduced. For example, in 1981 12% of F&F fires spread beyond the room, which increased to 15% in 1987. However, those Other Fires that spread beyond the room did not increase in the years before the FFRs were introduced. For example, in 1981 and in 1987 the percentage of the fires that spread beyond the room of origin remained at 7%; and
- Fewer F&F fires were confined to the item first ignited than Other Fires. For example, in 1981 23% of F&F fires were confined to the item first ignited whereas 41% of Other Fires were confined to the item first ignited.

Thus:

- F&F fires were far more likely to spread beyond the room of origin and beyond the item of origin than Other Fires.

7.5.4 Lethality by extent of fire spread

Fires that spread further are considered to be more lethal as they cause more fatalities per fire. The Crib 5 test aimed to reduce the spread of these fires and thus reduce their lethality. Therefore, analysis was conducted to identify whether a larger spread of F&F fires causes more deaths than with Other Fires.

Figure 35 and 36 show the lethality of F&F and Other Fires by "spread" before the FFRs were introduced. This is shown by the number of deaths per fire for those that are confined to the item first ignited, confined to the room of origin and spread beyond the room of origin.

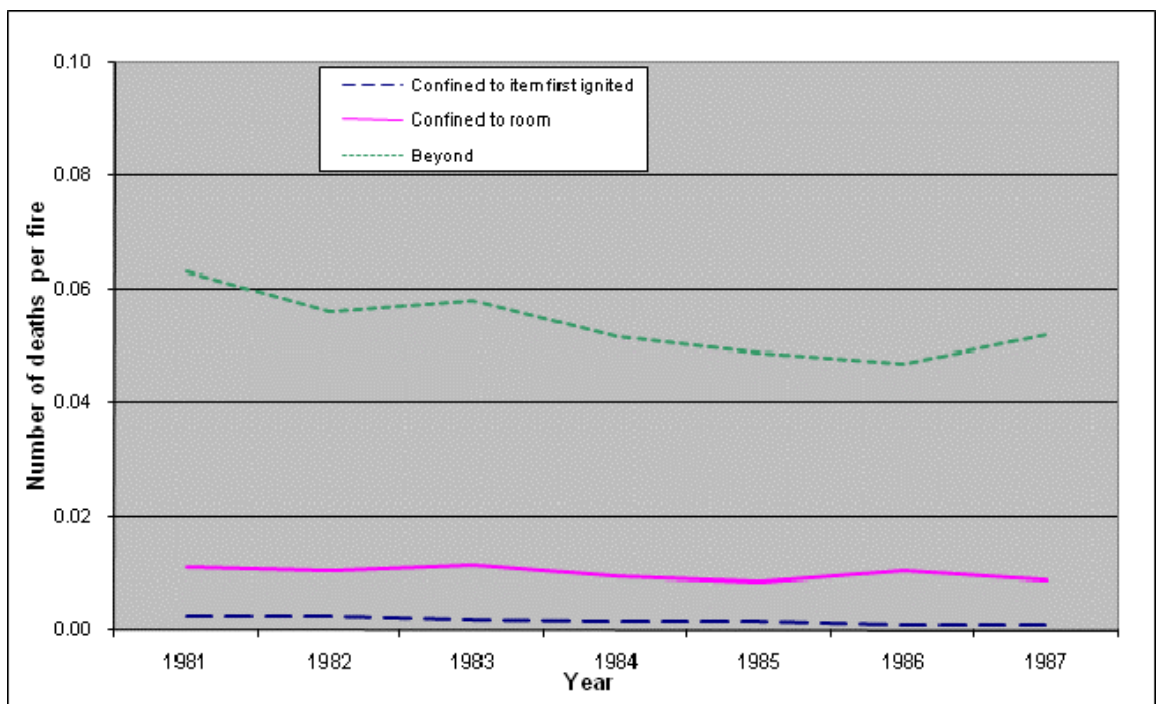
Figure 35: Lethality of F&F fires spread – before the FFRs

Figure 36: Lethality of Other Fires spread – before the FFRs

Figure 35 and Figure 36 identify that:

- Those F&F and Other Fires that spread beyond the room of origin were more lethal than those confined to the item first ignited and those confined to the room of origin, as they caused more deaths per fire. For example, in 1984 the number of deaths per F&F fire that spread beyond the room was 14 times greater than fires that were confined to the item first ignited;
- Those F&F and Other Fires that were confined to the item first ignited were the least lethal as fewest deaths were caused by these fires;
- The number of deaths per F&F fire that were confined to the item first ignited decreased in the years before the FFRs were introduced; and
- There were more deaths per F&F fire that were confined to the room and spread beyond the room than deaths per Other Fire. For example, in 1981 the number of deaths per F&F fire that spread beyond the room of origin was over twice as great as for Other Fires.

Thus:



- Fires that spread beyond the room of origin caused more fire deaths than fires which do not spread so far; and
- F&F fires that spread beyond the room of origin were more lethal than Other Fires that spread beyond the room of origin.

7.5.5 Type of injury

Furniture and furnishings were thought to be more lethal due to the production of toxic smoke associated with the foam fillings. This resulted in a greater proportion of deaths that were due to smoke. Therefore, the types of injury that caused fatalities and casualties in F&F and Other Fires were analysed before the FFRs were introduced.

Deaths

Figure 37 shows the number of F&F fire fatalities caused by different injury types before the FFRs were introduced.

Figure 37: Injury type for F&F fire fatalities – before the FFRs

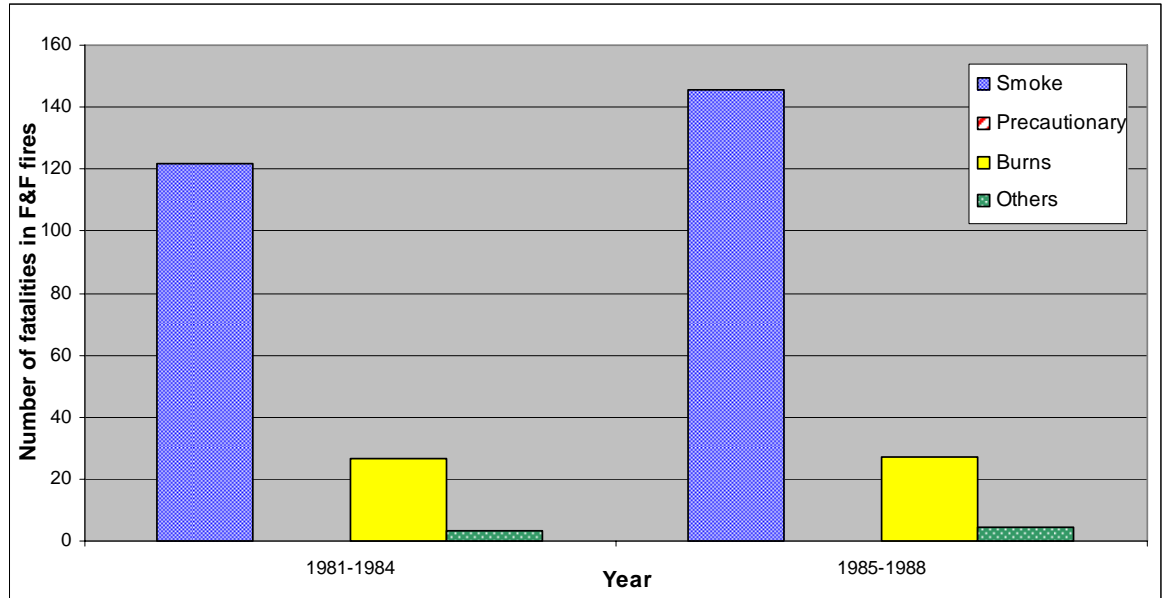


Figure 37 shows that:

- Most fatalities in F&F fires were caused by smoke inhalation. This increased before the FFRs were in place. For example, the average number of F&F fatalities due to smoke between 1981 and 1984 was 122, which increased to 146 between 1985 and 1988. This is a 20% increase; and
- Burns were the second most common cause of F&F fire fatalities. However the average number of F&F fatalities due to burns remained at 27 between 1981 to 1984 and 1985 to 1988.

As smoke inhalation was the most common injury in F&F fires, the percentage of fatalities caused by smoke was compared for F&F and Other Fires.

Figure 38 shows the percentage of fatalities caused by smoke for F&F and Other Fires before the FFRs were in place.

Figure 38: Percentage of fatalities caused by smoke

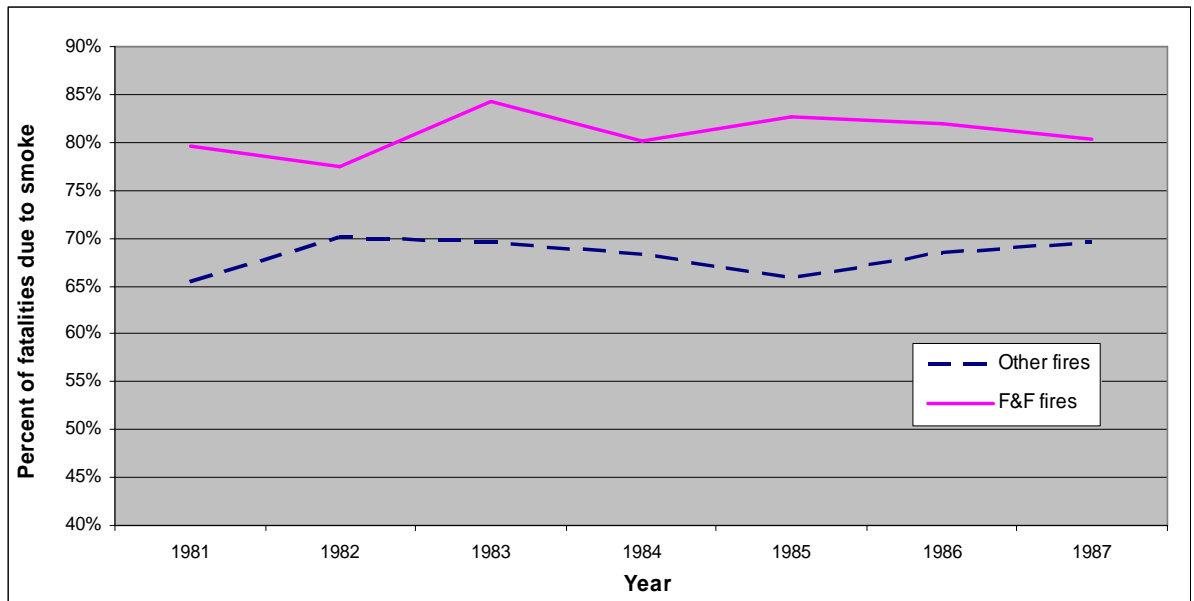


Figure 39 shows that more fatalities occurred in F&F fires due to smoke than Other Fires. For example, in 1981, 80% of F&F fire fatalities were due to smoke, whereas 65% of Other Fire fatalities were due to smoke.

Casualties

Figure 39 shows the number of F&F fire casualties caused by different injury types before the FFRs were introduced.

Figure 39: Injury type for F&F fire casualties – before the FFRs

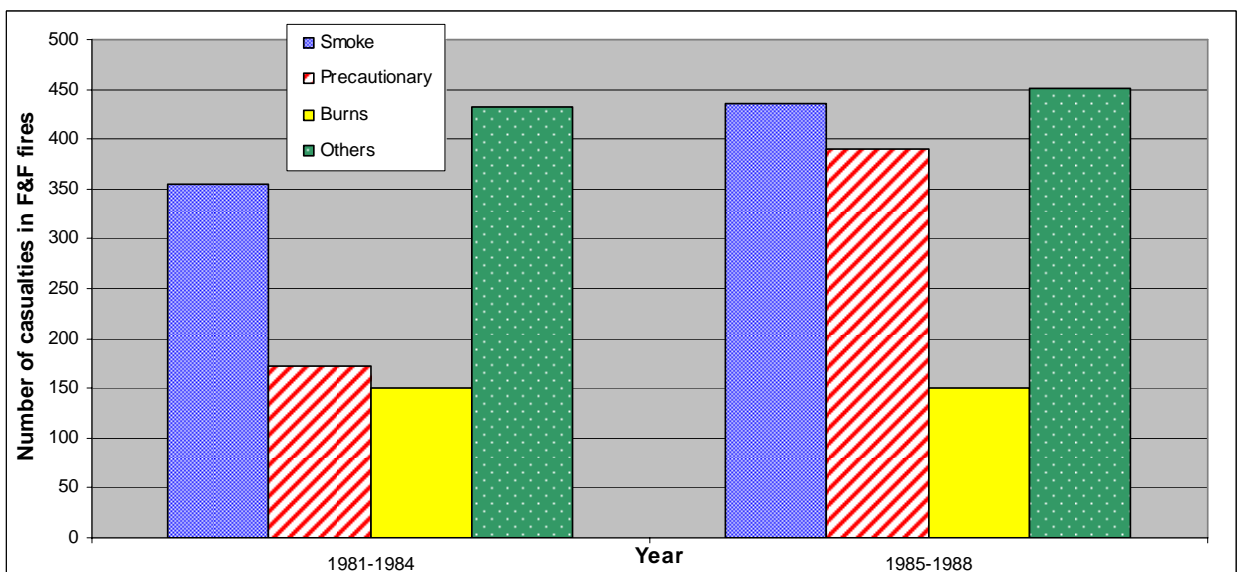


Figure 39 shows that:

- Other types of injury were the most common cause of F&F fire fatalities. These include physical injuries such as cuts, sprains and fractures, as well as shock;
- Casualties due to smoke inhalation increased before the FFRs were introduced. For example, they increased from an average of 354 between 1981 and 1984 to an average of 436 between 1985 and 1988, i.e. an increase of 23%;
- Casualties due to burns remained at the same level before the FFRs were introduced; and
- Precautionary check-ups also increased before the FFRs were introduced.

Figure 40 shows the percentage of F&F and Other Fire casualties that occurred due to smoke before the FFRs were introduced.

Figure 40: F&F and Other Fire casualties due to smoke – before the FFRs

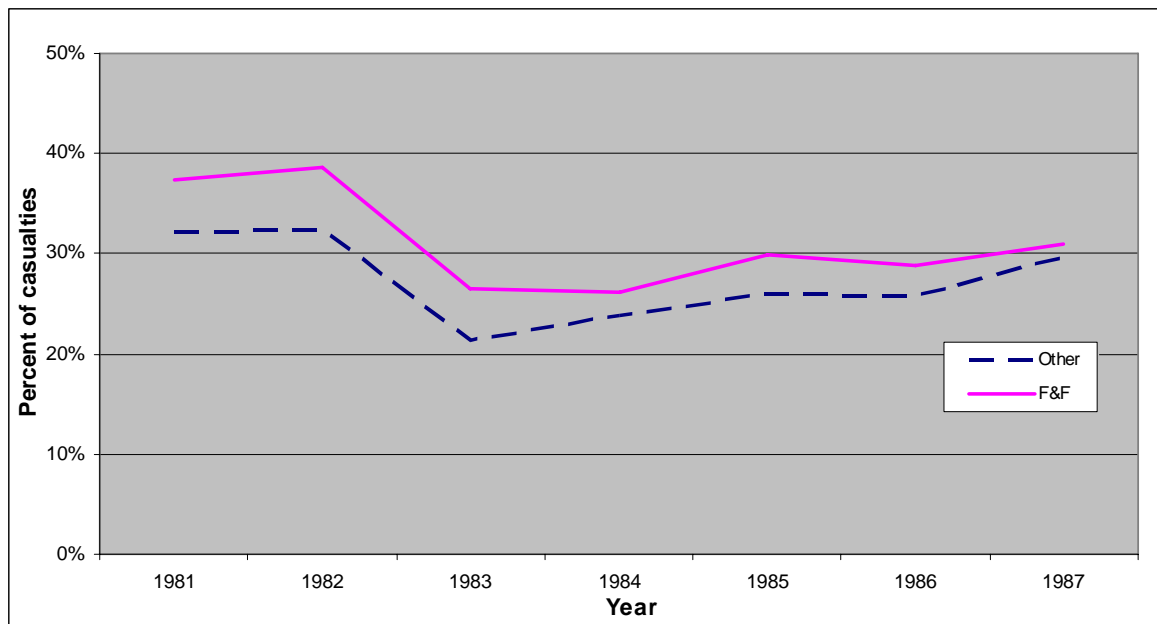


Figure 40 shows that more F&F fire casualties occurred due to smoke than Other Fire casualties. For example, in 1981 F&F fire casualties due to smoke were 5% higher than that of Other Fire casualties.

Thus:

- Smoke inhalation was the most common injury type for F&F fire fatalities;
- More F&F fire fatalities (e.g. 15% more in 1981) were due to smoke inhalation than Other Fires;
- Smoke was a prominent cause of F&F fire casualties; and
- Slightly more F&F fire casualties were due to smoke than Other Fire casualties.

8 APPENDIX D: THE CURRENT PICTURE WITH F&F FIRES

8.1 Introduction

Data recorded since the 2000 Surrey/DTI study (using statistics to 1997) was analysed to identify if F&F fires still remained a significant risk after the FFRs were introduced or if they became more of a significant risk. Analysis was conducted:

- To determine if the numbers of F&F fires, fatalities and casualties were increasing due to the possibility of the FFRs now being out of date;
- To identify if the three FFRs tests remained appropriate due to the causes of fires and the probability of fire spread; and
- To identify if differences between F&F fires and Other Fires still remained.

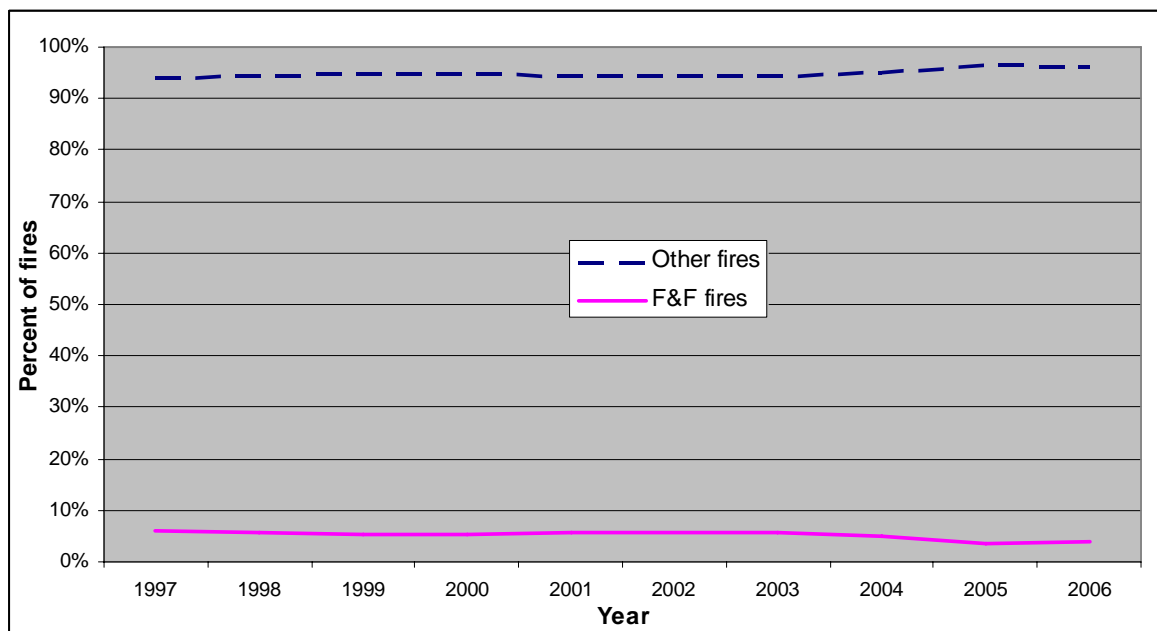
8.2 Number of F&F fires, deaths and casualties

The numbers of dwelling fires, fire deaths and fire casualties were analysed between 1997 and 2006 to identify if furniture and furnishings were still a risk as item first ignited.

Fires

Figure 41 shows the percentage of F&F and Other Fires between 1997 and 2006.

Figure 41: Percentage of F&F and Other Fires – 1997 to 2006

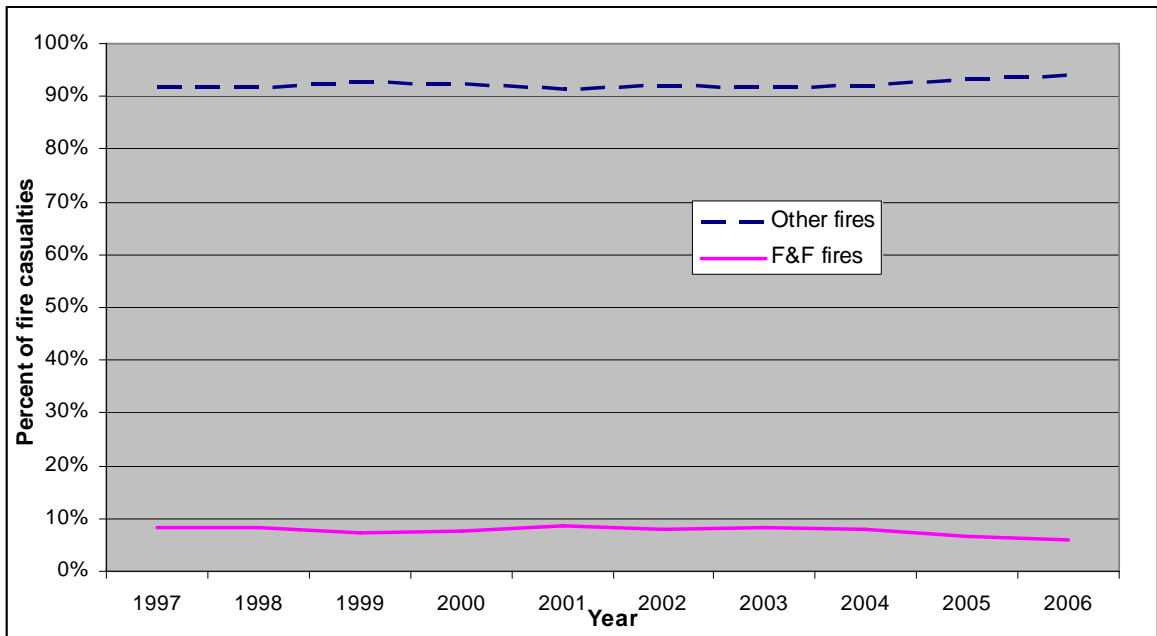


It can be seen from Figure 41 that there were more Other Fires than F&F fires between 1997 and 2006, i.e. around 94% of Other Fires and 6% of F&F fires. However, the percentage of F&F fires began to decrease after 2004.

Casualties

Figure 42 shows the percentage of F&F and Other Fire fatalities between 1997 and 2006.

Figure 42: Percentage of F&F and Other Fire casualties – 1997 to 2006

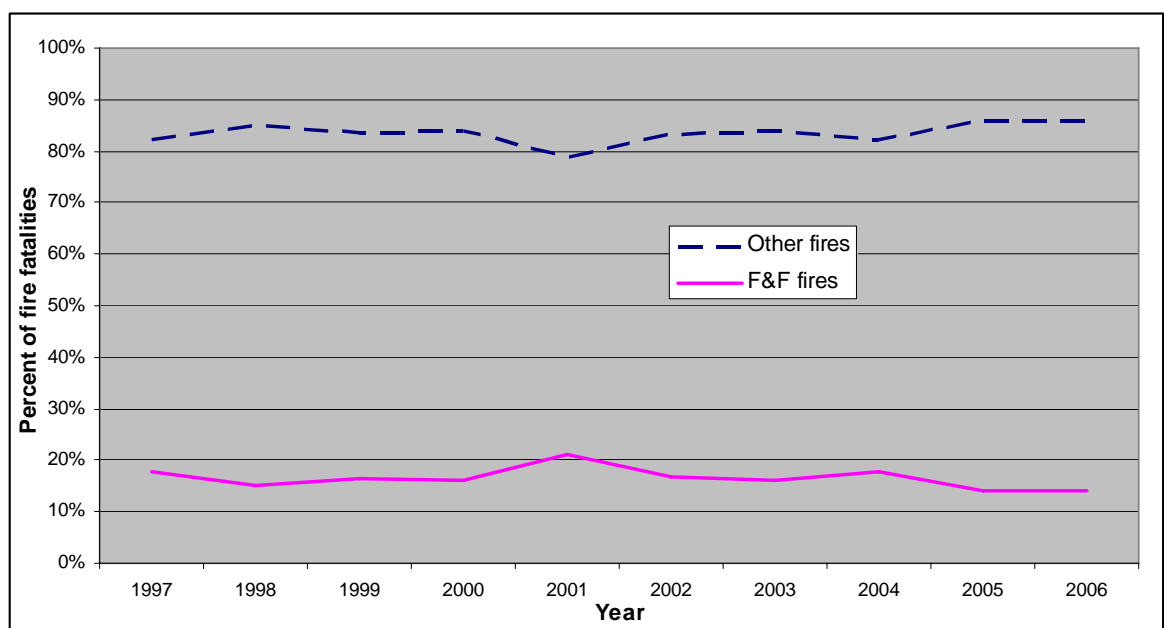


It can be seen from Figure 42 that there were more Other Fire casualties (e.g. 92%) than F&F fire casualties (8%) between 1997 and 2006.

Fatalities

Figure 43 shows the percentage of F&F and Other Fire Fatalities between 1997 and 2006.

Figure 43: Percentage of F&F and Other fire fatalities – 1997 to 2006



It can be seen from Figure 43 that there were more Other Fire fatalities (e.g. 85%) than F&F fire fatalities (e.g. 15%) between 1997 and 2006.

Thus:

- There were many more Other Fires, fire deaths and fire casualties than F&F fires between 1997 and 2006; and
- F&F fire deaths remain more of a problem as there is still a higher percentage of them than F&F fires and casualties.

The numbers of dwelling fires, fire deaths and fire casualties were analysed between 1997 and 2006 to identify if furniture and furnishings were still a risk at being the item first ignited compared to other household items.

8.3 Other textile fires

Figure 44 shows the number of fires with other types of textiles fires ignited between 1997 and 2006.

Figure 44: Number of dwelling fires by item first ignited – 1997 to 2006

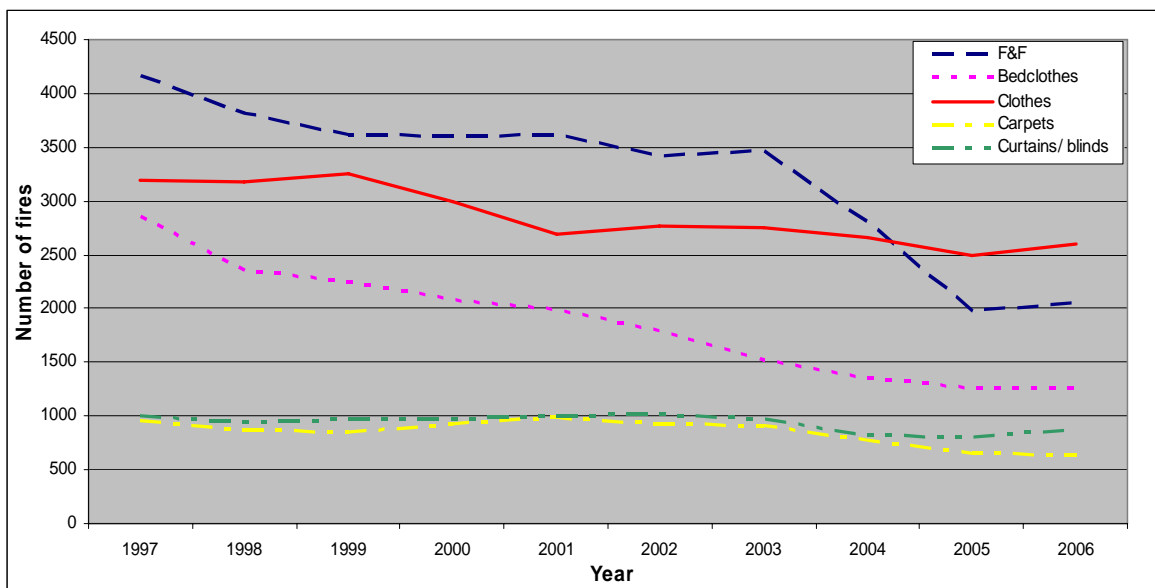


Figure 44 identifies that more fires still occurred where furniture and furnishings were the items ignited first compared to other items. However, there was a large decrease in the number of these fires in 2003 resulting in more fires occurring where the items first ignited were clothes from 2005 onwards.

Fires where the items first ignited were furniture and furnishings and bedclothes experienced the greatest decrease between 1997 and 2006 (i.e. 51% decrease for furniture and furnishings and 57% decrease for bedclothes).

Casualties

Figure 45 shows the number of casualties in fires with different items first ignited between 1997 and 2006.

Figure 45: Number of casualties by item first ignited – 1997 to 2006

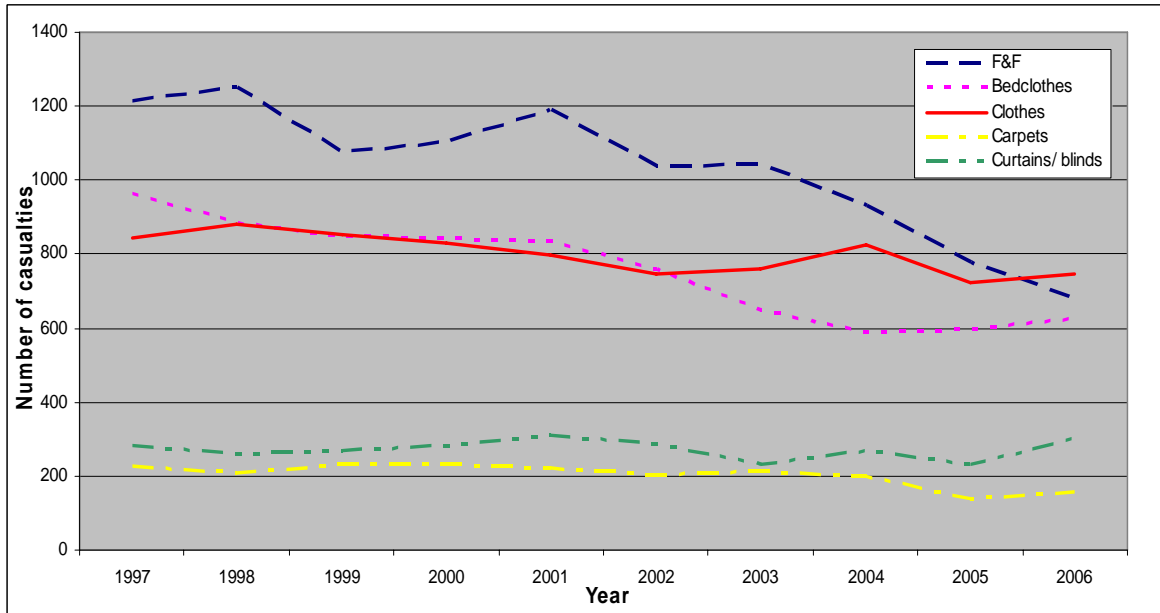


Figure 45 shows that more casualties still occurred in fires where furniture and furnishings were the item first ignited. These casualties nearly halved over this period: 1215 in 1997, decreasing to 682 in 2006.

Deaths

Figure 46 shows the number of deaths in fires with different items first ignited between 1997 and 2006

Figure 46: Number of fire deaths by item first ignited – 1997 to 2006

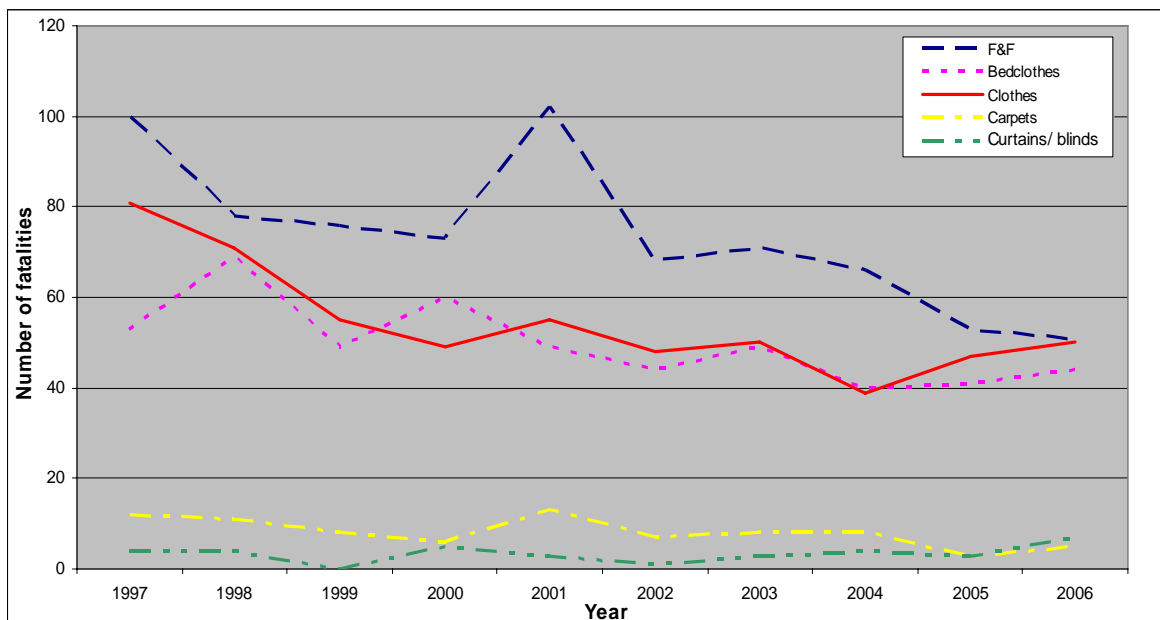


Figure 46 identifies that more fatalities still occurred in fires where furniture and furnishings are the item first ignited. The number of these fatalities halved in this period: in 1997 there were 100 fatalities whereas in 2006 this decreased to 51 deaths.

Thus:

- There was a high number of F&F fires, casualties and deaths where F&F was the item first ignited; and
- The number of F&F fires, casualties and deaths all declined, with a rapid decrease in F&F fires from 2003 onwards.

8.4 Sources of ignition of F&F fires

The analysis aimed to identify whether causes of F&F fires still matched the scenarios that the FFRs represent. Therefore, F&F fires were split according to cause.

Figure 47 shows the causes of F&F fires between 1997 and 2006. This is shown by the average number of F&F fires across this period caused by different SOI.

Figure 47: Causes of F&F fires – 1997 to 2006

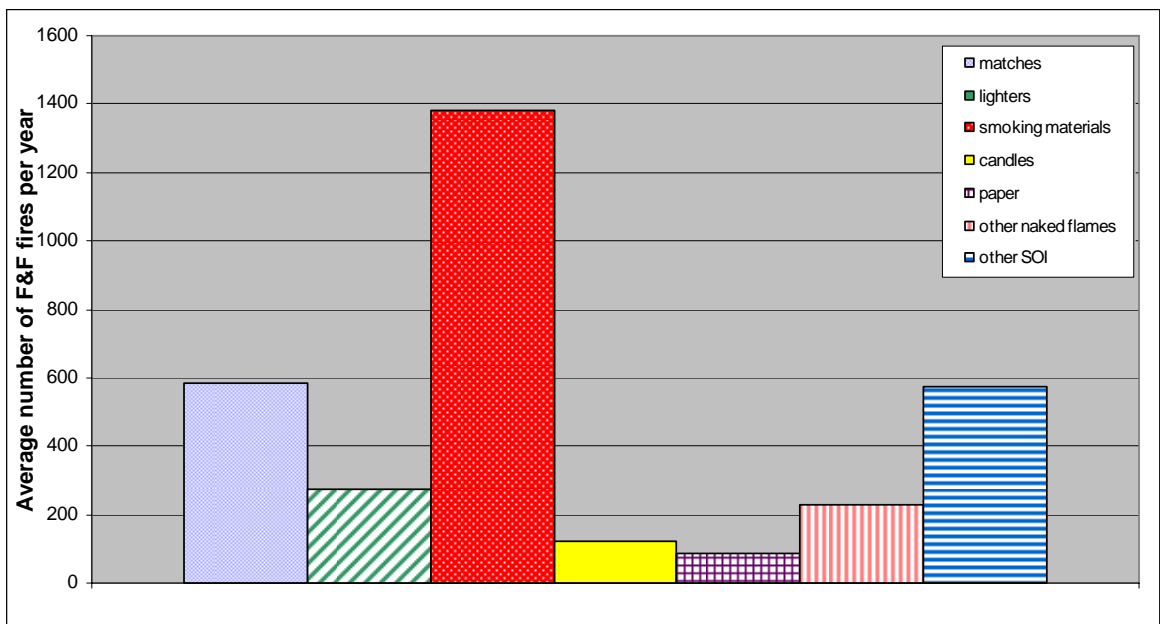


Figure 47 shows that:

- Smokers' materials were still the largest cause of F&F fires between 1997 and 2006, causing an average of 1381 F&F fires per year.
- Matches and other SOI were the next prominent cause of F&F fires, causing an average of around 600 F&F fires per year; and
- The number of F&F fires caused by lighters, candles, paper and other naked flames increased from before the regulations. This indicates that the Crib 5 test may not have been effectively preventing these ignition sources.

Furniture and furnishing fire casualties

Figure 48 shows the average number of F&F fire casualties between 1997 and 2006 caused by different SOI.

Figure 48: Causes of F&F fire casualties – 1997 to 2007

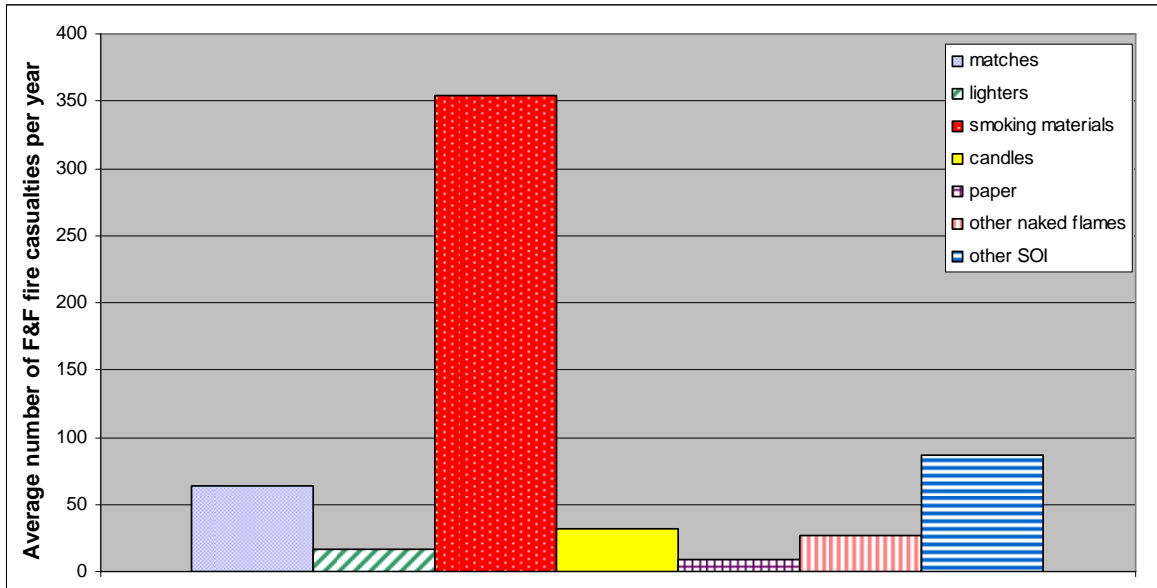


Figure 48 shows that:

- Smokers' materials were still the main cause of F&F fire casualties, causing an average of 350 casualties between 1997 and 2007;
- Matches and other SOI have caused fewer casualties (i.e. matches have caused an average of 119 casualties, other SOI have caused an average of 133 casualties); and
- The number of casualties that were caused by lighters, candles, and other naked flames has increased from the period before the regulations were introduced. This indicates that the Crib 5 test did not protect against these secondary heat sources.

Furniture and furnishing fire fatalities

Figure 49 shows the average number of F&F fire fatalities caused by different SOI between 1997 and 2006.

Figure 49: Causes of F&F fire fatalities – 1997 to 2006

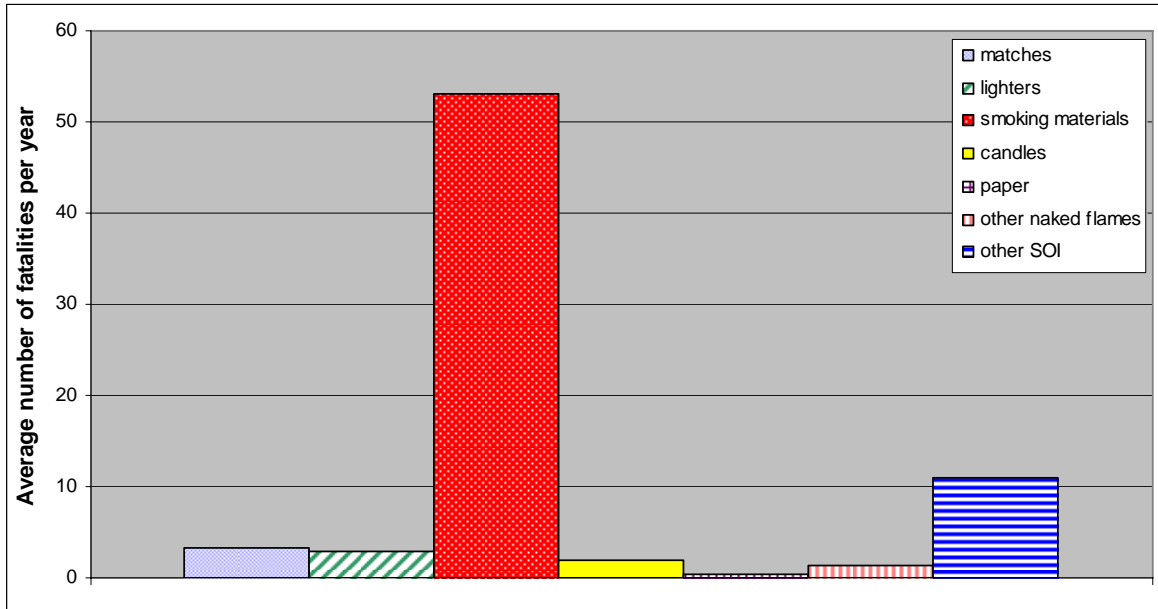


Figure 49 shows that:

- Smokers' materials were still the main cause of F&F fire fatalities with an average of 53 fatalities between 1997 and 2006;
- Other SOI were the second largest cause of F&F fire fatalities but have only caused an average of 11 F&F fire fatalities per year between 1997 and 2006. 44% of these other SOI were open fires and radiant heaters. Items such as electric blankets and lighting also make up this category; and
- Matches caused an average of three F&F fatalities per year between 1997 and 2006.

Thus:

- Smokers' materials remained the main source of ignition of F&F fires;
- Matches remained a major source of ignition of F&F fires, along with other SOI; and
- Lighters, candles and other naked flames became an important source of ignition of F&F fires between 1997 and 2006. However, these did not cause so many deaths.

8.5 Behaviours associated with F&F fires

8.5.1 Children playing with fire

Figure 50 shows the percentage of fatalities in F&F and Other Fires caused by children playing with fire between 1997 and 2006.

Figure 50: Fatalities in fires caused by children playing with fire – 1997 to 2006

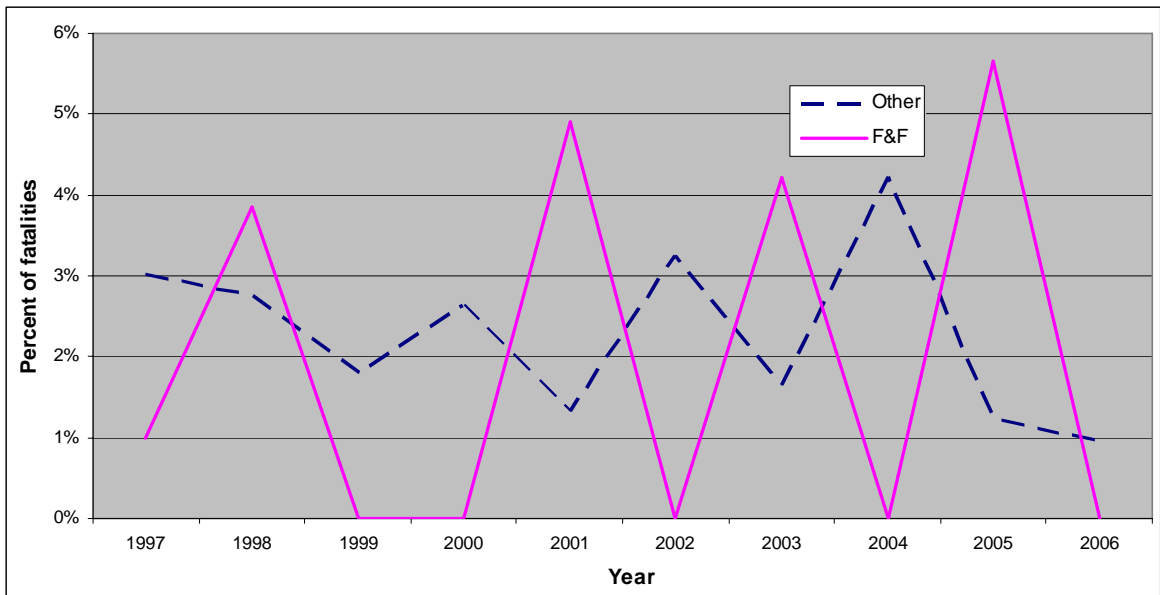


Figure 51 shows the percentage of casualties in F&F and Other Fires caused by children playing with fire between 1997 and 2006.

Figure 51: Casualties in fires caused by children playing with fire – 1997 to 2006

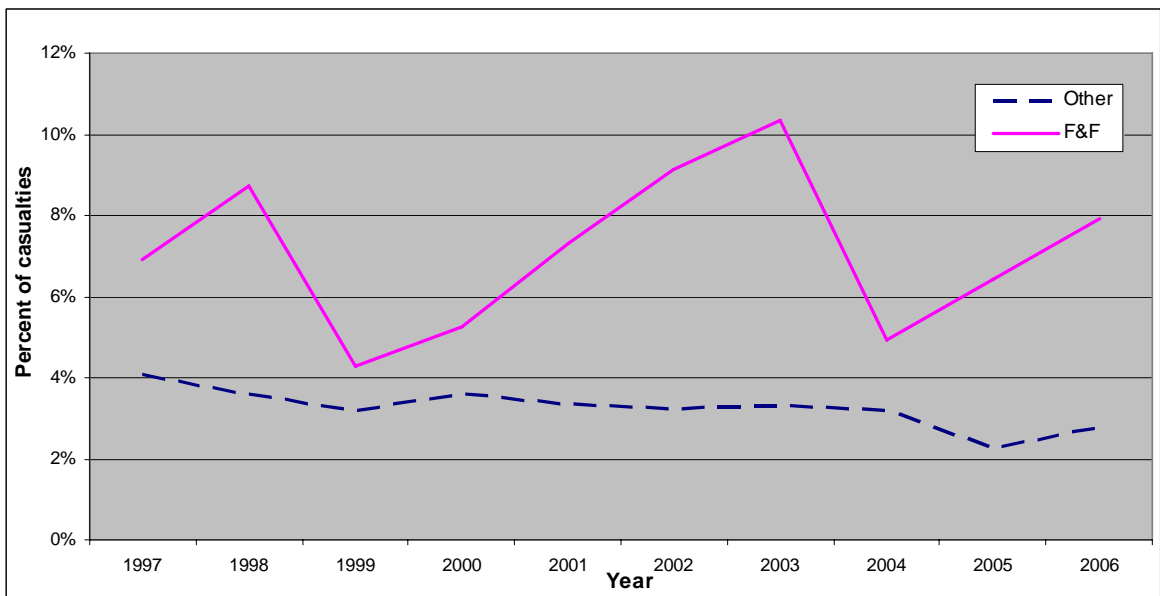


Figure 50 and Figure 51 show that:

- There is no real trend in the percentage of F&F and Other Fire fatalities caused by children playing with matches; and

- The amount of F&F fire casualties caused by children playing with fire has remained higher than that of Other Fire casualties. For example, in 1997 the percentage of F&F fire casualties is nearly twice that of Other Fire casualties.

Thus:

- The trend in the percentage of F&F fire fatalities caused by children playing with fire was very 'noisy' and unclear, often dipping below that of Other Fires;
- The percentage of Other Fires caused by children playing with fire steadily decreased between 1997 and 2006; and
- The percentage of F&F fire casualties caused by children playing with fire fluctuated between 1997 and 2006, and always remained greater than that of Other Fires.

8.5.2 Contributing factors

The contributing factors of causes of F&F and Other Fires were explored in more detail to determine if they had changed since before the FFRs were introduced. This aimed to justify whether the Crib 5 test was effective at preventing F&F fires that were caused by fires being spread easily from the original heat source.

Figure 52 and 53 show the contributing factors to causes of F&F and Other Fire fatalities. This is shown by the average percentage of fire fatalities between 1997 and 2006.

Figure 52: Contributing factors of F&F fire fatalities – 1997 to 2006

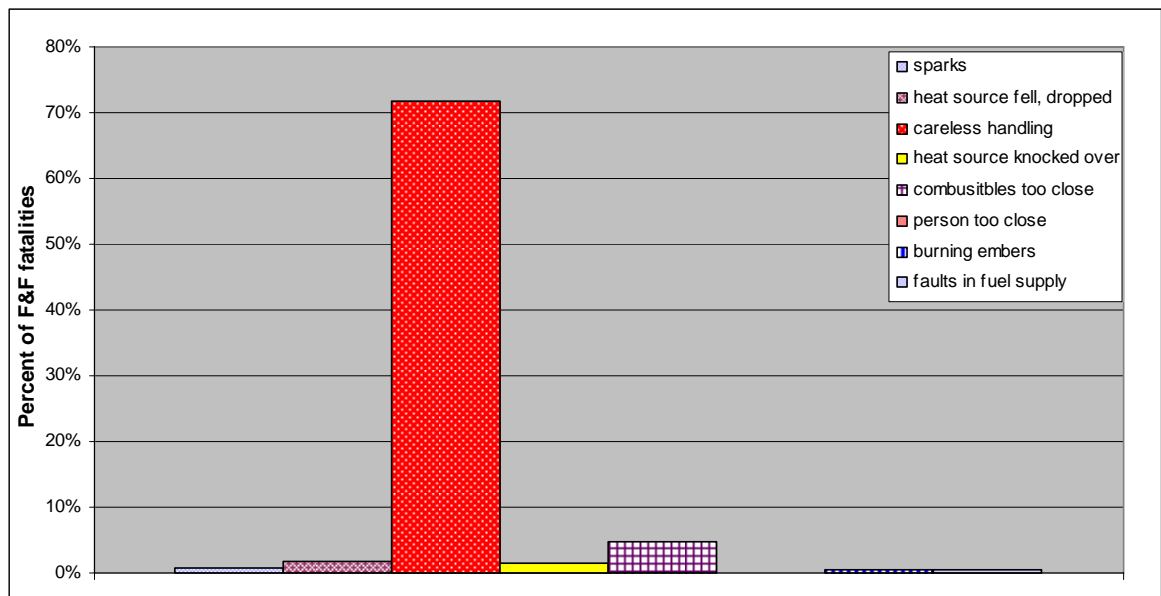


Figure 53: Contributing factors of Other Fire fatalities

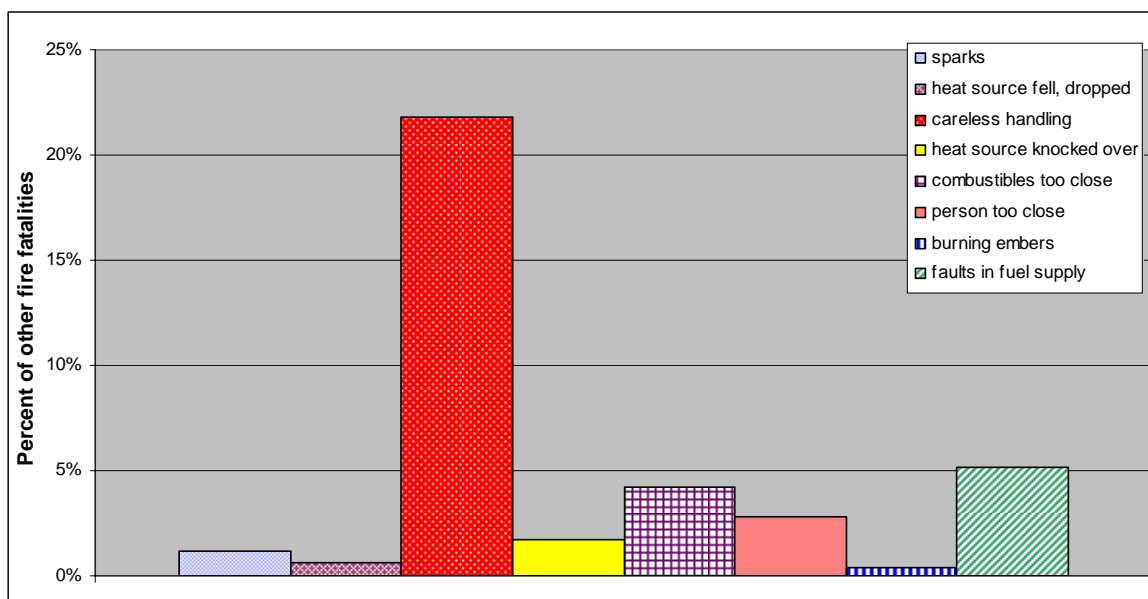


Figure 52 and 53 show that:

Careless handling has remained the largest cause of F&F and Other Fire fatalities. However, this was much lower for Other Fire fatalities than for F&F fire fatalities.

- Combustibles too close to the fire remained the second largest cause of F&F fire fatalities. However, faults in fuel supplies (e.g. faults in wiring circuits and/or gas or oil pipes. Also, faults within appliances, mechanical heat and sparks resulting from equipment defects) were the second largest cause of other fire fatalities.

Figure 54 and 55 show the contributing factors of causes of F&F and Other Fire casualties. This is shown by the average percentage of fire casualties between 1997 and 2006.

Figure 54: Contributing factors of F&F fire casualties – 1997 to 2006

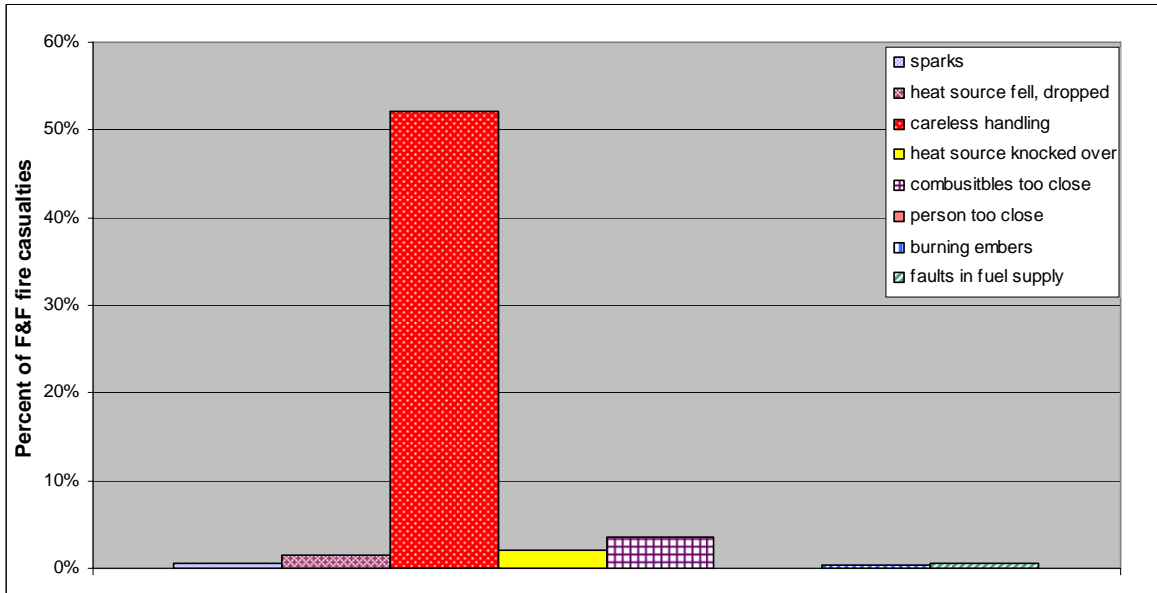


Figure 55: Contributing factors of Other Fire casualties – 1997 to 2006

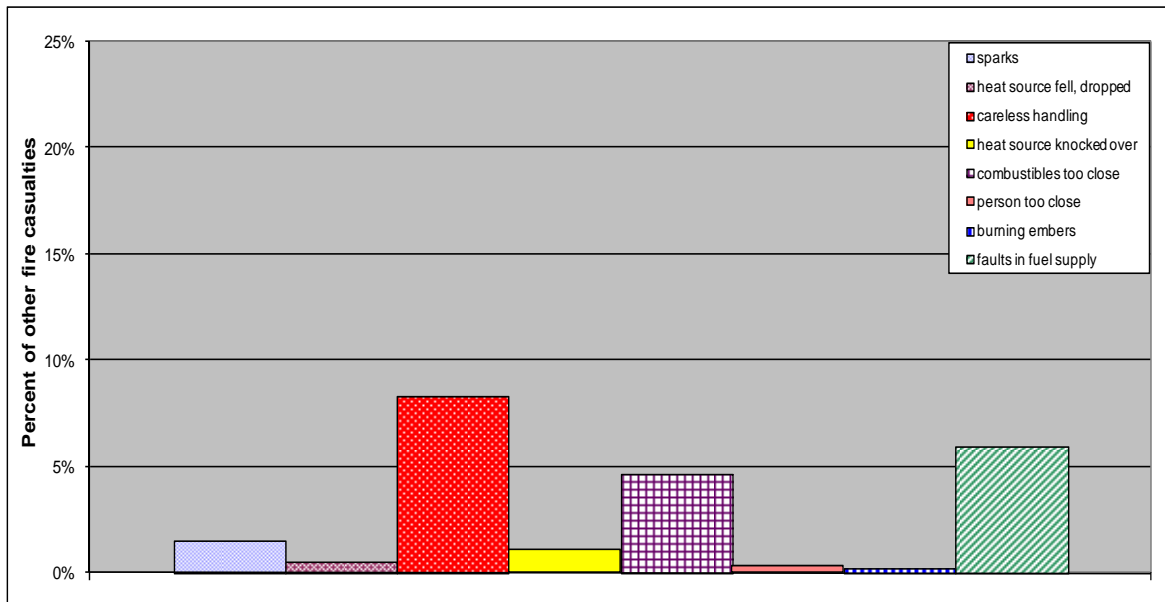


Figure 54 and Figure 55 show that:

- Careless handling has remained the major cause of F&F and Other Fire casualties. However, there is a much larger percentage for F&F fire casualties (52%) than for Other Fire casualties (8%); and

- Combustibles too close to the fire remained the second largest cause of F&F fire casualties. However, faults in fuel supplies was the second largest cause of Other Fire casualties.

Thus:

- Careless handling of fire or a heat source remained the main causes of F&F fire casualties and fatalities; and
- Combustibles too close to the heat source and faults in the fuel supply were also a common contributing factor of Other Fires.

8.6 Material first ignited vs. material mainly responsible

The following analysis looks at data from fires where furniture and furnishings were the material mainly responsible but were ignited by different items.

The Crib 5 test guards against secondary sources that become ignited and spread to furniture and furnishings. These furniture and furnishings would then be the material mainly responsible for the fires. Therefore the analysis has identified the patterns of fire fatalities where secondary sources were the items first ignited and spread to furniture and furnishings which then became the material mainly responsible. This also includes furniture and furnishings being the item first ignited and the material mainly responsible.

Figure 56 shows the average number of fatalities between 1997 and 2007 in F&F fires where different materials were first ignited.

Figure 56: Material first ignited for F&F fire fatalities – 1997 to 2006

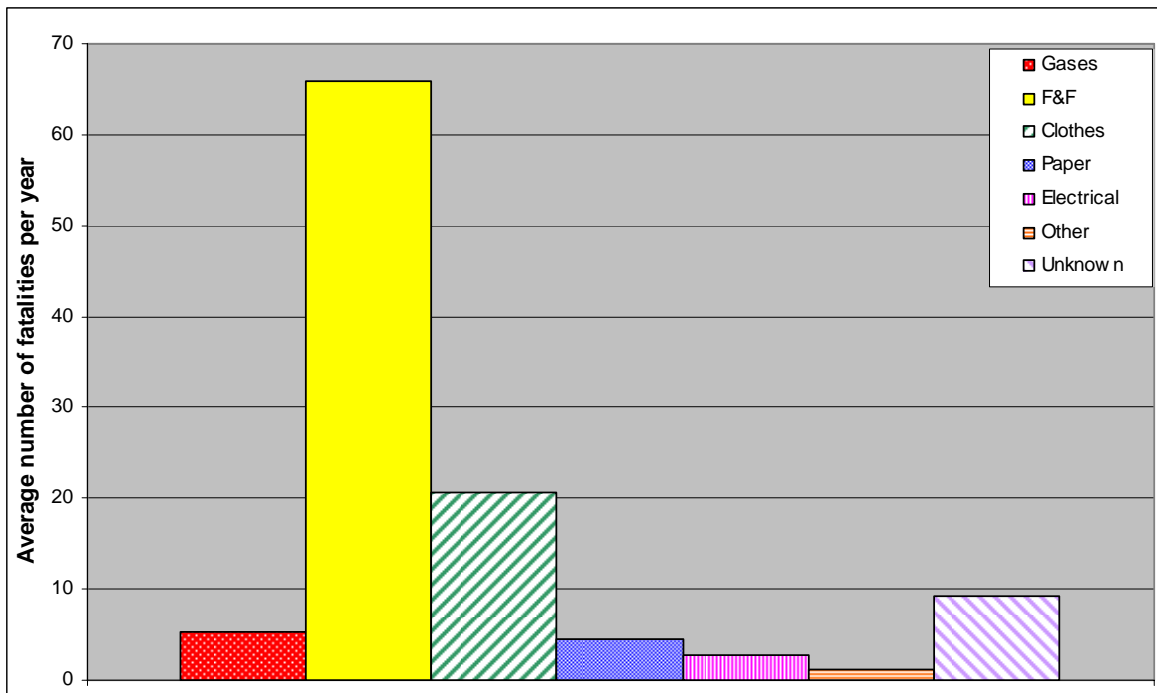


Figure 56 shows that most fatalities still occurred in F&F fires where the material first ignited was furniture and furnishings. For example, an average of 62 fatalities between 1997 and 2006 occurred in F&F fires where furniture and furnishings were the material first ignited.

There were more fatalities that occurred in F&F fires where the material first ignited was clothes.

Thus:

- In most cases, furniture and furnishings were both the item first ignited and the material mainly responsible for fire fatalities; and
- Other materials still only comprised a small minority of items first ignited.

8.7 Lethality and spread of fires

8.7.1 Deaths per fire

F&F fires were considered to be lethal due to spreading quickly and being highly toxic due to the foam fillings in the furniture. Therefore, analysis was conducted to identify whether the lethality of F&F fires had reduced and whether they were still more lethal than Other Fires since the FFRs were introduced.

Figure 57 shows the number of deaths per fire of F&F fires and Other Fires from 1997 to 2006, indicating the lethality of these fires.

Figure 57: Lethality of F&F and Other Fires – 1997 to 2006

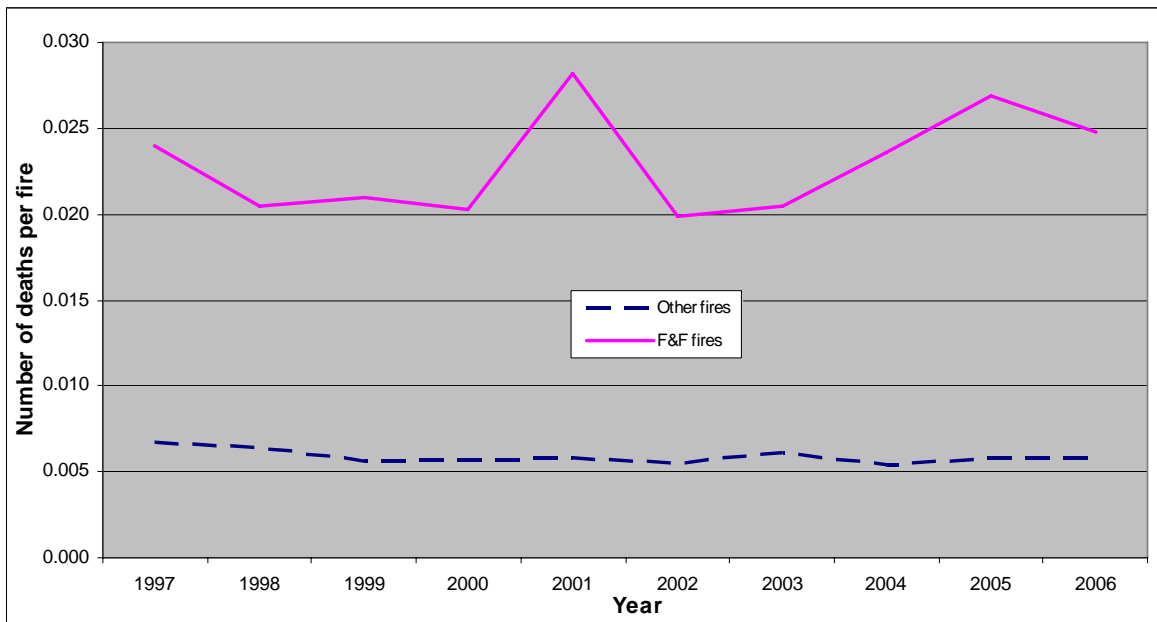


Figure 57 shows that F&F fires were still more lethal than Other Fires over the period 1997 to 2007, as they caused more deaths per fire. For example, in 2006 the number of deaths per F&F fire was over four times greater than that of Other Fires.

8.7.2 Impairment

Analysis was conducted to explore in more detail the causes behind F&F fires and whether they have changed since the regulations were introduced.

Alcohol and sleep impairment

The role of impairment in F&F fire fatalities and casualties was analysed to identify if it has decreased over the years in line with the decline in F&F fires. This might provide a reason why F&F fires, fatalities and casualties have declined. Fires may have still occurred due to impairment, however, but be less lethal due to the FFRs.

Figure 58 shows the percentage of F&F and Other Fire fatalities where people have been impaired by alcohol or sleep.

Figure 58: Alcohol and sleep impairment for fatalities – 1997-2006

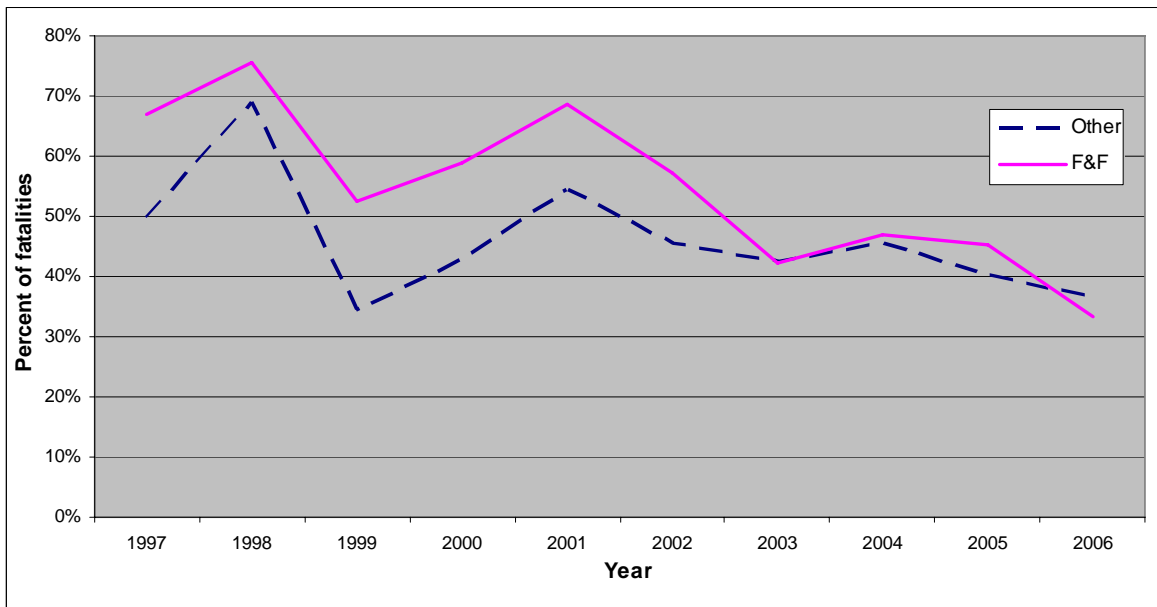


Figure 58 shows that F&F fire fatalities where people are impaired by alcohol or sleep has remained higher than for Other Fire fatalities. This percentage has increased since the period before the FFRs; for example, in 1997 the percentage of F&F fire fatalities where people are impaired was 67%. This however declined to 33% in 2006.

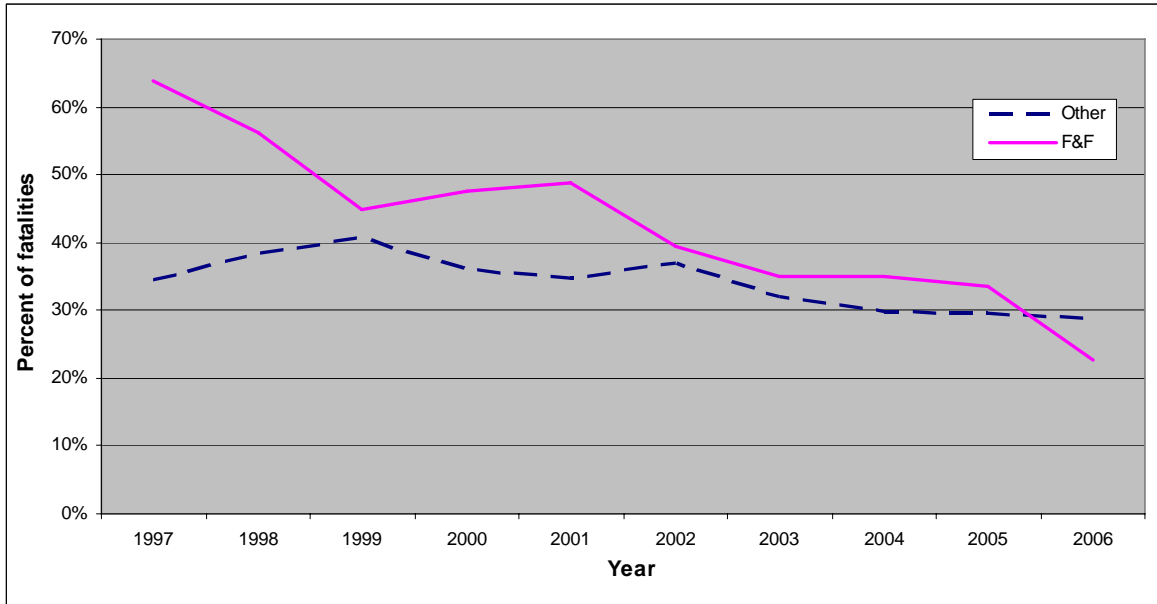
Figure 59 shows the percentage of F&F and Other Fire casualties where people have been impaired by alcohol or sleep. Figure 59 shows that F&F fire casualties where people are impaired by alcohol or sleep has remained higher than that for Other Fire casualties. This percentage has increased since the period before the FFRs; for example, in 1997 the percentage of F&F fire casualties where people are impaired was 64%. This however declined to 23% in 2006.

Thus:

- Casualties in F&F fires were still more likely to be impaired by alcohol or sleep than victims of Other Fires;
- However, there is little difference between F&F and Other Fires from 2002 onwards; and

- The percentage of casualties in F&F fires being impaired by alcohol or sleep declined.

Figure 59: Alcohol and sleep impairment for casualties – 1997-2006

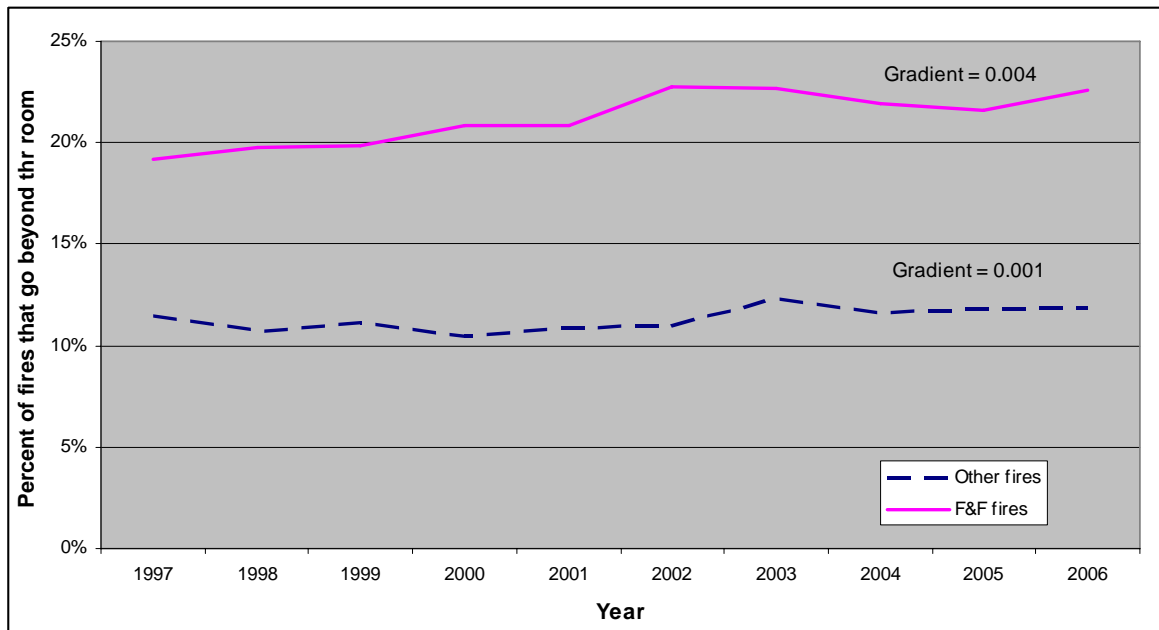


8.7.3 Fire spread

Analysis was conducted to identify if F&F fires still spread further than Other Fires since the Crib 5 test was introduced.

Figure 60 shows the percentage of F&F and Other Fires that spread beyond the room of origin between 1997 and 2006.

Figure 60: Percentage of F&F and Other Fires that go "beyond the room of origin"



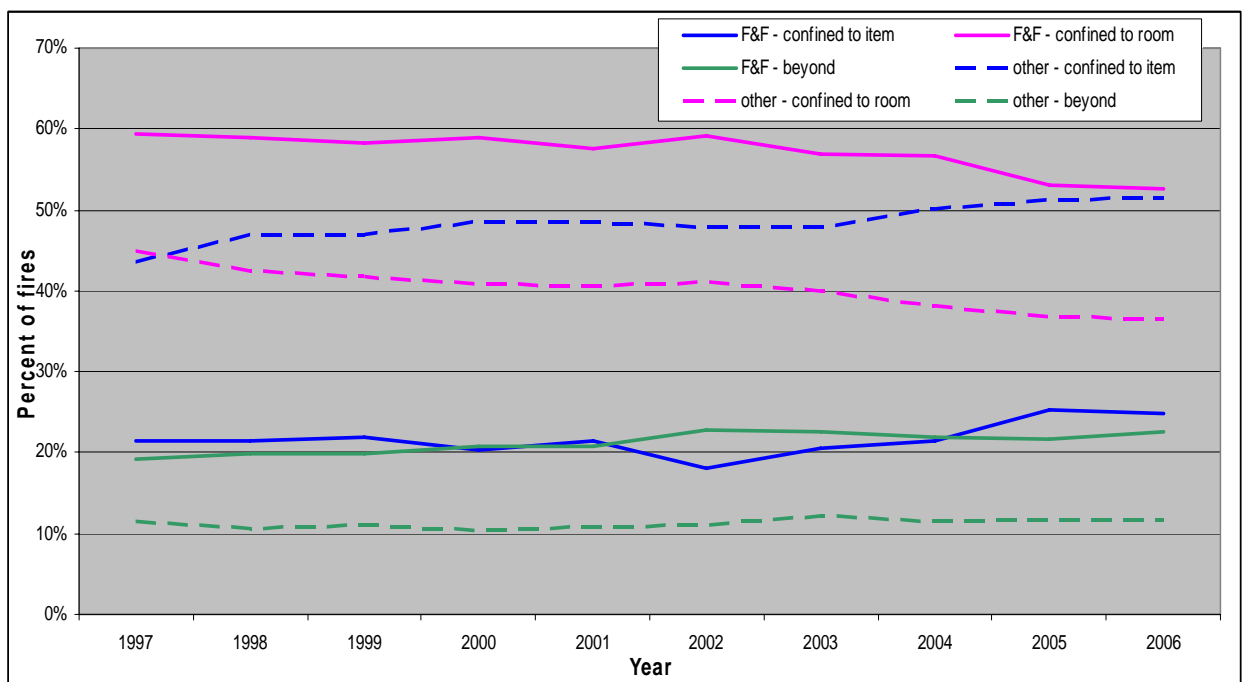
1997 to 2006

Figure 60 shows that more F&F fires still spread beyond the room of origin than Other Fires. The trend of the F&F fires that spread beyond the room of origin increased at a greater rate than Other Fires. This is shown by the steeper gradient of F&F fires (0.004) compared to other fires (0.001).

The spread of F&F and Other Fires was analysed to identify how many fires were confined to the item first ignited, confined to the room and spread beyond the room.

Figure 61 shows the percentage of F&F and Other Fires that were confined to the item first ignited, confined to the room and spread beyond the room between 1997 and 2006.

Figure 61: F&F and Other Fire spread – 1997 to 2006



From Figure 61 it can be seen that:

- More F&F than Other Fires were confined to the room;
- More F&F than Other Fires spread beyond the room of origin;
- Around twice the amount of Other Fires than F&F fires were confined to the item first ignited; and
- F&F and Other Fires that were confined to the item first ignited increased slightly, whereas F&F and Other Fires that were confined to the room decreased slightly.

Thus:

- F&F fires were still more likely to be confined to the room of origin and spread beyond the item of first ignition than Other Fires.

8.7.4 Lethality by extent of fire spread

F&F fires were suggested as being very lethal due to foam fillings when ignited producing toxic smoke and fire spreading very quickly. Therefore, analysis was conducted to identify if F&F fires are still more lethal than F&F fires after the FFRs were introduced, and particularly where the Crib 5 test is concerned.

Figure 62 shows the deaths per F&F and Other Fires that spread beyond the room of origin.

Figure 62: Lethality of F&F and Other Fire spread beyond the room of origin – 1997 to 2006

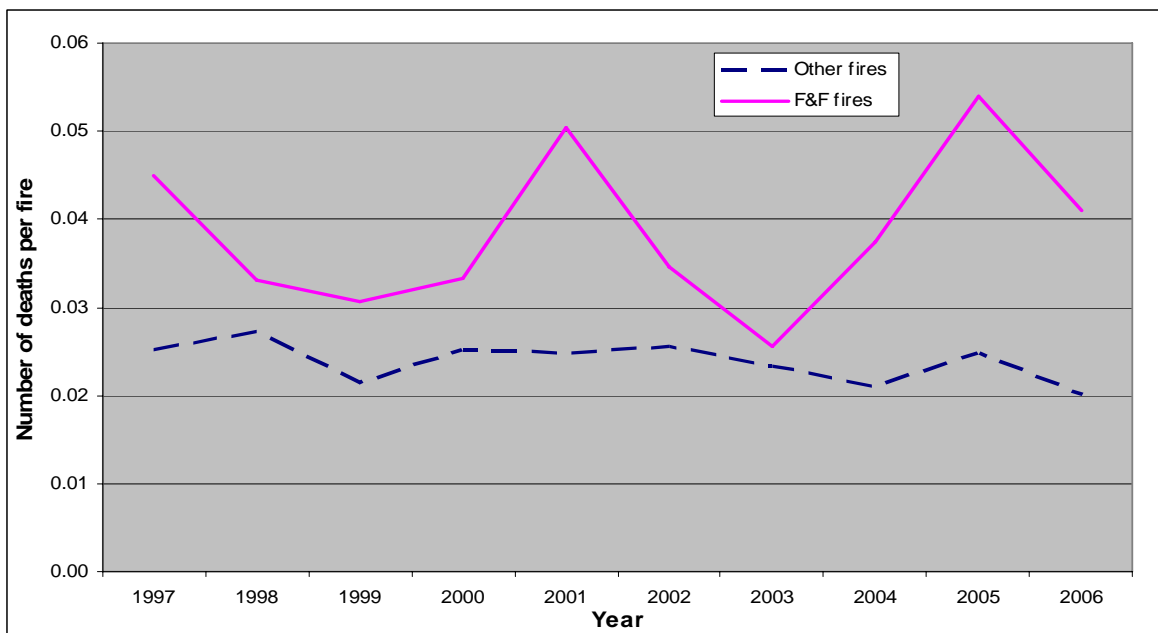
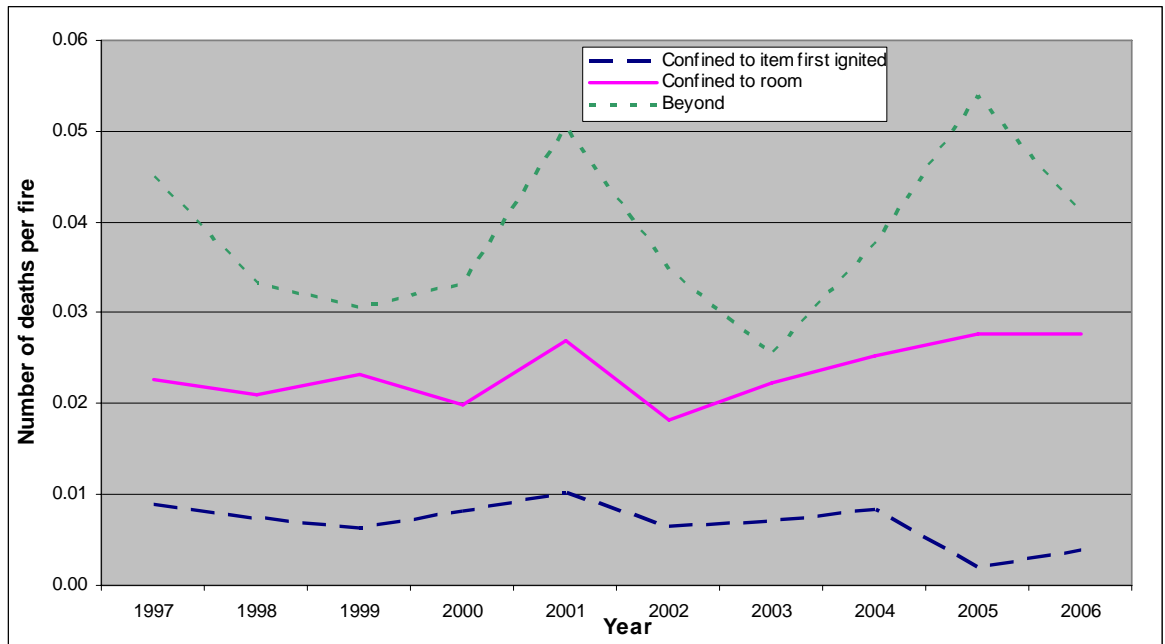


Figure 62 identifies that F&F fires that spread beyond the room of origin were still more lethal than Other Fires after the FFRs were introduced. Figure 63 shows the number of lethality of F&F fire spread between 1997 and 2006. This is shown by the number of deaths per fire.

Figure 63: Lethality of F&F fire spread – 1997 to 2006



It can be seen from Figure 63 that those F&F fires that spread beyond the room of origin were more lethal because they caused more deaths per fire. Those fires confined to the item first ignited were the least lethal. For example, in 2001, F&F fires that spread beyond the room of origin caused five times more deaths per fire than those that were confined to the item first ignited.

Figure 64 shows the lethality of Other Fire spread between 1997 and 2006.

Figure 64: Lethality of Other Fire spread – 1997 to 2006

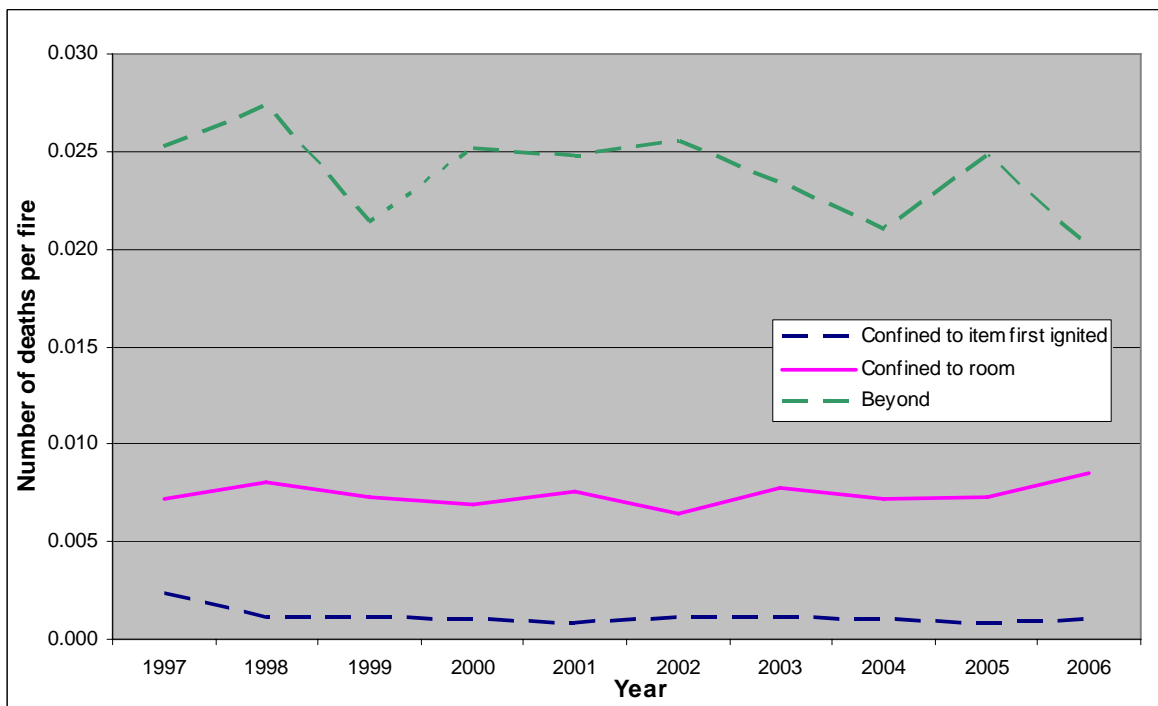


Figure 64 shows that Other Fires that spread beyond the room of origin were more lethal because they cause more deaths per fire. For example, in 2001 the number of deaths per fire that spread beyond the room of origin was 25 times greater than for those that were confined to the item first ignited.

Thus:

- Fires that spread beyond the room of origin caused more fire deaths than fires that did not spread so far; and
- F&F fires that spread beyond the room of origin were still more lethal than other fires that spread beyond the room of origin.

8.8 Type of injury

Analysis was conducted to identify the main injury type in F&F and Other Fire fatalities. The FFRs aimed at reducing the spread of fire and the toxicity of smoke produced by an F&F fire. Therefore, this analysis aimed to highlight whether any changes had occurred in the type of injury causing fatalities and casualties since the FFRs had been in place, e.g. burns and smoke inhalation.

Deaths

Figure 65 shows the average number of F&F fire fatalities between 1997 to 2006 caused by different injury types.

Figure 65: Injury type for F&F fire fatalities – 1997 to 2006

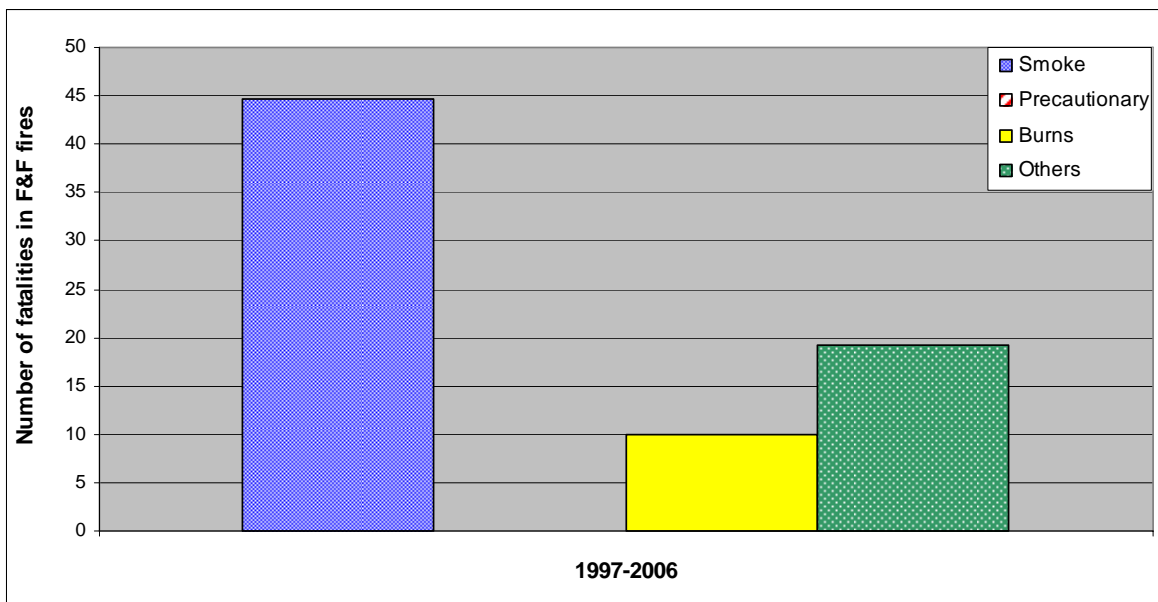


Figure 65 shows that:

- Smoke was the most common cause of F&F fire fatalities, causing an average of 45 fatalities between 1997 and 2006; and

- The second largest cause of F&F fire fatalities was 'other' injuries, causing an average of 19 fatalities between 1997 and 2006. These include physical injuries such as cuts, sprains and fractures, as well as shock. However, it should be noted that this category now includes a combination of smoke and burns, which was not included prior to 1994¹⁰.

Further analysis compared the number of F&F and Other Fire fatalities due to smoke in order to determine if the FFRs had an impact on reducing F&F fire fatalities due to smoke.

Figure 66 compares the percentage of F&F and Other Fire fatalities due to smoke.

¹⁰ From 1994 onwards FDR1 data includes a code referring to a combination of smoke and burns under the 'other' category. This code was not included before 1994.

Figure 66: F&F and Other Fire fatalities caused by smoke

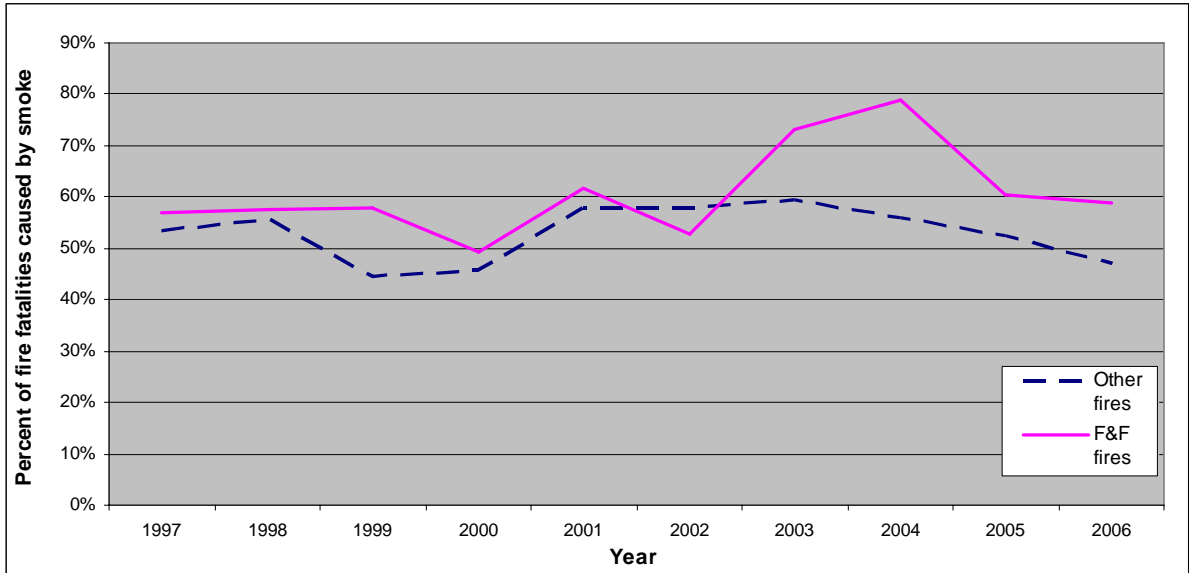


Figure 66 shows that slightly more F&F fire fatalities were caused by smoke than for Other Fire fatalities. For example, F&F fire fatalities due to smoke were around 2 percent greater than Other Fire fatalities until 2001. This gap does increase from 2003 onwards.

Casualties

Figure 67 shows the number of F&F casualties that were caused by different types of injuries between 1997 and 2006.

Figure 67: Injury type for F&F fire casualties – 1997 to 2006

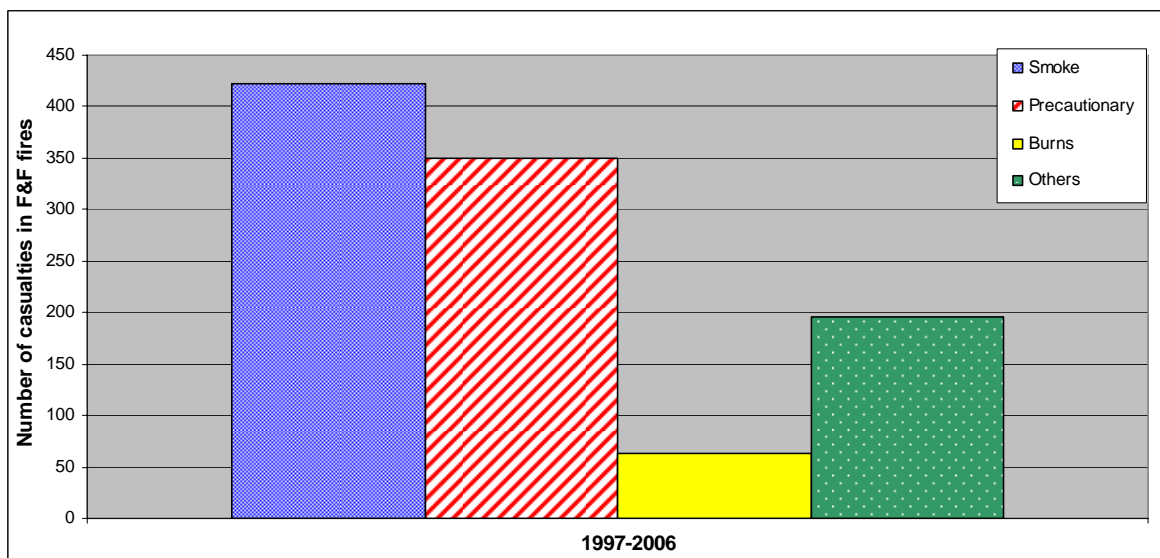


Figure 67 shows that:

- Smoke was the highest cause of F&F fire casualties, causing an average of 422 casualties between 1997 and 2006;
- Precautionary check-ups were the second most common injury type; and
- Burns were the least common injury type, with an average of 64 casualties due to burns between 1997 and 2006.

Further analysis compared the amount of F&F and Other Fire casualties due to smoke, as shown by Figure 68.

Figure 68: F&F and Other Fire casualties due to smoke – 1997 to 2006

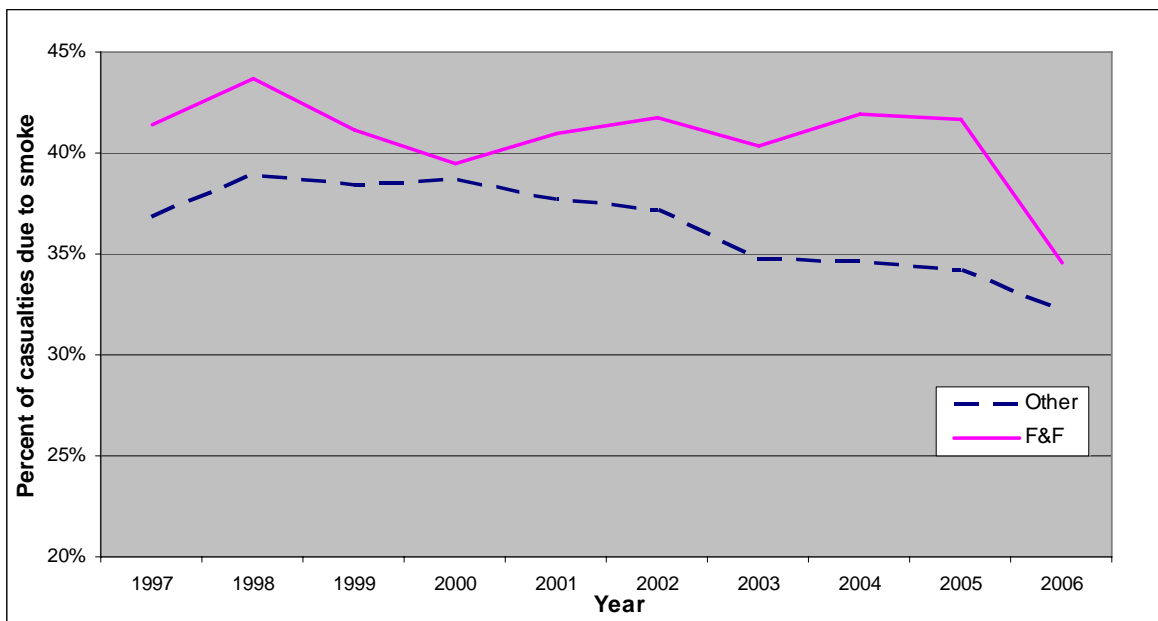


Figure 68 shows that more F&F fire casualties occurred due to smoke than for Other Fire casualties. For example, in 2004 the F&F fire casualties due to smoke were 7% higher than for Other Fire casualties. F&F and Other Fire casualties due to smoke both decreased between 1997 and 2006.

Thus:

- Smoke inhalation was the most common injury type for F&F fire fatalities and casualties;
- F&F fire fatalities and casualties due to smoke were higher than for Other Fire fatalities and casualties; and
- F&F and Other Fire fatalities due to smoke remained at a similar level between 1997 and 2006, whereas F&F and Other Fire casualties due to smoke decreased between 1997 and 2006.

9 APPENDIX E: IMPACT OF THE FFRS

9.1 Trends in numbers of fires, deaths and casualties

9.1.1 Introduction

The aim was to assess whether:

- There was a clear change in the F&F fires trend before and after the FFRs; and
- The trend in the number of F&F fires was different to trends in Other Fires.

It can be noted that:

- The number of F&F fires rose before the FFRs and declined afterwards;
- The trend in the number of F&F fires and fatalities was not significantly different to the trend in Other Fires; and
- The trend in F&F non-fatal casualties was significantly different to the trend in Other Fires, with F&F casualties falling and Other Fire casualties initially rising.

It should be noted, however, that just because the trends in F&F and Other Fires follow the same trajectory, it does not mean that they are caused by the same factors. That is, they could decline at the same rate due to different socio-economic or for fire safety reasons. On the other hand, the similarity of the trends could be interpreted as evidence that they both relate to common underlying factors, such as a general improvement in fire safety behaviour, rather than the trend in F&F fires being specific to the effects of the FFRs.

This point is further explored in section 9.3.

9.1.2 Before and after trends in F&F fires

The trends of F&F fires were analysed to determine if they were different before and after the FFRs were introduced. Figure 69 shows the trend in the number of F&F fires before the FFRs were introduced, just after they were introduced and in the recent period of 1997 to 2006. The trends were split into the three time periods in order to correspond with:

- A period before the FFRs were introduced;
- The period between the introduction of the FFRs and the period covered by the previous evaluation of the impact of the FFRs, namely to 1997; and
- The period since 1997, reflecting the "current day" trend.

It should be noted that a large proportion of pre-1988 furniture may have been naturally replaced by 1997, i.e. it was previously estimated that furniture is replaced at a rate of 4% to 8% per year. Therefore any impact of the FFRs might be expected to diminish after 1997.

These trends are based on the number of fires in the United Kingdom where F&F was the item first ignited, e.g. where a SOI such as a match ignited a sofa.

It can be noted Figure 69 shows that:

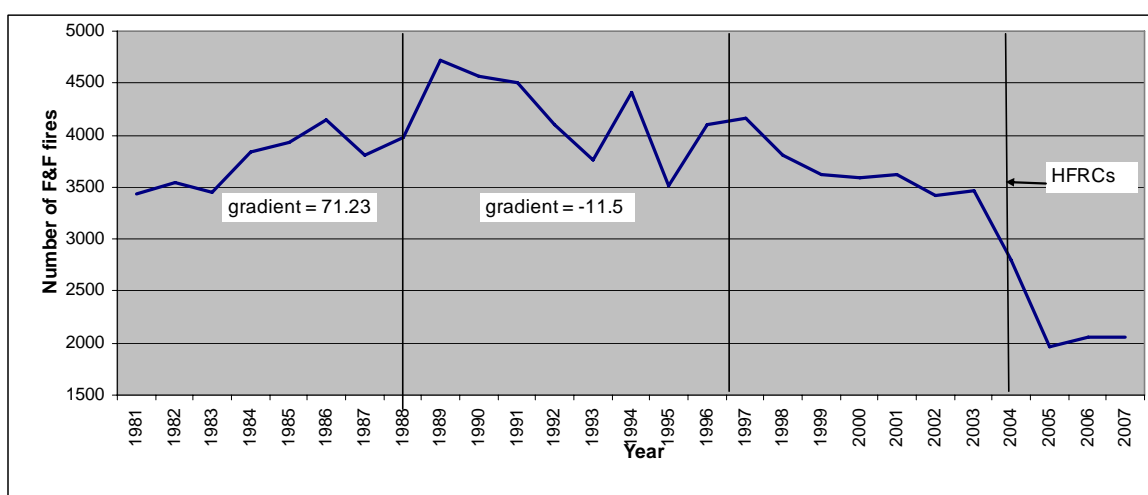
- The number of F&F fires was increasing before the FFRs were introduced. For example, the number of F&F fires increased from 3064 in 1981 to 3317 in 1987 (an 8% increase);

- The number of F&F fires over the years immediately following the introduction of the FFRs (1988 to 1996) fires levelled off; and
- Between the years of 1997 and 2006 the number of F&F fires decreased, e.g. from 4178 in 1997 to 2053 in 2007 (a 51% decrease).

Figure 69 also indicates when community fire safety initiatives such as the Home Fire Risk Check scheme started (2004).

Thus, there was a clear change in the trend after the FFRs were introduced, with a rising trend replaced by a plateau then a decline. The next section compares the trend with that of Other Fires, to see if it was common to all fires.

Figure 69: Number of F&F fires – before and after the FFRs



9.1.3 Comparison of trends in F&F fires against Other Fires

Fires

Analysis also compared the trend of F&F fires with Other Fires to highlight any differences before and after the FFRs were introduced, e.g. to identify if the FFRs significantly reduced F&F fires compared to Other Fires.

Again, the number of fires where F&F was the item first ignited was compared with the number of fires where F&F was not the item first ignited (i.e. all Other Fires). The main types of Other Fires include food, electrical insulation, paper/cardboard, textiles and clothing, bedding, liquids (e.g. petroleum) and gases (e.g. mains gas). Other Fires are used as a control. The trend in Other Fires was assumed to represent a "background" trend, independent of the impact of the FFRs.

The trends in F&F and Other Fires were compared in a number of ways. The main aim was to explore if the rate of change in the number of fires was greater for F&F than for Other Fires. Therefore, analysis involved:

- Comparing F&F with Other Fires, the change in the number of fires between 1985-1988 and subsequent periods;

- Indexing the number of fires at 100 for 1981, then comparing trends over subsequent years; and
- Calculating the rate of change by dividing the number of fires in one year by the number in the previous year, then comparing trends in the rate of change.

Statistical tests were used to check the significance of differences in these trends.

As noted below, two out of the three measures showed that the trend in F&F fires was different to Other Fires, with F&F fires falling faster than Other Fires. The number of F&F fires in 2003-07 was 37% lower than 1981-1985, whilst Other Fires fell by 10% over the same period.

Change in number of fires

Table 4 shows the change, as a percentage, in the number of fires reported in 1985-88 with subsequent periods. By using blocks of years, the amount of statistical volatility in the data is reduced, which helps to identify trends. It can be noted that F&F fires initially rose at a faster rate than for Other Fires, but then fell more than for Other Fires. For example, there were 2% more F&F fires in 1994-97 than 1985-88, but 9% fewer in 1998-01 than in 1985-88.

It should be noted that non-compliant pre-1988/post-1950 furniture is likely to have taken many years to be replaced, as residents buy new furniture to replace older furniture at a rate of about 6% per year. Therefore, it is reasonable to observe a gradual change in the number of fires after 1988 rather than a sudden decline.

Table 4: Change in number of fires compared to 1985 to 1988

	1989-1993	1994-1997	1998-2001	2001-2007
Other Fires	2%	3%	4%	-12%
F&F fires	9%	2%	-9%	-38%
Difference	7%	1%	13%	-26%

A t-test did indicate that the changes were not significantly different ($P > 0.2$). However, with only four data points this may be a type II error, where a true difference is not detected due to the small number of data points.

Indexed number of fires

Figure 70 shows the indexed trend of the number of F&F fires and Other Fires. The number of fires was indexed as 100 at 1981. The number of fires in subsequent years is presented relative to the number in 1981, so if the number of fires increased by 20% this would be an indexed number of 120, and if they fell by 30% this would be an indexed number of 70. Indexing the trend enables the numbers of each type of fire to be comparable on the same axis despite there being far more Other Fires than F&F fires.

Figure 70: Indexed trend of the number of F&F and Other Fires

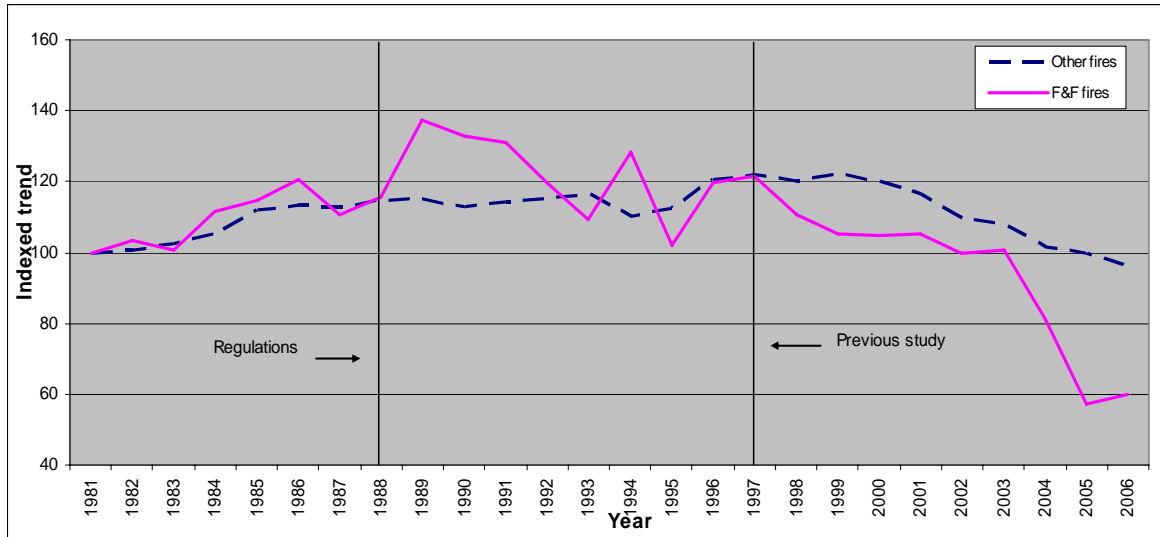


Figure 70 shows that there were no major differences between the trends in the number of F&F and Other Fires until 2004. A series of t-tests indicated that:

- There were no significant differences between the two trends in the period 1981-1988 ($p > 0.3$); and
- There were significant differences between the two trends in the periods 1989 to 1997 ($p < 0.05$) and 1998 to 2006 ($p < 0.01$).

Thus, whilst F&F and Other Fires increased at the same rate before the introduction of the FFRs, F&F fires fell at a different rate afterwards, initially rising faster and then declining faster than Other Fires.

Rate of change in number of fires

Figure 71 shows the rate of change per year for F&F and Other Fires from 1982 to 2006. The rate of change measures if fires rose or fell from one year to the next, and the amount by which the number of fires changed.

Figure 71: Rate of change for F&F and Other Fires

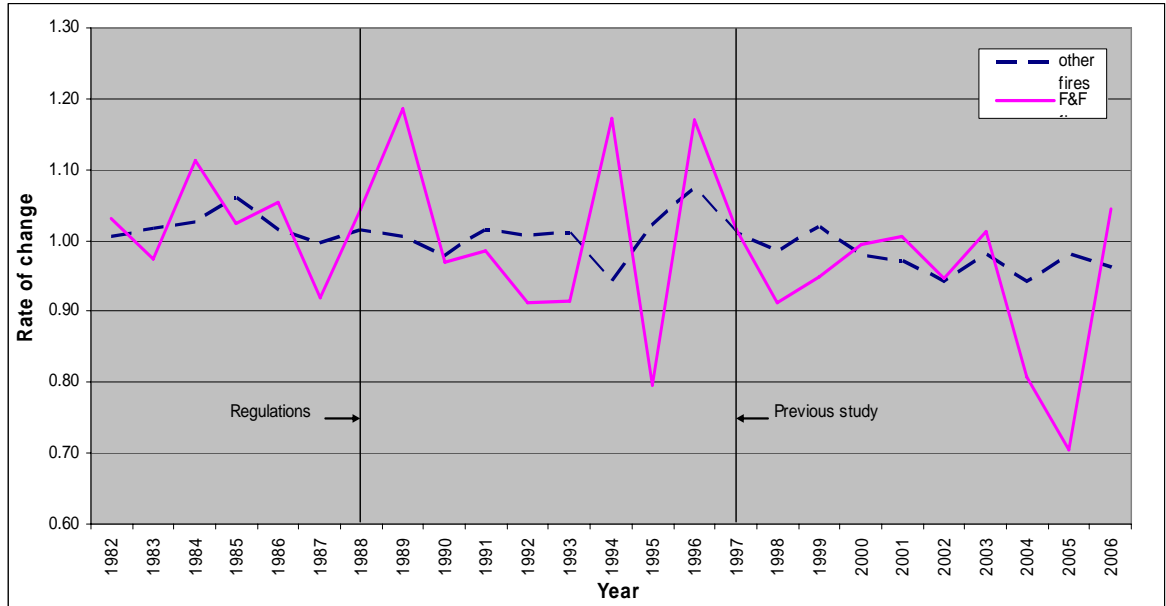


Figure 71 shows that although the rate of change per year for Other Fires follows a smoother line than that for F&F fires, there was no major difference in the rate of change for F&F and Other Fires. It should be noted that as there are far more Other Fires than F&F fires, the trend in Other Fires is likely to be "smoother" than in F&F fires. The trend in F&F fires is likely to be somewhat volatile due to the relatively lower rate of F&F fires.

The rate of change in the number of F&F and Other Fires between 1981 and 2006 were not correlated¹¹:

- 0.376 for 1981-1988;
- -0.066 for 1989-1997; and
- -0.008 for 1998-2006.

However, t-tests indicated that there were no significant differences between two sets of data for any of the three time periods (1981-1988, 1989-1997 and 1998-2006). Thus, using this measure, there was no significant difference between the rate of change of F&F fires and the rate of change of Other Fires ($p > 0.05$).

¹¹ Correlations range from -1 through 0 to +1. They are graded as 0 to 0.19 = Very Low, 0.2 to 0.39 = Low, 0.4 to 0.59 = moderate, 0.6 to 0.79 = strong, >0.79 = very strong.

F&F and Other Fire dwelling fire fatalities

Analysis also compared the trend of F&F fire fatalities with Other Fire fatalities in order to highlight any differences before and after the FFRs were introduced. The same three measures were used. Care should be taken in assessing these trends because the trend in F&F fire deaths is volatile, i.e. it rises and falls greatly from one year to the next. This was due to the relatively smaller number of F&F fire deaths, starting at 173 in 1981 but falling to 49 in 2007. The high volatility of this trends made it difficult to compare with the trend in Other Fires.

As with the number of fires, two out of the three measures indicated that F&F fire deaths fell more than Other Fire deaths, if with somewhat weaker statistical support.

Nonetheless, the number of fire deaths fell by 64% for F&F fires and 44% for Other Fires between 1981-85 and 2003-07. Thus, F&F fire deaths fell more than Other Fire deaths.

Change in number of fire deaths

Table 5 shows the change in the number of fire deaths between 1985-88 and subsequent periods. The number of F&F fires fell more than Other Fires in all periods except for 2002-07.

Table 5: Change in number of dwelling fire deaths since 1985-88

	1989-1993	1994-1997	1998-2001	2002-2007
Other Fires	-17%	-19%	-27%	-41%
F&F fires	-27%	-34%	-31%	-35%
Difference	-10%	-15%	-4%	6%

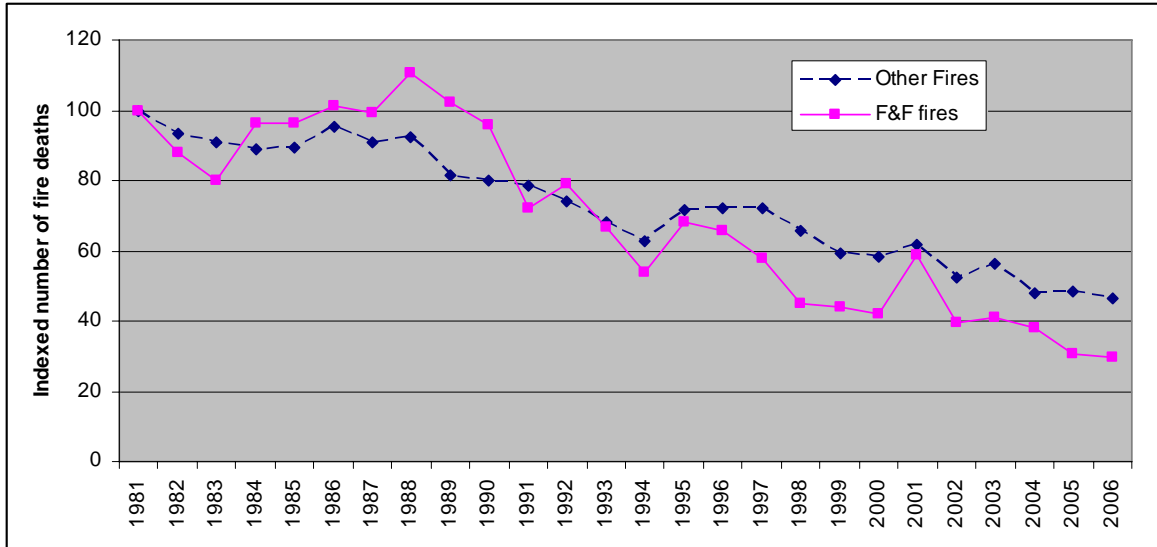
As with fires, these differences were not significantly different, but again this may be due to the small number of data points.

Indexed number of dwelling fire deaths

Figure 72 shows the indexed trend of the number of F&F and Other Fire fatalities, again using 1981 as an origin of 100. The two trends had a low correlation ($r = 0.22$) in the period 1981-88, with F&F fire deaths tending to rise whilst Other Fire deaths fell. After 1988 the two trends are very similar with very strong correlations ($r = 0.87$), i.e. after 1988 they both started to fall at about the same rate. However, after 1997 the two trends appear to diverge again, with a t-test indicating they are significantly different ($p < 0.01$).

Thus, the number of F&F deaths appears to have risen before 1988, possibly more so than Other fires, then joins Other Fires in declining after 1988, with a faster rate of decline after the mid-1990s. Therefore, there was some evidence here of a difference in the trends in fatalities between F&F and Other fires.

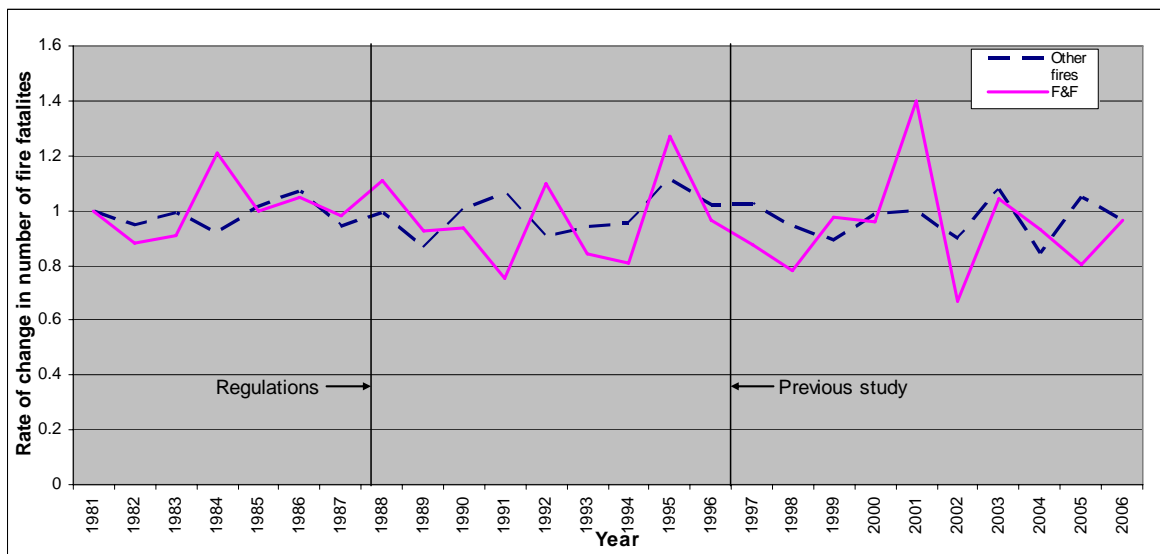
Figure 72: Indexed trend of the number of F&F and Other Fire fatalities



Rate of change in number of fire deaths

Figure 73 shows the trends in the change in the number of fire deaths. There were no apparent differences in the trends using this measure. The t-tests again found no differences in the trends in any of the three time periods (1981-88, 1989-97 or 98-06).

Figure 73: Rate of change in number of fire deaths



F&F and Other Fire casualties

There was a major difference in the trends for non-fatal dwelling fire casualties between F&F and Other Fires. Between 1981-85 and 2003-07:

- F&F fire casualties fell by 26%; and
- Other Fire casualties rose by 75%.

The difference in the trends is shown in Figure 74, which shows the indexed trends of F&F and Other Fire casualties between 1981 and 2006. Figure 74 shows that the trends of F&F and Other Fire casualties were similar between 1981 and 1991 as they were both increasing at a similar rate. However, F&F fires decreased after the FFRs were introduced and earlier than Other Fire casualties. It was not until 1998 that Other Fire casualties began to decrease.

The differences in the trends are clearly large and were found to be significantly different by a t-test ($p < 0.000002$).

Figure 74: Indexed trend of casualties – 1981 to 2006

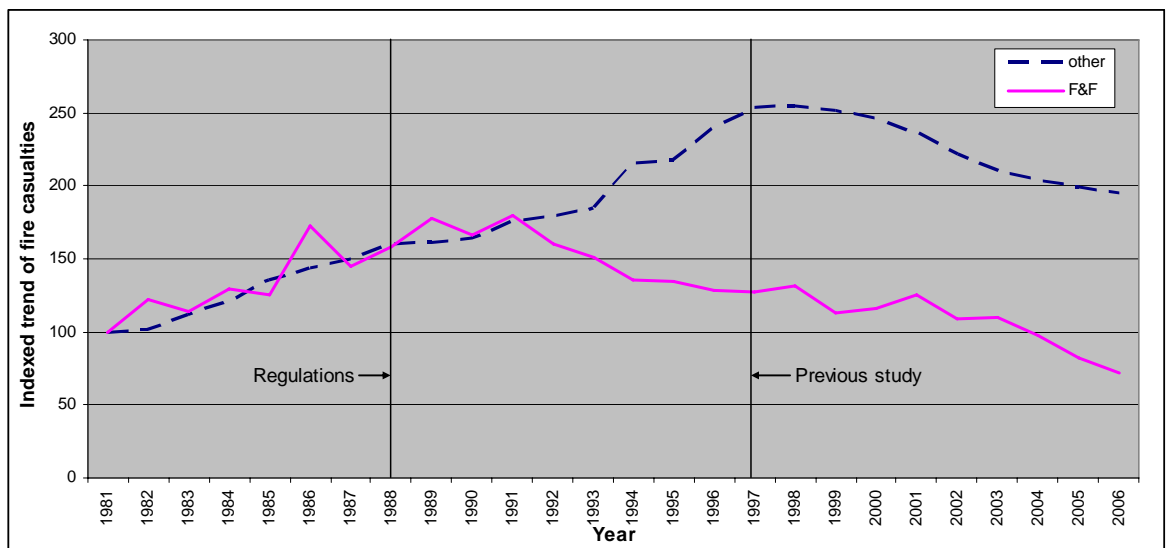


Table 6 shows the number of non-fatal casualties for each time period and the rate of change (number in one period divided by previous period) between them. Clearly, the F&F casualties declined after 1989-93 whilst Other Fire casualties continued to rise. It is pertinent to note that these differences, despite being large, are not statistically significant, again due to the small number of data points.

Table 6: Average number per year of non-fatal dwelling fire casualties and rate of change

		1981-1984	1985-1988	1989-1993	1994-1997	1998-2001	2002-2007
Other Fires	Number	5,866	9,390	10,927	13,754	14,484	11,834
	Rate of change		1.60	1.16	1.26	1.05	0.82
F&F	Number	1,108.5	1,427	1,587	1,251	1,155	865
	Rate of change		1.29	1.11	0.79	0.92	0.75

9.1.4 F&F fires versus other textile fires

The trends in F&F fires, fire deaths and fire casualties were also compared with other textile fires. The aim here was to explore whether the trend in F&F fires differed from other types of textile fires. The results indicate that all types of textile fires followed similar trends, except in the case of casualties, where F&F casualties and bedclothes fire casualties fell whilst other causes rose.

Fires

It can be noted from Figure 75 and Table 7 that F&F fires initially rose along with bedding but then decreased whilst clothes, carpet, curtain and blind fires changed little.

Figure 75: F&F fires versus other textile fires (1981 to 2006)

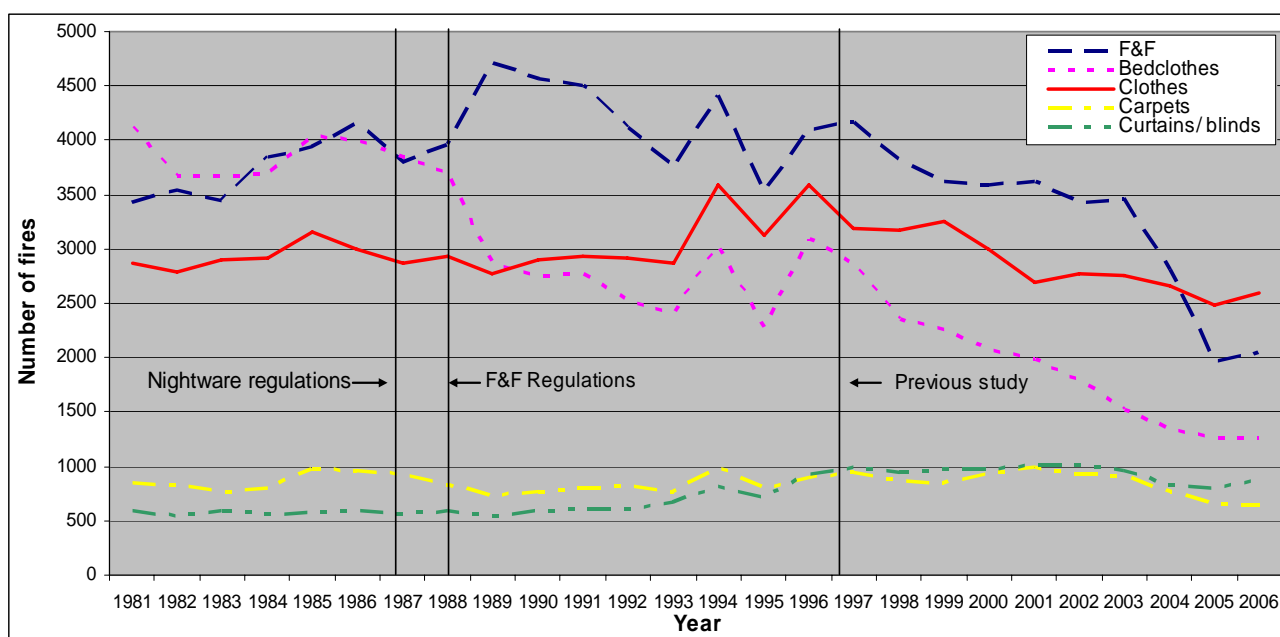


Table 7: Change in the number of textile fires (1981-87 vs. 2000-2006)

	1981-1987	1988-1999	2000-2006	Pre- regulations vs. 2000-2006
F & F	3,737	4,104	2,989	-20% decrease
Bedclothes	3,862	2,744	1,610	-58% decrease
Clothes	2,928	3,105	2,709	-7% decrease
Carpets	877	844	831	-5% decrease
Curtains and blinds	576	749	924	+61% increase

Fire deaths

In the case of fire deaths, according to Figure 76:

- F&F fire fatalities initially rose whilst other textile fire fatalities decreased; and
- All categories tended to fall across the study period except for curtain and blind fire fatalities which rose from a low level.

Figure 76: F&F fire fatalities versus other textile fire fatalities (1981 to 2006)

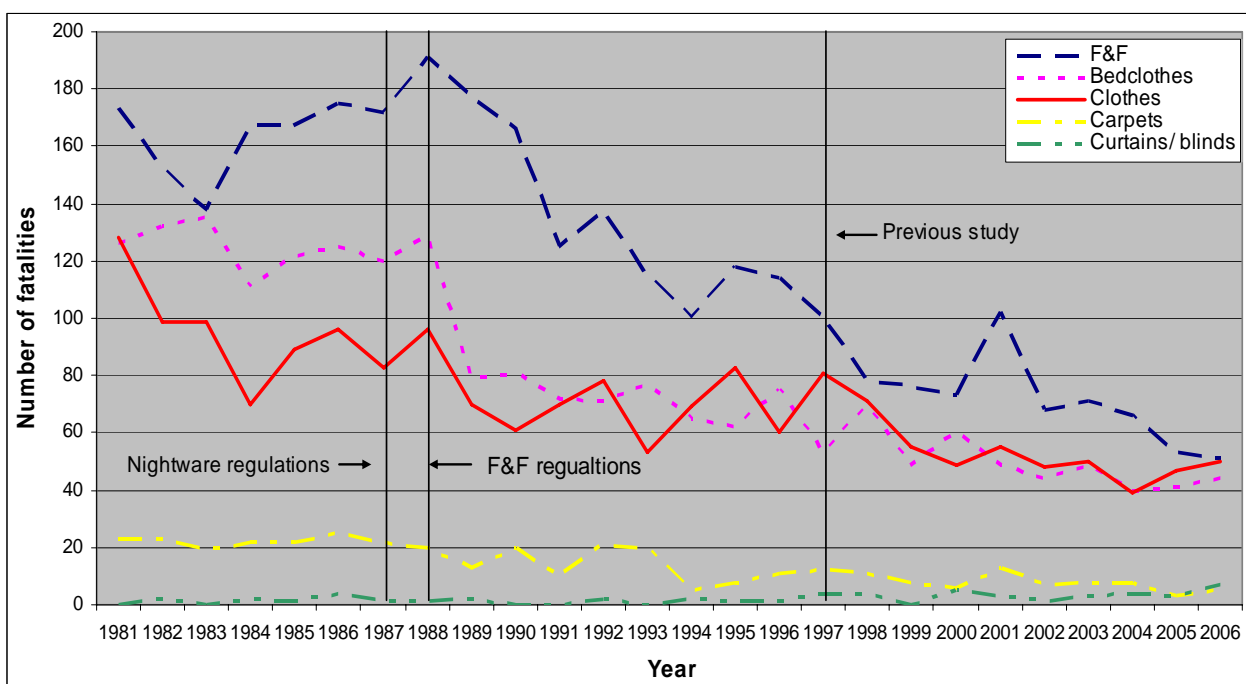


Table 8: Change in the number of textile fire fatalities (1981-87 vs. 2000-2006)

	1981-1987	1988-1999	2000-2006	Pre- regulations vs. 2000-2006
F & F	163	125	69	-58% decrease
Bedclothes	124	74	47	-62% decrease
Clothes	95	71	48	-49% decrease
Carpets	22	13	7	-68% decrease
Curtains and blinds	1.4	1.4	4	+160% increase

Fire casualties

In the case of casualties it was found that F&F fire casualties decreased the most, with the majority of other categories rising.

Figure 77: F&F fire casualties versus other textile fire casualties (1981 to 2006)

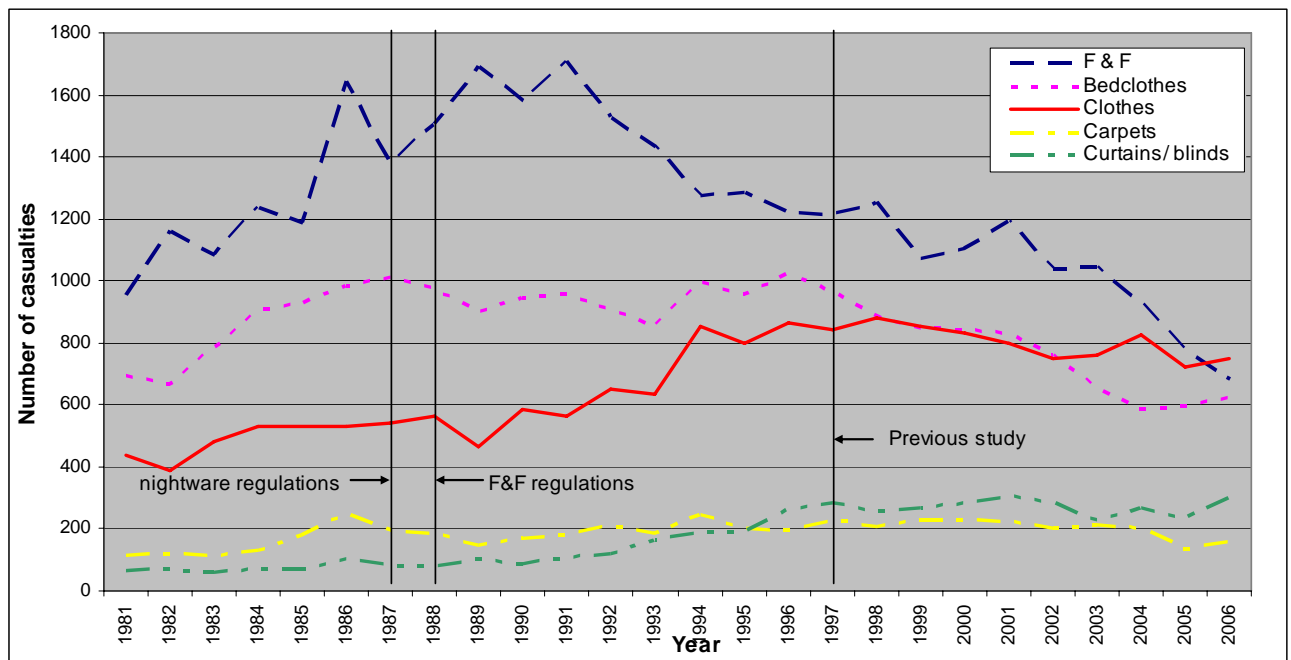


Table 9: Change in number of textile fire casualties (1981-87 vs. 2000-2006)

	1981-1987	1988-1999	2000-2006	Pre regulations vs. 2000-2006
F & F	1,234	1,397	967	-22% decrease
Bedclothes	853	935	700	-18% decrease
Clothes	490	713	776	+55% increase
Carpets	158	200	195	+23% increase
Curtains and blinds	75	178	274	+267% increase

9.2 Sources of ignition and causes of fires

9.2.1 Introduction

The aim was to explore if those SOI targeted by the FFRs (cigarettes, matches and other stronger SOI) had declined overall and relative to other SOI. If the targeted SOI had declined more than other SOI, it might indicate a specific impact of the FFRs.

As elaborated in this section, the SOI targeted by the FFRs did fall after their introduction whilst other causes rose. The subsequent section explores factors, other than the FFRs, that may have contributed to these trends.

9.2.2 Furniture and Furnishing fires

As a first step, the SOI of F&F fires were analysed to identify if there had been any changes to the causes of the fires before and after the FFRs were introduced.

Figure 78 shows the average number of F&F fires caused by different SOI. The data has been presented for periods of five years, such as 1981 to 1985, to enable a clear presentation of trends.

Figure 78: Causes of F&F fires

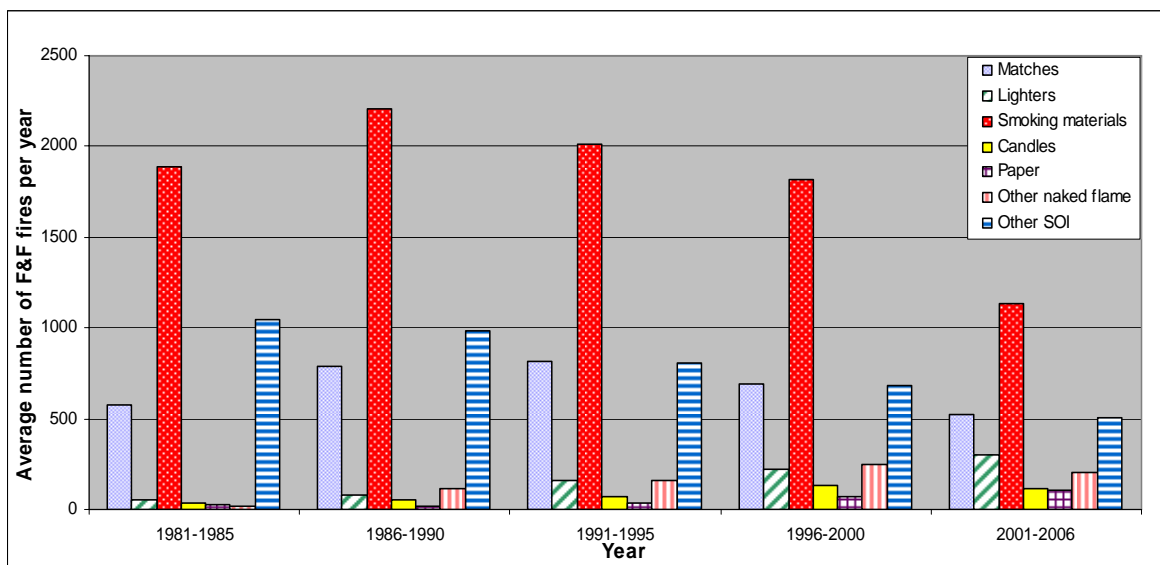


Figure 78 indicates that:

- The average number of F&F fires caused by smokers' materials increased in the years before the FFRs were introduced but started to decrease afterwards;
- The average number of F&F fires caused by matches also increased before the FFRs and then decreased afterwards;
- The average number of F&F fires caused by other SOI steadily decreased between 1981 and 2006;
- The average number of F&F fires caused by lighters continued to increase between 1981 and 2006; and

- The average number of F&F fires caused by paper, candles and other naked flames generally increased over the years after the FFRs were introduced.

Thus, the sources targeted by the regulations (cigarettes, matches and other stronger sources) declined, whilst some other SOI rose. Care must be taken in interpreting this finding, as some of these trends could reflect societal change. For example, the increase in fires caused by lighters and candles might reflect their increased usage. Also, there has been a decline in the number of adult cigarette smokers in this period. This issue is assessed further in section 9.3.3.

9.2.3 Furniture and furnishing fire fatalities

The SOI of F&F fire fatalities were analysed to identify if there had been any changes to the causes of the fires before and after the FFRs were introduced.

Figure 79 shows the average number of F&F fire fatalities caused by different SOI between 1981 and 2006.

Figure 79: Causes of F&F fire fatalities

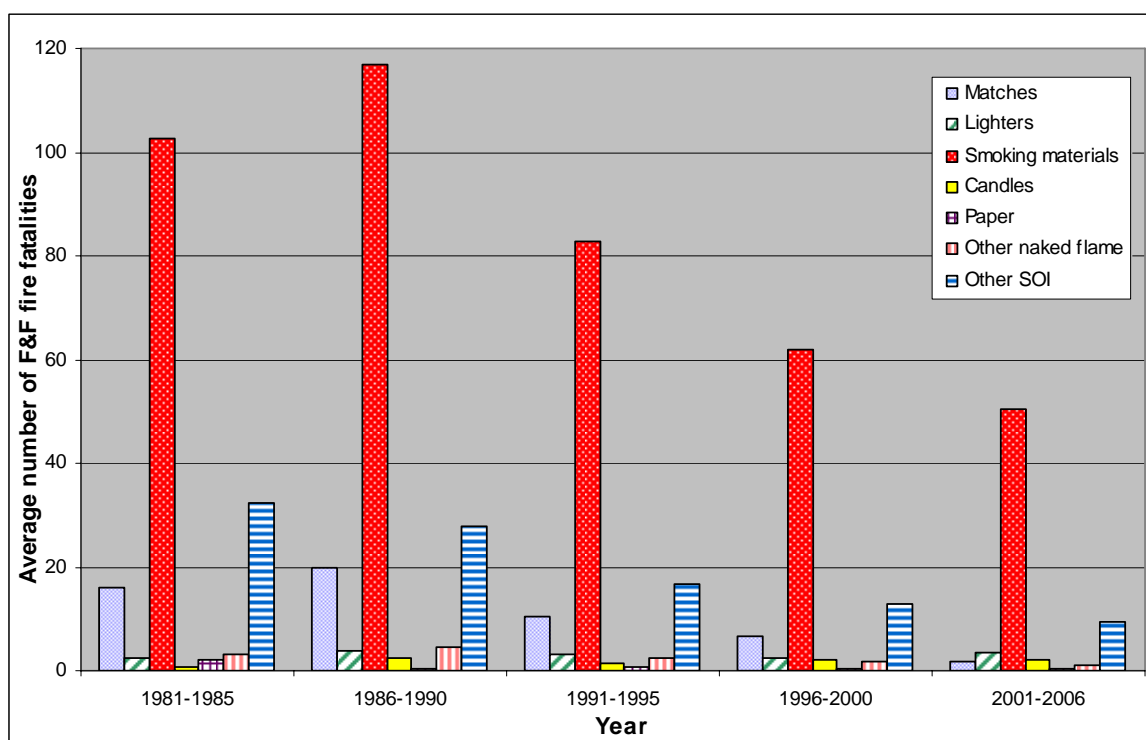


Figure 79 indicates that:

- The average number of F&F fire fatalities caused by smokers' materials and matches increased in the years before the FFRs were introduced but started to decrease afterwards;
- The average number of F&F fires caused by other SOI decreased between 1981 and 2006. In addition, the type of other SOI changed between 1981 – 1993 and 1994 – 2006:
 - Between 1981 and 1993 other SOI were mainly radiant heaters/open fires (61%); and

- Between 1994 and 2006 other SOI were radiant heaters/open fires (44%) but there were also more lighting (3.5%) and electrical (4.9%) fires reported; and
- The average number of F&F fire fatalities between 2001 and 2006 caused by lighters and candles exceeded those caused by matches.

Thus, again, the sources targeted by FFRs decreased whilst other sources rose.

9.2.4 Furniture and furnishing fire casualties

Figure 80 shows the average number of F&F fire casualties caused by different SOI between 1981 and 2006.

Figure 80: Causes of F&F fire casualties

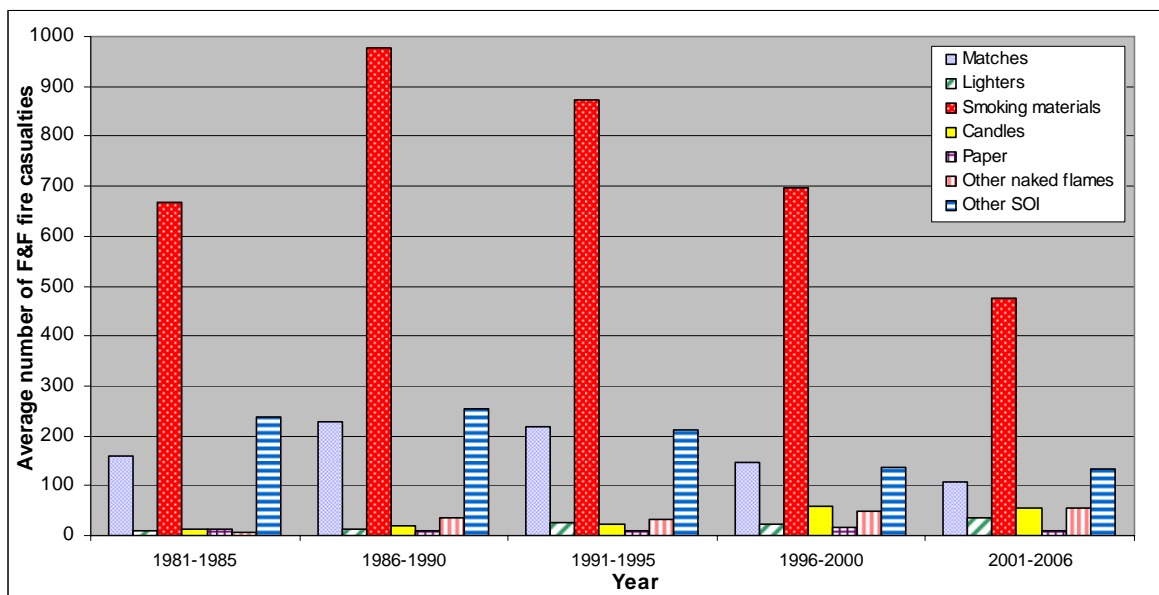


Figure 80 indicates that:

- The average number of F&F fire casualties caused by smoker's materials, matches and other SOI increased before the FFRs were introduced but then began to decrease in the years after; and
- The average number of F&F fire casualties caused by lighters, candles and other naked flames increased between 1981 and 2006.

9.2.5 Discussion

Thus, in the case of fires, deaths and casualties, those causes targeted by the FFRs rose before their introduction then fell afterwards, whilst other causes rose throughout the period before and after introduction of the regulations.

Some of the latter increases may reflect social trends. That is, other sources that increased included:

- Cigarette lighters – which might reflect increased use of lighters;
- Candles – possibly reflecting an increase in their use in the home; and

- Electric blankets and hair dryers – reflecting greater use of electrical items.

There may also be fewer open fires due to the installation of central heating systems.

In addition, fires caused by smokers' materials may have declined for reasons other than the FFRs. This possibility is explored further in section 9.3.3.

9.2.6 Material first ignited vs. material mainly responsible

Fire data is also available regarding what material was "Mainly Responsible" for fires. For example, a match may ignite paper in a rubbish bin which spreads to a sofa. If burning of the sofa causes more damage than the bin fire, the sofa would be the item mainly responsible for the fire, whilst the paper in the bin would be the "Item First Ignited". It is possible for the item first ignited to also be the item mainly responsible for the fire, such as a sofa being ignited by matches and causing most of the fire damage. Therefore, this offers another way of assessing trends in the causes of F&F fires, and whether certain causes of fire targeted by the FFRs had changed more than other causes.

The Crib 5 test guards against stronger ignition sources, such as where a fire spreads from one item to the F&F. Therefore the analysis identified the patterns of fire fatalities for where F&F was the item mainly responsible for a fire over the period of 1981 and 2006.

Figure 81 shows the average number of fatalities in F&F fires with differing materials first ignited.

Figure 81: F&F fire fatalities with material first ignited – 1981 to 2006

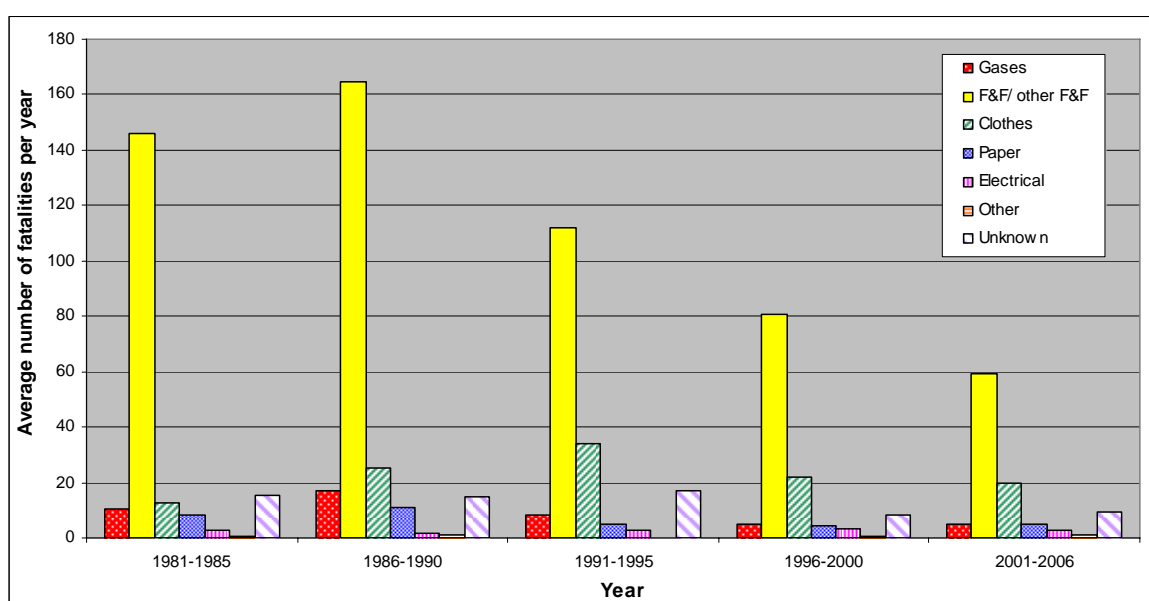


Figure 81 shows that in most cases F&F was the item first ignited and the item mainly responsible for the fire. These increased in the years before the FFRs were introduced, but decreased after they were in place. For example, the average number of fatalities in the periods of 1981 to 1985 and 1985 to 1990 increased by 13%. By 2001 to 2006 this had decreased by 64%.

The average number of fatalities in F&F fires where clothes, gases (such as LPG) and paper were the materials first ignited also increased before the FFRs were introduced and decreased afterwards.

These changes are consistent with the trends in the SOI for F&F fires.

9.3 Exploration of factors underpinning trends in the number of F&F fires

9.3.1 Children playing with fire

The aim was to explore to what extent the reduction in the number of F&F fires could be attributed to fire safety education of children.

The pattern of F&F and Other Fire fatalities and casualties caused by "children playing with fire" was analysed to determine any changes since the FFRs were brought in. Children playing with fire was examined because there was an increase in schools-based fire safety education in the study period and other fire safety schemes aimed at children. Therefore, the comparison should show a greater fall in F&F fires involving children playing with matches in order for the FFRs to be associated with an impact over and above the wider fire safety education work.

Figure 82 and 83 show the indexed number of F&F and Other Fire fatalities and casualties caused by children playing with fire between 1981 and 2006.

Fire deaths

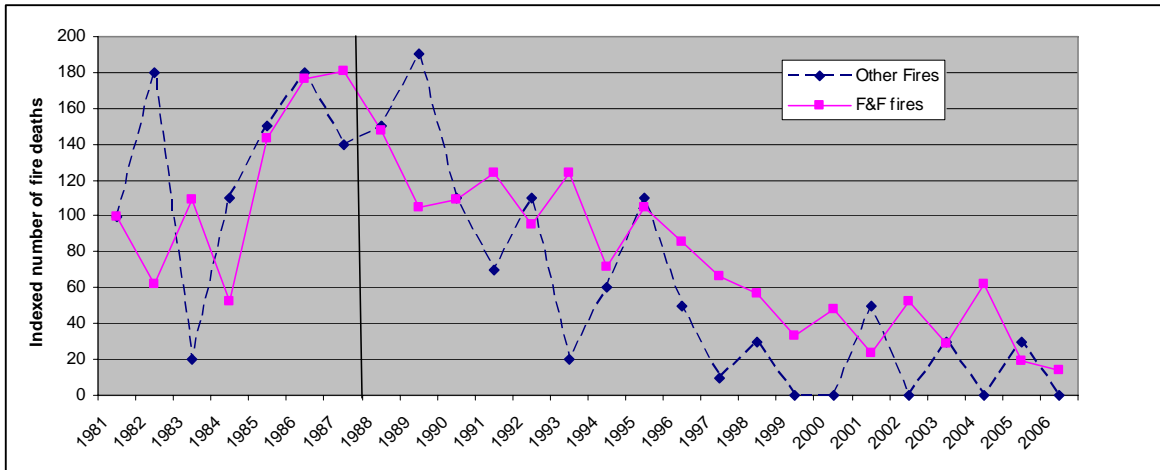
The comparisons indicate that:

- The number of fire deaths fell more for Other Fires than for F&F fires over this period, as shown in Table 10; and
- The trends in the Indexed number of fire deaths were very similar, as in Figure 82, with only the period 1998-2006 different (i.e. Other Fires declining more than F&F fires).

Table 10: Average number per year of fire deaths involving children playing with matches

	81-85	86-88	89-93	94-97	98-01	02-06	Change from 1985-88 to 2002-06
Other Fires	11	16	10	6	2	1	92%
F&F fires	20	35	23	17	9	7	79%

Figure 82: Indexed number of fire fatalities caused by children playing with fire – 1981 to 2006



Casualties

- Table 11 shows that there was a greater fall in the number of F&F casualties than for Other casualties;
- The rate of change was not significantly different in any of the time periods (pre-1989, 1989-1997, or 1989-2006), as per Figure 83; and
- The indexed trends in the number of casualties were different in all three times periods ($P < 0.05$), as per Figure 84.

Thus, there was some evidence of a more marked trend amongst F&F fires.

Table 11: Average number per year of non-fatal casualties involving children playing with fire

	81-85	86-88	89-93	94-97	98-01	02 to 06	Change from 1985-88 to 02-06
F&F fires	128	151	184	118	75	71	53%
Other Fires	367	477	576	593	458	331	31%

Figure 83: Rate of change in fire casualties caused by children playing with fire – 1981 to 2006

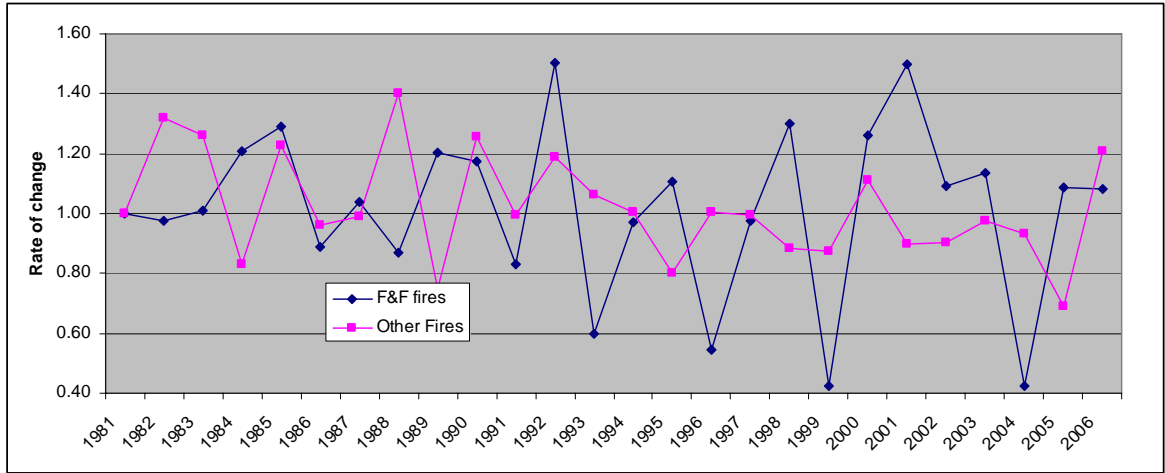
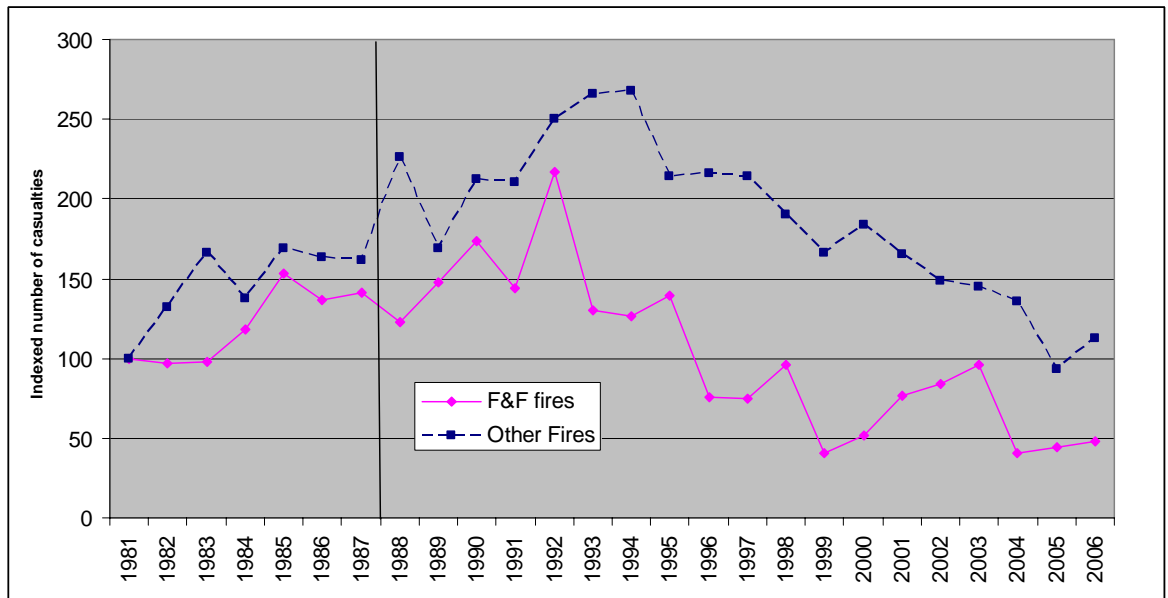


Figure 84: Indexed number of non fatal fire casualties involving "children playing with matches"



It can be noted that:

- F&F fire fatalities caused by children playing with fire fell by 12 per year between the period 1981-85 and 2002-2006. This accounts for 12% of the fall in all F&F fire fatalities; and

- F&F fire casualties caused by children playing with fire fell by 57 between the period 1981-85 and 2002-2006. This accounts for 25% of the fall in all F&F fire casualties over this period.

Thus, the fall in F&F fire deaths and casualties may have been caused, in part, by a general fall in the role of children playing with matches over this period. However, it would account for a small part of the fall in fire deaths.

9.3.2 Contributing factors

Data is also available on other "behaviours" that contributed to fires. These were analysed to explore if the reduction in F&F fires was specific to those types of behaviour targeted by the FFRs, and whether the reduction in smokers' materials fires was more pronounced in F&F fires.

Fire deaths

Analysis was conducted to explore in more detail the contributing factors of the causes of F&F and Other Fire fatalities and casualties. Figure 85 and 86 show the contributing factors, as a percentage, to causes of F&F and Other Fire fatalities. This is shown by the average percentage of F&F and Other Fire fatalities between 1981 and 2006. Table 12 and Table 13 show the average number of F&F and Other Fire fatalities between 1981 and 2006.

"Careless handling" tends to involve careless handling of smokers' materials, such as dropping lighted matches.

Careless handling caused a greater proportion of F&F fires and so would have a greater impact on F&F fires than on Other Fires.

Figure 85 and Figure 86 and Table 12 and Table 13 show that:

- "Careless handling of fire or heat source" fell as a cause of Other Fire fatalities between 1986-1990 and 2006, but it fell more for F&F than Other Fires; and
- "Burning embers" fell for Other Fires, in the same way that most of the other contributing factors fell for F&F fires.

Figure 85 Contributing factors of F&F fire fatalities – 1981 to 2006

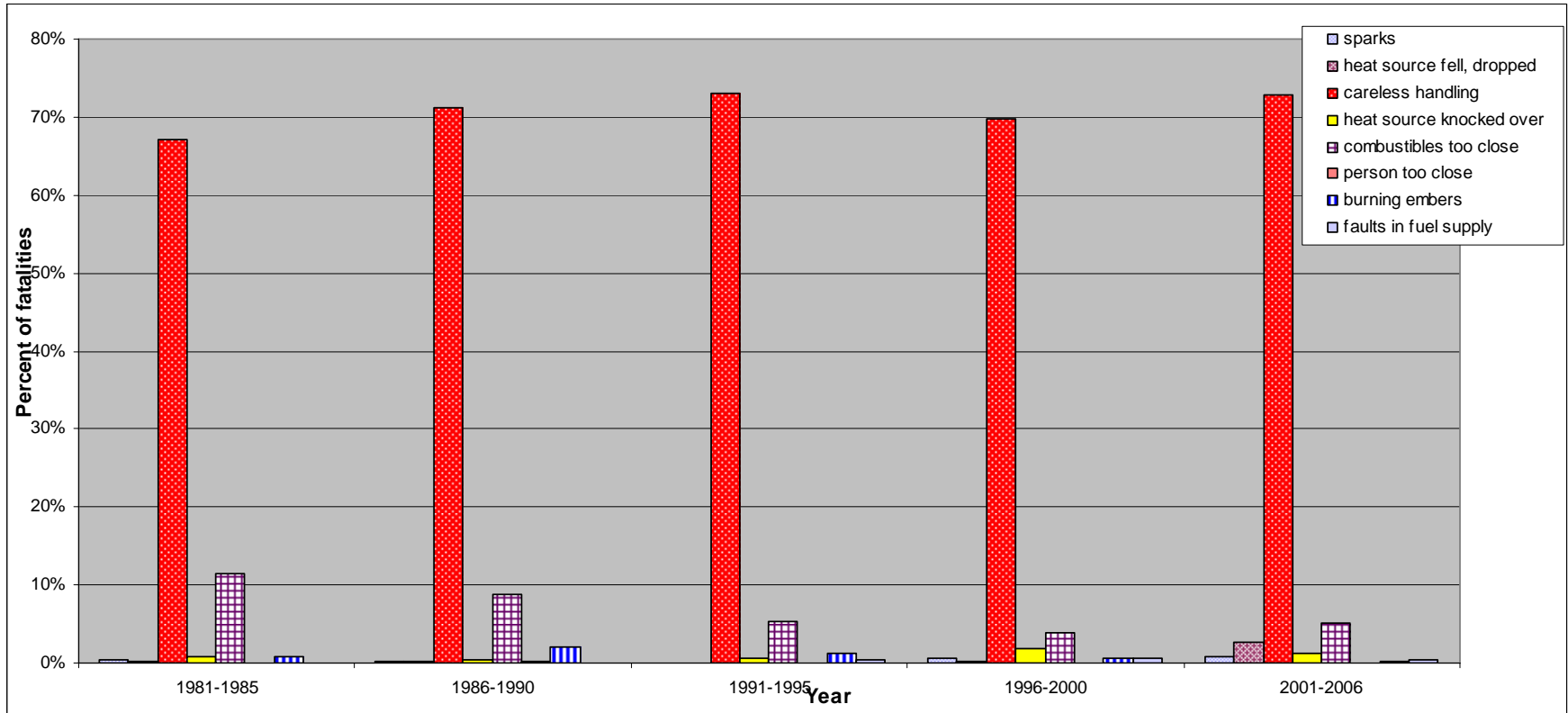


Figure 86: Contributing factors of Other Fire fatalities – 1981 to 2006

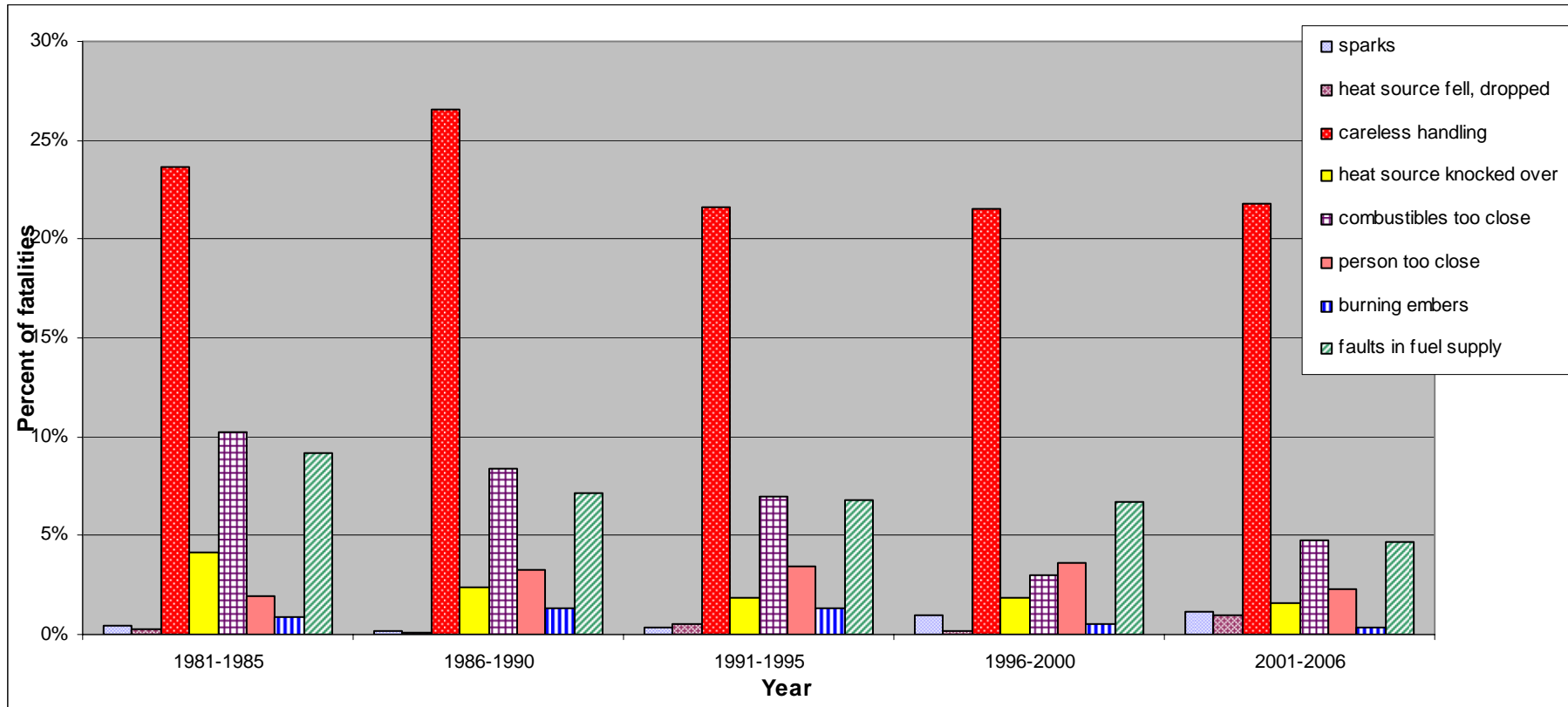


Table 12: Contributing factors of F&F fire fatalities – 1981 to 2006 (average number per year)

Contributing factor	1981-1985	1986-1990	1991-1995	1996-2000	2001-2006	Change since 1981-85
Sparks	0.6	0.2	0	0.4	0.5	-17%
Heat source fell, dropped	0.2	0.2	0	0.2	1.7	+733%
Careless handling	107	125.6	87	61.6	49.2	-54%
Heat source knocked over	1.4	0.8	0.6	1.6	0.8	-40%
Combustibles too close	18.2	15.4	6.6	3.4	3.2	-83%
Person too close	0	0.2	0	0	0	N/A
Burning embers	1.2	3.4	1.6	0.6	0.2	-86%
Faults in fuel supply	0	0	0.4	0.6	0.3	N/A

Table 13: Contributing factors of Other Fire fatalities – 1981 to 2006 (average number per year)

Contributing factor	1981-1985	1986-1990	1991-1995	1996-2000	2001-2006	Decline since 1981-85
Sparks	2.4	0.8	1.6	4	3.8	+60%
Heat source fell, dropped	1.4	0.6	2.2	0.8	3.2	+126%
Careless handling	132.6	135.2	96.4	90.8	73.7	-44
Heat source knocked over	23.2	12.4	8.2	8	5.3	-77
Combustibles too close	57.6	43.2	31.6	12.8	16.3	-72
Person too close	11.2	16.4	15.2	15.4	8	-29
Burning embers	5.2	7	5.6	2.2	1.3	-74
Faults in fuel supply	51.2	36.6	30	28.4	16.2	-68

Fire casualties

Figure 87 and 88 show the percentage of contributing factors of F&F and Other Fire casualties. This is shown by the average percentage of F&F and Other Fire casualties between 1981 and 2006. Table 14 and Table 15 show the average number of F&F and Other Fire casualties between 1981 and 2006. It was again clear that F&F casualties had fallen whilst Other Fire casualties had risen. Figure 87 and Figure 87 and Table 14 and Table 15 show that:

- Careless handling of fire or heat source is the main cause of F&F and other fire casualties, and generally decreases as a cause after 1990; and
- Faults in the fuel supply and combustibles too close to the fire are also a prominent contributing factor to Other Fire casualties. These are also decreasing.

Table 14: Contributing factors of F&F fire casualties – 1981 to 2006

Contributing factor	1981-1985	1986-1990	1991-1995	1996-2000	2001-2006	Decline since 1981-85
Sparks	2.6	1.4	0.6	3	7.3	+182%
Heat source fell, dropped	1.2	6.2	4.6	4.6	19.2	+1497%
Careless handling	693.2	1023.4	902.8	689.4	456.5	-34%
Heat source knocked over	8.6	6	8.2	21.6	18.2	+111%
Combustibles too close	121.6	142.8	93.4	36.4	35.5	-71%
Person too close	0	0.6	0.2	0	0	N/A
Burning embers	13.8	21.6	15.8	7	3.3	-76%
Faults in fuel supply	5.8	7.4	8.8	5.4	7	+21%

Table 15: Contributing factors of Other Fire casualties – 1981 to 2006

Contributing factor	1981-1985	1986-1990	1991-1995	1996-2000	2001-2006	Decline since 1981-85
Sparks	30.4	30.8	73	138.8	196	+545%
Heat source fell, dropped	8.8	37	54.6	27.2	75	+752%
Careless handling	730.8	967	962	1050.4	989.5	+35%
Heat source knocked over	98.2	106.4	83.6	166.4	104.8	+7%
Combustibles too close	486	579.6	566.6	502.4	583.7	+20%
Person too close	31.8	21.8	28.4	42.6	28.8	-9%
Burning embers	41.4	54	49.2	39.5	21.2	-49%
Faults in fuel supply	683.6	769	824.2	788.2	684	0%

Figure 87: Contributing factors of F&F fire casualties – 1981 to 2006

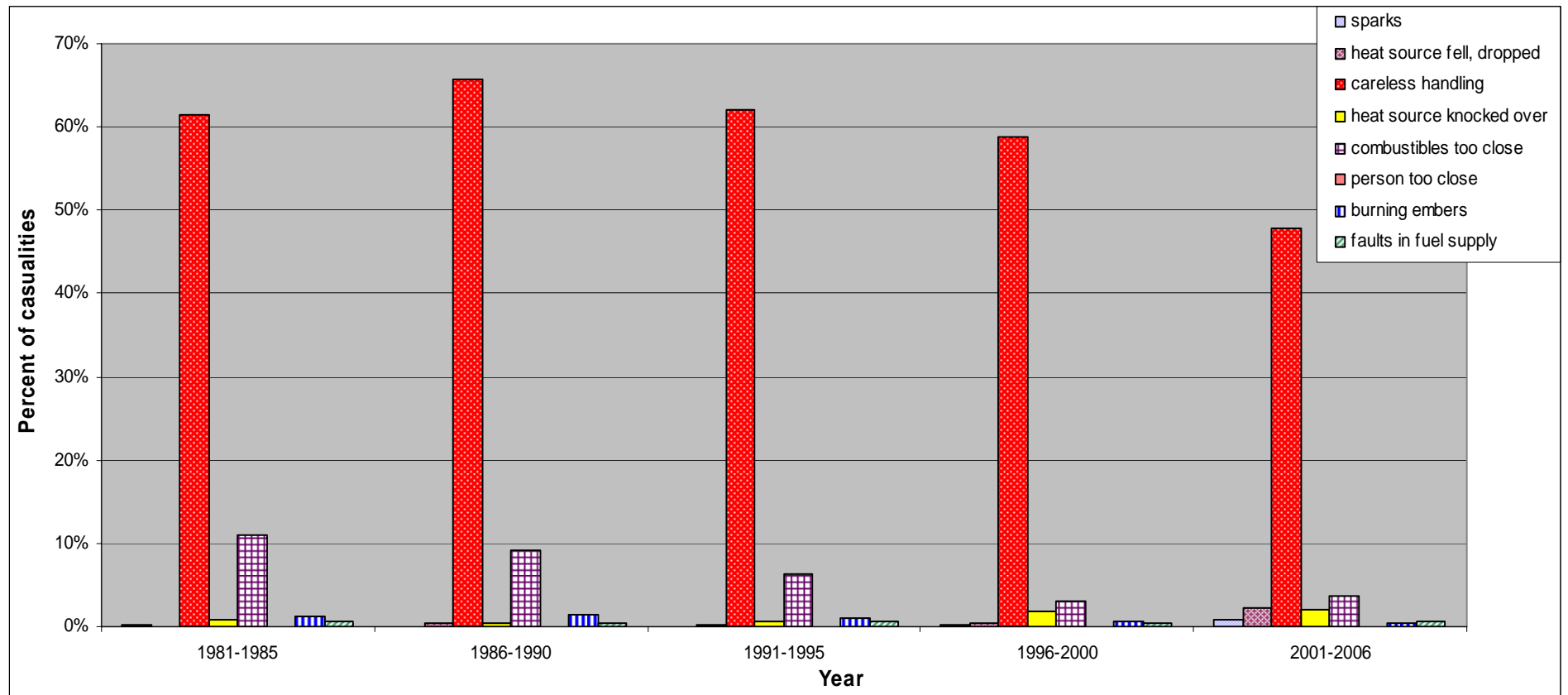
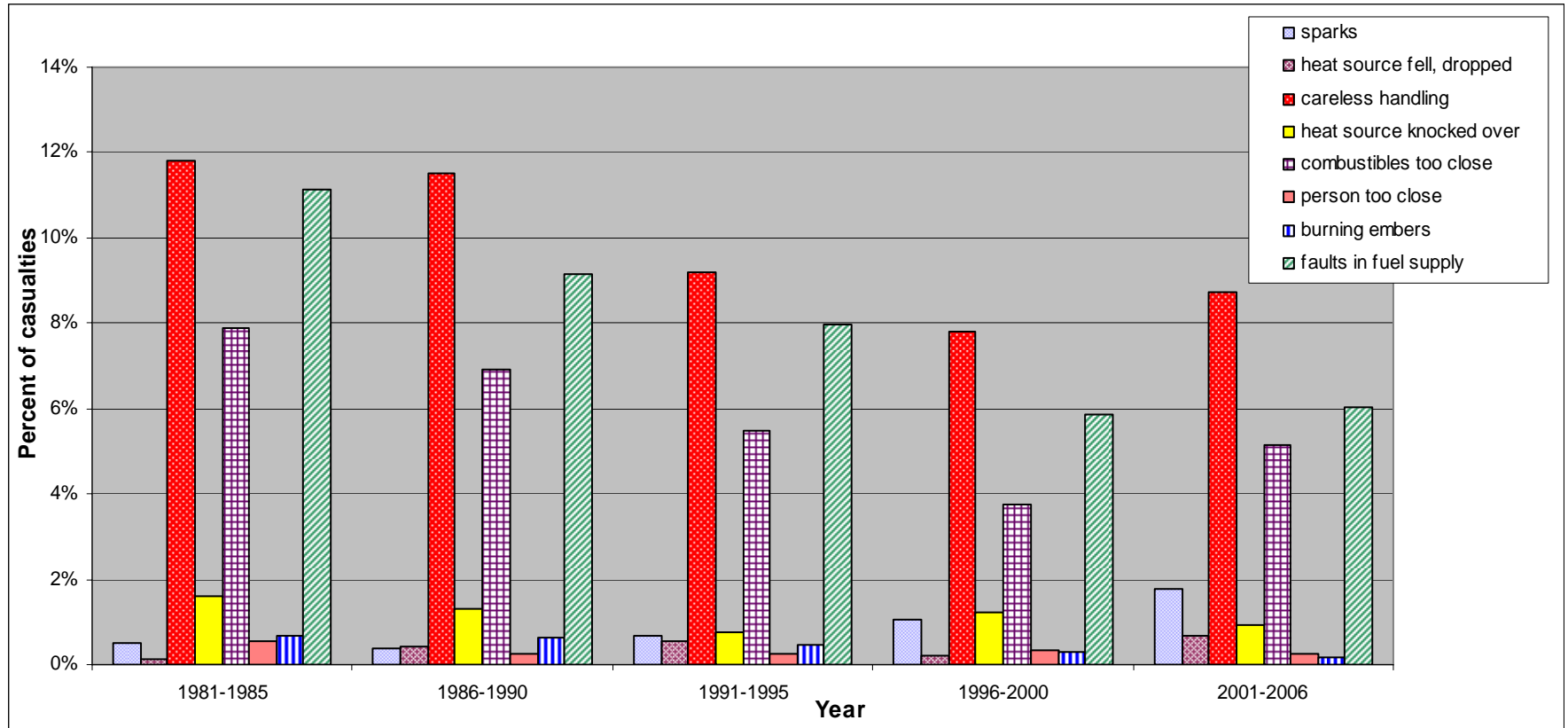


Figure 88: Contributing factors of Other Fire casualties – 1981 to 2006



9.3.3 Fewer adult smokers

Introduction

The number of F&F fires caused by smokers' materials has declined since the FFRs were introduced. However, the number of adult smokers has also declined over the years. Therefore, analysis aimed to identify if the reduction in F&F fires caused by smokers' materials was attributable to the decline in adult smokers. This was done through:

- A trend comparison of smoking-related F&F fires and number of adult smokers,
- Identifying the rate of smoking-related F&F fires per million smokers; and
- Comparing the trend in F&F smokers' materials fires per million smokers with the same measure for Other Fires.

The latter analysis aimed to assess if the decline in smokers' materials fires per million smokers was greater for F&F than for Other Fires.

Furniture and furnishing fires

Figure 89 shows the indexed number of adult smokers and the number of F&F fires involving lighters, matches or smokers' materials per million smokers. It indicates that:

- F&F fires were rising before the FFRs were introduced, when the number of smokers was falling; and
- The rate of F&F smokers' materials fires per million smokers continued to rise until 1994, after which they began to fall.

There was a very strong negative correlation of -1 in the period 1982 to 1988, between the number of adult smokers and the rate of F&F smokers' materials fires per million smokers. This correlation was reversed after 1988, with a strong positive correlation of 0.7 for the period 1990 and 2006, i.e. both the number of adult smokers and the number of F&F fire involving smokers' material fell in the period 1990 to 2006.

Thus, the association between adult smokers and F&F fires was reversed after the FFRs were introduced.

Figure 89: Indexed number of adult smokers and number of smoking F&F fires per million smokers (1982 =100)

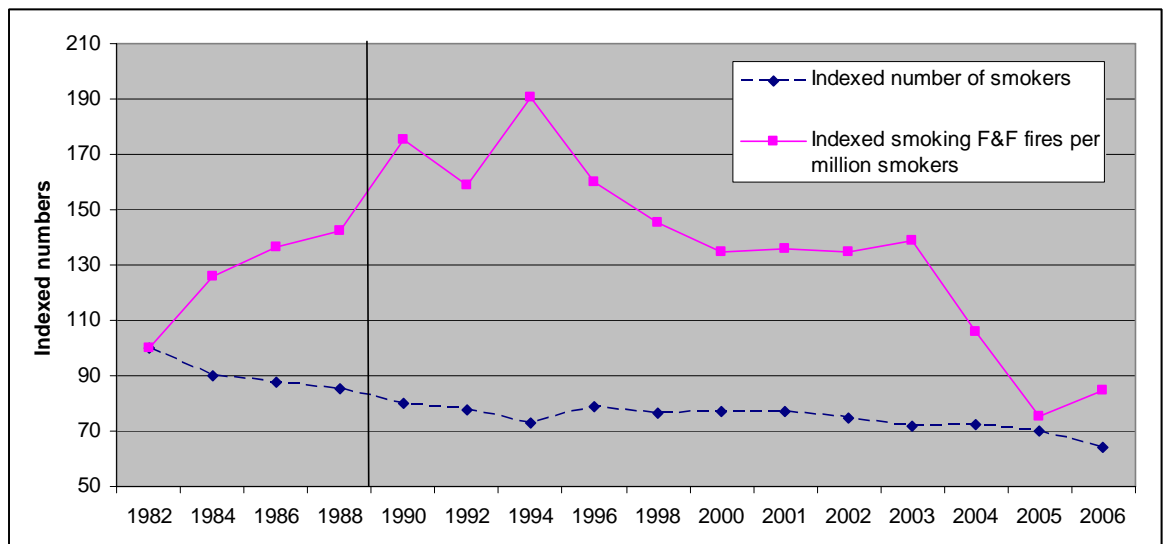


Figure 90 shows the rate of change in the number of adult smokers and the rate of change in the number of F&F smokers' materials fires per million smokers. Whilst there was a moderate negative correlation of -0.59 for the period 1990 to 2006, a t-test indicated that the difference in the rate of change was not statistically significant ($p>0.4$).

Figure 90: Rate of change in percentage of adult smokers and percentage of F&F fires caused by smokers' materials

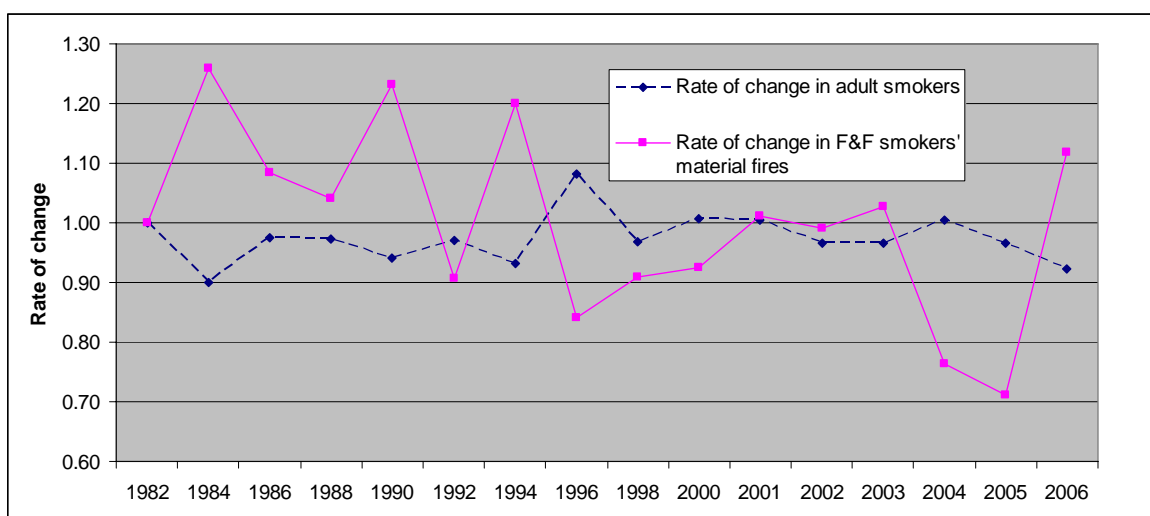


Table 16 shows the change in the number of smokers and the rate of F&F smokers' materials fires per million smokers between 1982-88 and 2004-06. It indicates that the rate of F&F smokers' material fires fell by 6% more than the number of smokers.

Table 16: Change in number of smokers and rate of F&F smokers' materials fires per million smokers

	Average for 1982-1988	Average for 2004-2006	Change between 1982-88 and 2004-06
Number of adult smokers	18251434	13841096	-24%
Smoking F&F fires per million smokers	150.88	105.90	-30%

Furniture and furnishing fatalities

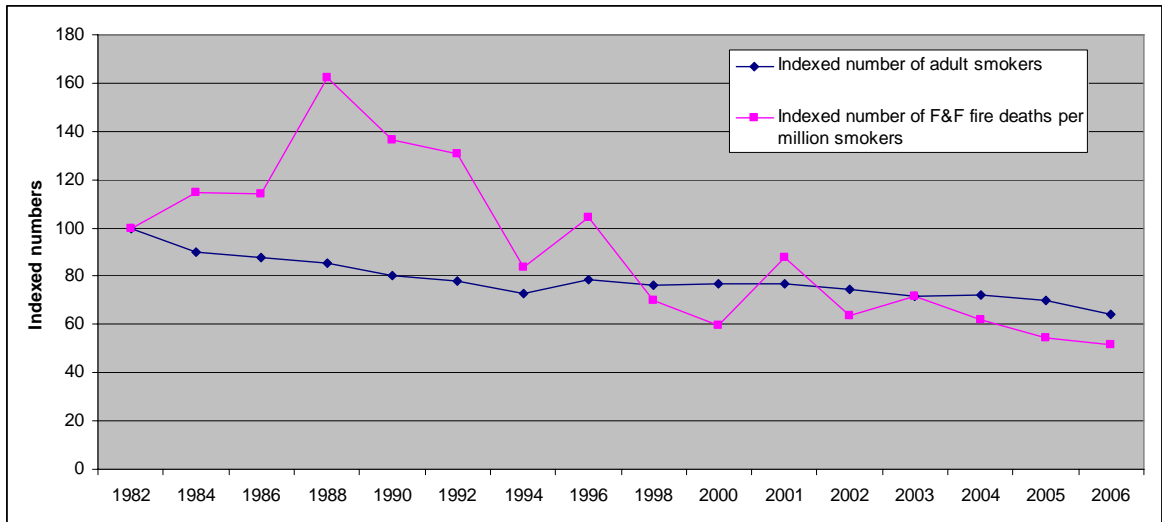
Figure 91 presents the indexed number of adult smokers and number of F&F smokers' materials fire deaths per million smokers. It was clear that:

- Before 1990 the number of fire deaths was rising despite a fall in the number of adult smokers; and

- After 1988 the number of fire deaths fell at about the same rate as the number of smokers.

There was a strong correlation of 0.73 for the period 1990 to 2006 and a t-test indicated there was no significant difference in the indexed numbers over this period.

Figure 91: Indexed number of adult smokers and F&F smokers' materials fire deaths (1982 = 100)



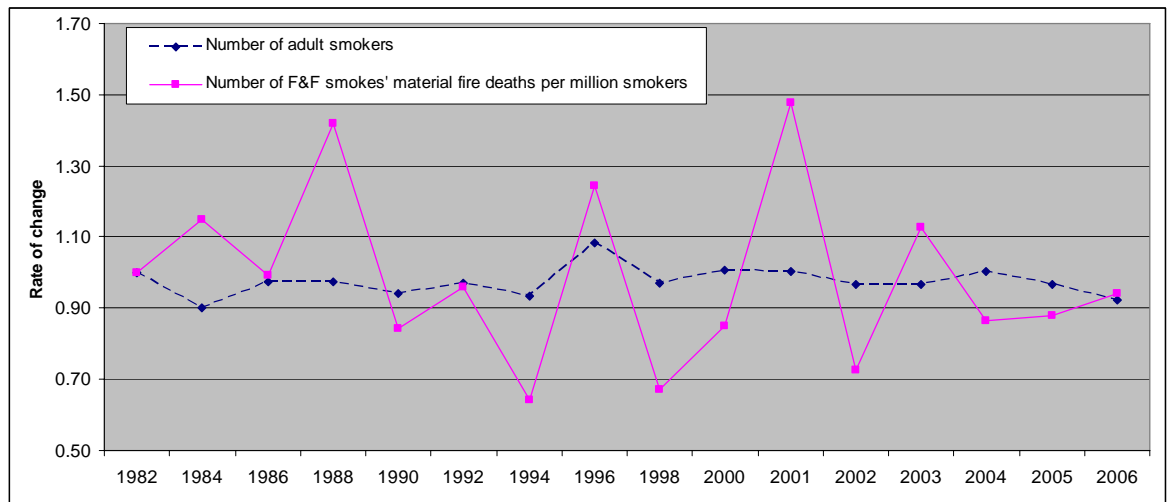
Rate of change

Figure 92 shows the rate of change in the number of adult smokers and the rate of change in the number of F&F fire fatalities involving smokers' materials per million smokers. Figure 92 identifies that:

- The two trends were not correlated before 1990, with a correlation of -0.18 for this pre-FFRs period (a t-test indicated that these trends were significantly different at $p=0.07$, which is reasonable for such a small number of data points); and
- After 1988 there was little difference in the trend of adult smokers and smoking-related F&F fire fatalities. The two trends were correlated at 0.53 between 1990 and 2006. A t-test confirmed that these trends were not significantly different ($t=0.28$).

Thus, the rate of fire deaths was rising before the FFRs were introduced whilst the number of smokers was declining. After the FFRs were introduced, both the number of smokers and number of F&F fire deaths fell.

Figure 92: Rate of change in number of adult smokers and number of F&F fire fatalities caused by smokers' materials per million smokers



Comparison with Other Fires

Table 17 shows a comparison of the amount of change in the rate of fire deaths per million smokers of F&F and Other Fires involving smokers' materials. It indicates that F&F fire deaths fell more than Other Fire deaths between 1982-88 and 2002-06. It should be noted that the Home Office initiated a fire safety mass media campaign at about the same time that the FFRs were introduced. This may have contributed to a general decline in smokers' materials fire deaths, but nonetheless there was some evidence of a more marked fall amongst F&F fires.

Table 17: Change in rate of smokers' materials fire deaths per million smokers

	1982 to 1988	2002-2006	Decline between 1982-88 and 2002-06
Other fires	10	6	42%
F&F	7	4	51%

Figure 93 shows the number of F&F fire fatalities and Other Fire deaths caused by smokers' materials when accounting for the number of adult smokers. Figure 93 shows that the number of F&F and Other Fire fatalities per million smokers follow similar trends, with a very strong correlation of 0.85. Both categories of fire fatalities increased as a rate per million smokers before the FFRs were introduced. For example, for F&F fire fatalities this was a 42% increase between 1982 and 1998. This then decreased after the FFRs were introduced: a 38% decrease between 1990 and 1996. Between 1998 and 2006 this decreased at a slower rate, with a 9% decrease.

Figure 94 shows the indexed rates of fire deaths for F&F and Other Fires per million smokers. Again the trends were very similar, but with F&F fire deaths rising higher than Other Fire deaths before falling to a similar extent.

Figure 93: F&F and Other Fire fatalities caused by smokers' materials and matches per million smokers

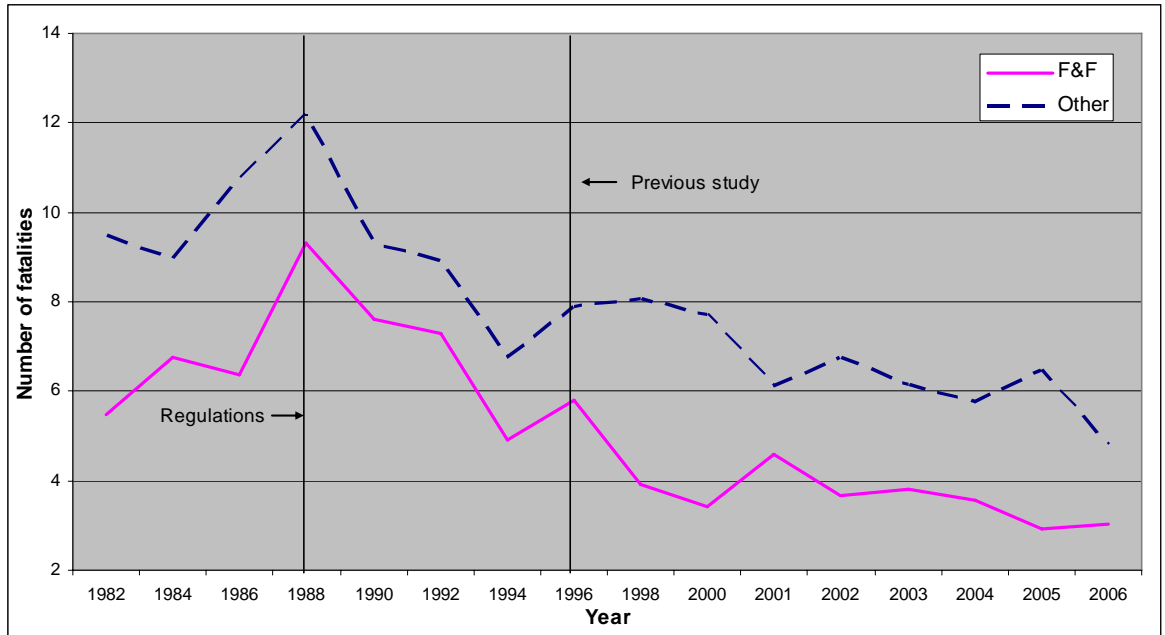
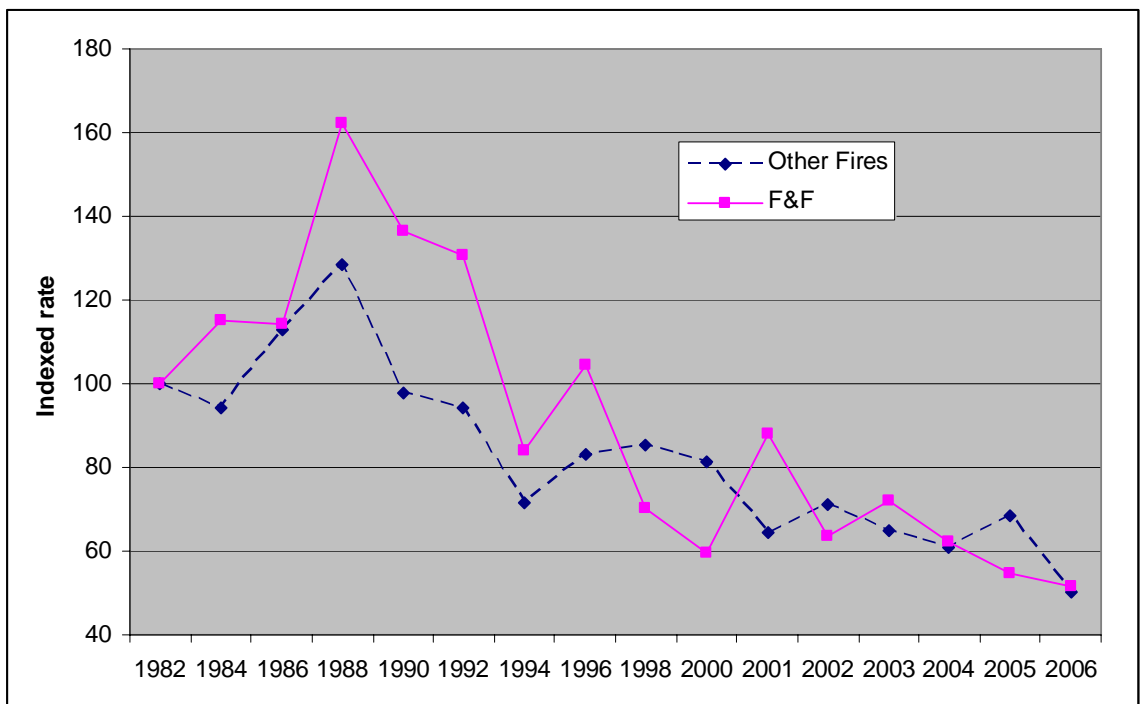


Figure 94: Indexed rate of smokers' materials fire deaths per million smokers for F&F and Other Fires

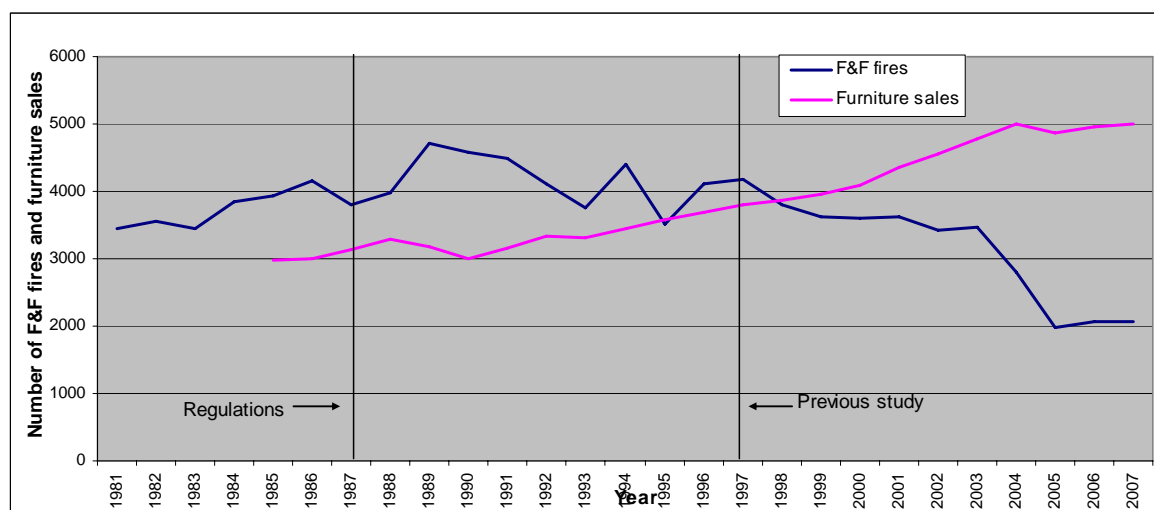


9.3.4 Furniture sales

The cost of furniture sales was analysed to determine if the value of furniture sold had changed since the FFRs were introduced and whether this had an impact on the number of F&F fires. Furniture sales were adjusted for inflation over the years, and sales were based on UK production for the UK and for imports.

Figure 95 shows the number of F&F fires and the cost of UK furniture sales before and after the FFRs were introduced. Figure 95 shows that whilst F&F fires initially rose in line with increasing furniture sales, the number of fires after 1989 fell against a background of rising furniture sales.

Figure 95: F&F fires and furniture sales – 1981 to 2006



9.3.5 Multiple regression analysis

A multiple regression analysis was conducted to determine if variables other than the FFRs were associated with F&F fires between 1981 and 2006. A selection of factors identified in other research as contributing to fires was used, namely:

- Furniture sales data¹²;
- Number of adult smokers;
- Number of lone parents – as these are a high risk group; and
- Number of people unemployed (as these are also seen as a high risk group).

¹² It should be noted that this does not represent the number of units sold, but the monetary values spent on furniture. This was adjusted according to the consumer price index.

A multiple regression analysis was conducted to identify "lone parent" as the variable which had the strongest association with the rate of F&F fires. However, this is negatively associated with F&F fires, indicating that as the amount of lone parents increased, F&F fires decreased. Other research¹³ found that lone parents were strongly related to the number of fires and fire deaths, i.e. there are more fires in areas with more lone parents. Therefore, despite adverse changes in socio-demographic factors, F&F fires still declined.

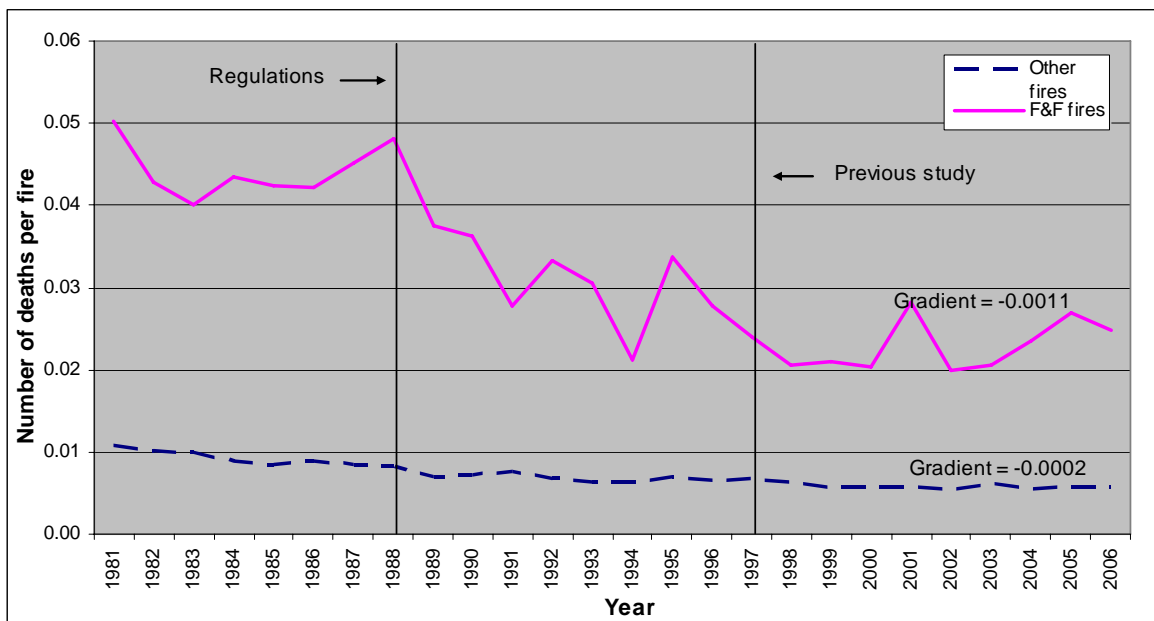
9.4 Lethality of fires

9.4.1 Relative trends in deaths per fire

The Crib 5 test was aimed at testing the rate of fire growth and associated production of toxic smoke. The potential impact of this test would be reflected by trends in the lethality of fires. Therefore, analysis was conducted to identify whether the reduction in the lethality of F&F fires between 1981 and 2006 exceeded that of Other Fires.

Figure 96 shows the number of deaths per fire for F&F and Other Fires between 1981 and 2006, using data on item first ignited to sort fire data. It is noticeable that F&F fires were far more lethal than Other Fires before 1988, and that the lethality of F&F fires fell after 1988.

Figure 96: Lethality of F&F and Other Fires



The trend in F&F fire deaths was volatile. This made it difficult to compare trends. Therefore,

¹³ <http://www.communities.gov.uk/publications/fire/frsperformanceanalysis?view=Standard>

Table 18 shows the lethality rate for bands of years, and the amount of reduction in lethality over the review period.

Table 18: Lethality of fires

	1981-88	1989-1993	1994-1997	1998-2001	2002-2006	Reduction between 1981-88 and 2002-2006
Deaths per Other Fire	0.0093	0.0070	0.0067	0.0059	0.0057	38%
Rate of change		0.76	0.95	0.88	0.97	
Deaths per F&F fire	0.0443	0.0331	0.0266	0.0225	0.0231	48%
Rate of change		0.75	0.80	0.85	1.03	

It can be noted that:

- The lethality of F&F fires was steady or rising before 1988, after which lethality fell, as shown in Figure 96;
- The lethality of Other Fires declined at a steady rate between 1981 to 2006;
- Lethality of F&F fires declined at a greater rate than Other Fires as the gradient is steeper for F&F fires (-0.0011) than other fires (-0.0002); and
- Taking the study period as a whole, the lethality of F&F fires fell by 48% compared to a 39% fall for Other Fires.

It can also be noted that:

- The decline in lethality is particularly apparent in the years immediately after the FFRs were introduced, whilst the lethality of Other Fires declines at a more even pace across the period 1981 to 2006; and
- The lethality of F&F fires remains reasonably level after 1998. This is consistent with the view that a 10% replacement rate of furniture would mean that most non-compliant furniture might be scrapped by 1998, and so the decline in lethality might slacken off.

This provides some contextual support for the suggestion that the decline in lethality of F&F fires between 1988 and 1998 was associated with the FFRs, particularly the fire resistance requirements arising from the Crib 5 test.

The next section explores whether the decline in lethality was related to the extent of F&F fire spread, whilst section 9.4.4 explores the role of smoke alarms.

9.4.2 Relative trends in lethality by fire spread

The Crib 5 test was intended to restrict the spread and toxicity of F&F fires in order to reduce the lethality of them. Therefore, analysis was also conducted to identify if there was a greater reduction in lethality for F&F fires that spread further than other F&F fires.

Lethality of fires that spread beyond the room of origin

Figure 97 shows the number of deaths per F&F and Other Fires that spread "beyond the room of origin" between 1981 and 2006.

Figure 97: Lethality of F&F and Other Fire spread beyond the room of origin

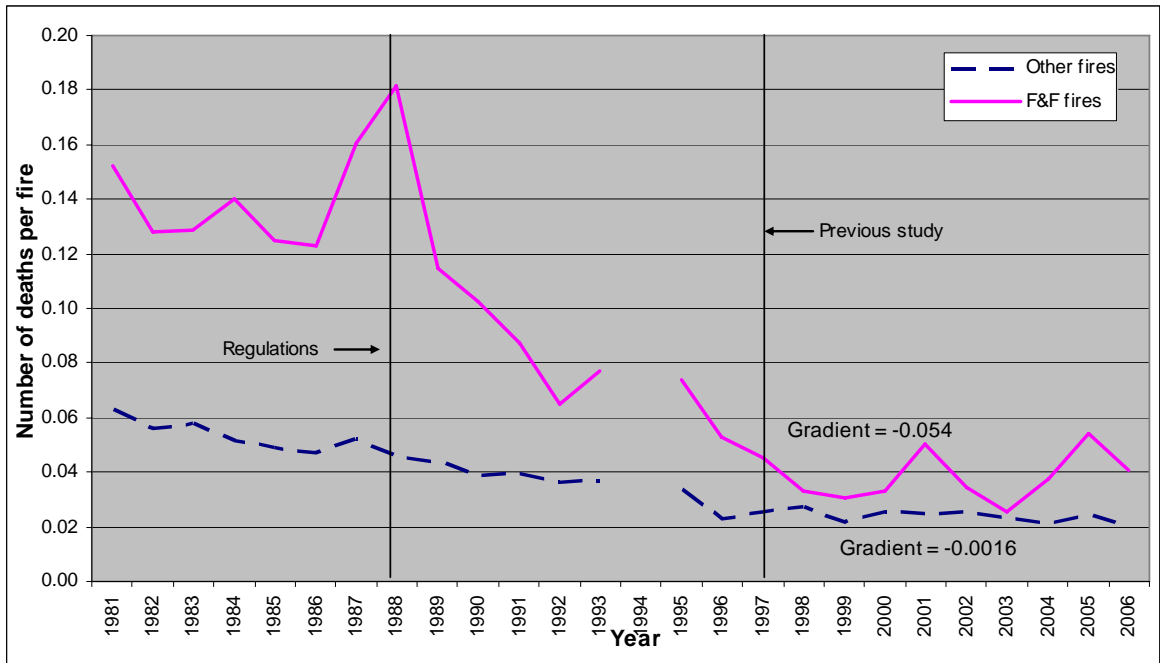


Figure 97 shows that the lethality of F&F fires that spread beyond the room of origin has reduced at a faster rate than for Other Fires. This is shown by the steeper gradient for F&F fires (-0.054) than for Other Fires (-0.0016).

Confined to item of origin

Figure 98 shows the number of deaths per F&F and Other Fires that are confined to the item, confined to the room of origin and spread beyond the room of origin.

Figure 98: Lethality of F&F and Other Fire spread

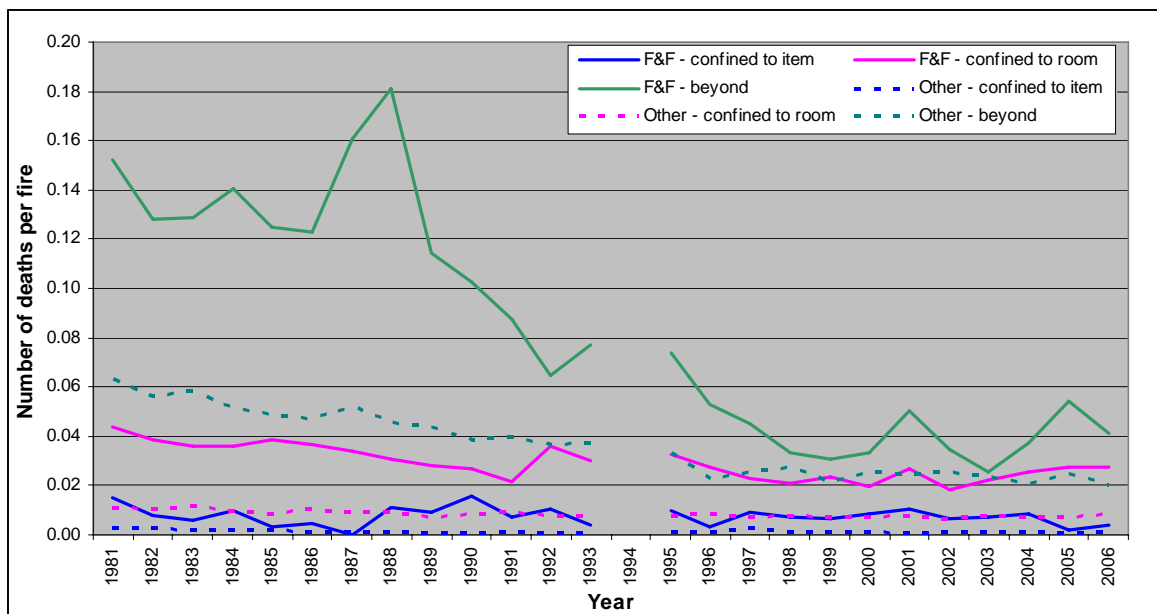


Figure 98 shows that:

- The reduction in lethality was particularly significant in F&F fires that spread beyond the room of origin, declining from 0.14 in 1984 to 0.04 in 2006.

The table below shows the reduction in lethality of fires by fire spread between 1981-1985 and 2001 to 2006. This indicates that:

- The lethality of F&F fires that spread beyond room of origin and spread beyond item of origin but confined to room of origin, fell far more than in the case of Other Fires; and
- The lethality of fires confined to the item of origin fell less for F&F fires than for Other Fires.

Thus, there was a particular fall in the lethality of F&F fires that spread beyond the item of origin which exceeded the trend in Other Fires.

Table 19: Reduction in lethality of fires between 1981-1985 and 2001-2006 (% fall)

	Deaths per fire				Fall in lethality rate	
	1981-85		2001-06			
	Other	F&F	Other	F&F	F&F fires	Other Fires
Confined to item of origin	0.0022	0.008	0.0010	0.0055	31%	55%
Confined to room of origin	0.010	0.038	0.0074	0.024	36%	26%
Beyond room of origin	0.056	0.135	0.0230	0.039	70%	59%

9.4.3 Alcohol and sleep impairment

The aim here was to explore whether the reduction in lethality could be associated with changes in the vulnerability of victims, and whether changes in the vulnerability of victims was peculiar to F&F fires. Figure 99 shows the percentage of F&F and Other Fire fatalities between 1981 and 2006 where the victim was asleep or impaired by alcohol.

Figure 99: Alcohol and sleep impairment for fatalities – 1981 to 2006

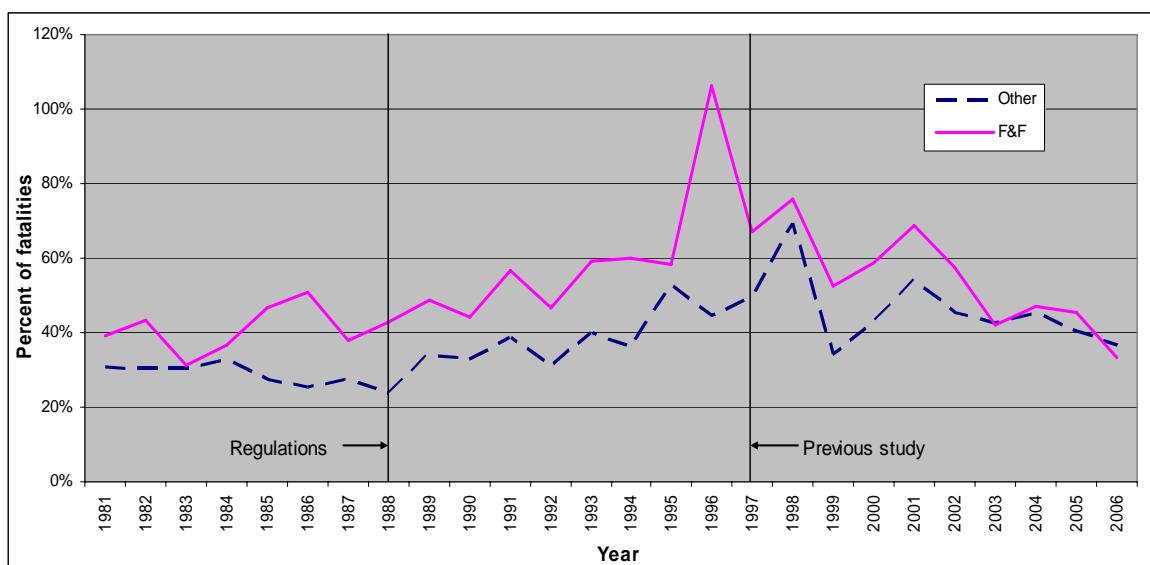
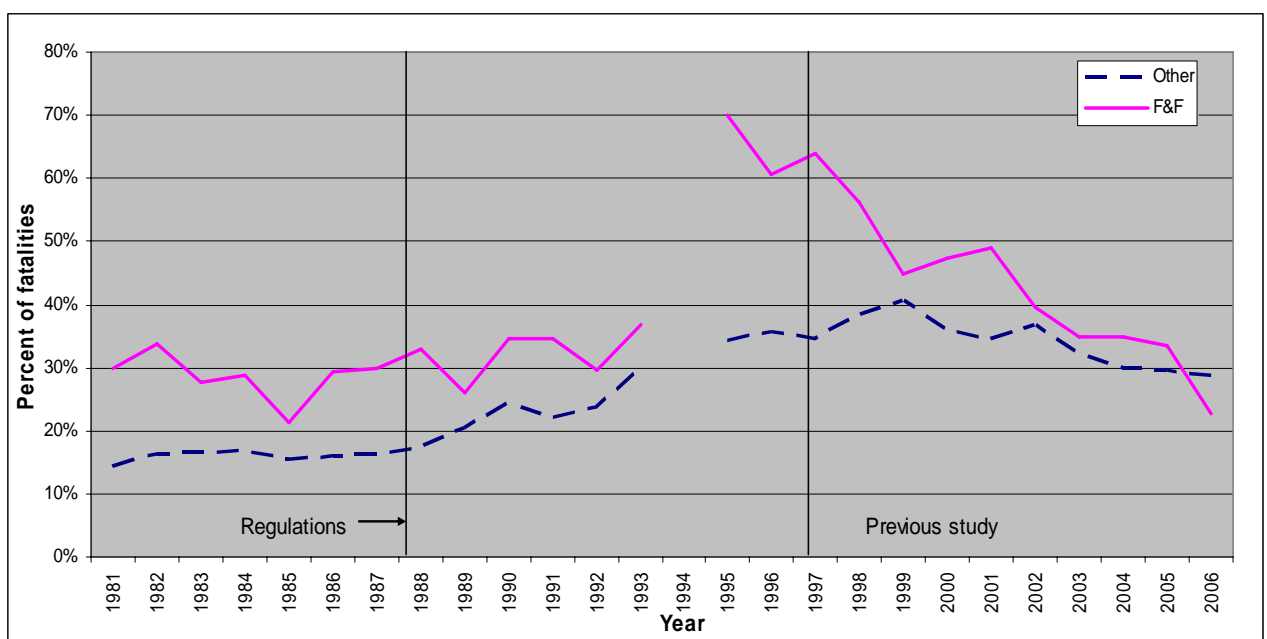


Figure 99 shows that the trend of F&F and Other Fire fatalities where people are impaired by alcohol and sleep were similar, as they increased up to 1997 before they began to decrease.

Figure 100 shows the percentage of F&F and other fire casualties between 1981 and 2006. The two trends are again similar. Thus, the reduction in lethality cannot be attributed to a decline in the involvement of impaired persons. Data for 1994 was excluded, because there was a change in coding procedures in that year. Therefore, the jump in F&F casualties involving sleep or alcohol may be a spurious change associated with the change in coding.

Figure 100: Alcohol and sleep impairment for casualties – 1981 to 2006¹⁴



9.4.4 Role of smoke alarms in reducing lethality

There was a continued and sustained increase in the installation of smoke alarms from the late 1980s to the early 2000s. This trend coincided with a Home Office mass media campaign promoting the purchase of smoke alarms. The aim here was to explore to what extent the increase in the installation and use of smoke alarms may be a reason why the number of F&F fatalities fell.

First, analysis was conducted to identify whether smoke alarms detected a significant amount of F&F fires. Second, the analysis estimated the lives saved by smoke alarms for F&F fires and Other Fires.

Figure 101 and Table 20 show the average number of F&F fires that were detected by alarms and by people between 1981 and 2006. Clearly the number of F&F fires discovered by alarms rose from 0.32% to 11.52%.

¹⁴ FDR1 data for 1994 was incorrect and therefore removed from the analysis, as detailed in section 2.1.

Whilst Figure 101 shows that the number of F&F fires discovered by alarms rose, very few F&F fires were discovered by smoke alarms, even in 2001-06. This may be explained by the phenomena of F&F fires occurring in close proximity to people, e.g. people drop cigarettes on their seating which then ignites. Whilst the number of F&F fires discovered by alarms rose across the period, the proportion remained low.

Figure 101: Detection of F&F fires – 1981 to 2006

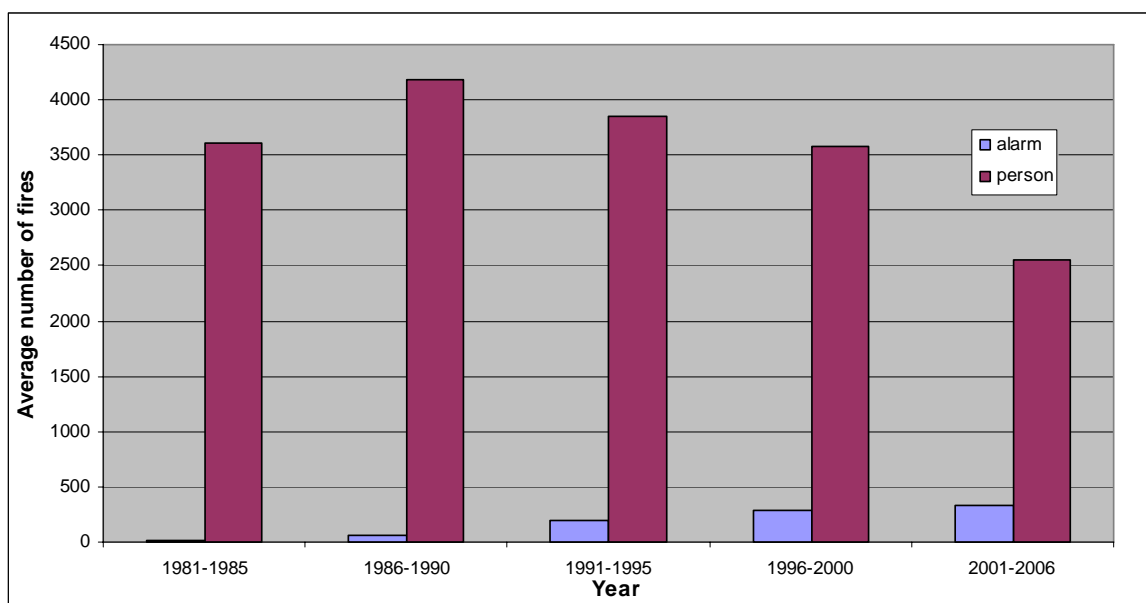


Table 20: F&F fires discovered by alarms, people and 'other'

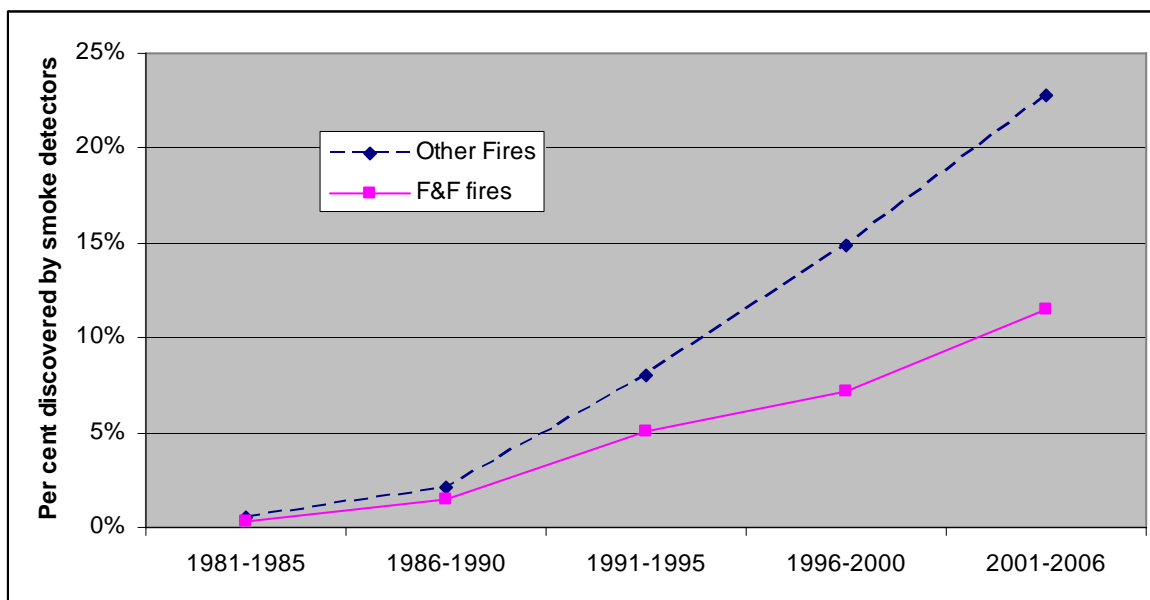
	1981-1985	1986-1990	1991-1995	1996-2000	2001-2006
Alarm	11.8	55.0	193.9	283	332.7
Person	3,609.8	4,175.4	3,851.6	3,572.6	2,550.0
Other	20.0	12.4	10.0	5.1	4.7
All	3,641.6	3,783.6	3,836.0	3,940.6	2,887.4
% of F&F fires discovered by smoke detectors	0.32%	1.45%	5.06%	7.17%	11.52%

Table 21 shows the proportion of Other Fires discovered by alarms. The proportion of Other Fires discovered by alarms was greater than in F&F fires in all years. The two trends are shown in Figure 102.

Table 21: Other Fires discovered by alarms, people and 'other'

	1981-1985	1986-1990	1991-1995	1996-2000	2001-2006
Alarm	305	1,239	4,768	9,542	12,798
People	54,017	57,912	54,693	54,366	43,195
Other	314	317	173	52	80
Total	54,636	59,468	59,635	63,960	56,073
Per cent of Other Fires discovered by smoke detectors	0.6%	2.1%	8.0%	14.9%	22.8%

Figure 102: Comparison of trends in F&F and Other fires discovered by smoke detectors



Lives saved by smoke alarms

The lives saved by smoke alarms was estimated as follows.

The fatality rate was calculated in F&F fires discovered by smoke alarms and for F&F fires discovered by people. The difference between these two rates equates to the reduction per fire in the fatality rate associated with smoke alarms. The calculation was repeated for Other Fires to give the following:

- Proportion of fall in deaths for F&F fires associated with smoke alarms = 6.8%
- Proportion of fall in deaths for Other Fires associated with smoke alarms = 41.5%

Thus, smoke alarms account for a small fraction of the fall in F&F lethality and a large proportion of the reduction in lethality of Other Fires.

The calculation is shown for Other Fires in Table 22.

Table 22: Calculation for lives saved by smoke alarms for Other Fires

	1981-1985			2002-2006		
Discovered by	Fire discovered by	Deaths in fire discovered by	Deaths per fire	Fire discovered by	Deaths in fire discovered by	Deaths per fire
Alarm	1,525	9	0.0059	64,543	117	0.0018
Person	270,085	2,756	0.010	209,720	1,533	0.0073
		Difference	0.0041		Difference	0.0055

With 0.0051 fewer deaths per fire when discovered by alarms and 12908 (64543 ÷ 5) Other Fires per year in the period 2002-2006, this gives 0.0055 x 12908 = 71 fewer deaths per year associated with fires discovered by alarms in Other Fires.

The calculation is shown for F&F fires in Table 23.

Table 23: Calculation for lives saved by smoke alarms for F&F fires

	1981-1985			2002-2006		
Discovered by	Fire discovered by	Deaths in fire discovered by	Deaths per fire	Fire discovered by	Deaths in fire discovered by	Deaths per fire
Alarm	59	4	0.068	1,706	28	0.016
Person	18,049	783	0.043	10,621	249	0.023
		Difference	-0.024		Difference	0.007

With 0.007 fewer deaths per F&F fire (in 2002-06) when discovered by alarms and 341 (1706 ÷ 5) F&F fires per year in the period 2002-2006, this gives 0.007 x 341 = 2.4 fewer deaths per year associated with fires discovered by alarms in F&F fires.

The lethality rate (excluding fires discovered by other means) fell as follows:

- For F&F fires from 0.043 to 0.022;
- For Other Fires from 0.01 to 0.006.

The proportion of this reduction that can be attributed to smoke alarms is given by the difference in what the fatality would be if there had not been an increase in smoke detectors. In the case of F&F, in the absence of an increase in smoke alarms there would have been:

$$((3.2\% \times (1706+10621) \times 0.016)+(96.7\% \times (1706+10621) \times 0.023)) = 288 \text{ deaths if no increase in smoke alarms.}$$

The deaths in F&F fires were 277. Thus, smoke detectors accounted for 3.3% (288-277/288) of the fall in F&F deaths. The lethality rate of F&F fires fell by 48% in this period. 3.3% is 6.8% of the 48% fall in F&F fire deaths.

The same calculation for Other Fires gives:

$$((5.6\% \times (64543+209720) \times 0.018)+(96.9\% \times (64543+209720) \times 0.0073)) = 1993 \text{ if no increase in smoke detectors.}$$

The deaths in Other Fires were 1650. Thus, smoke detectors accounted for 17% (1993-1650/1993) of the fall in deaths in Other Fires. The lethality rate of Other Fires fell by 41% in this period. 17% is 41.5% of the 41% fall in Other Fire deaths.

Alarms and fire spread

In order to identify if other factors apart from the FFRs had an impact on the reduction of the lethality of fires, analysis was conducted to identify if alarms had an impact on the spread of F&F and Other Fires, fatalities and casualties.

Figure 103 shows the percentage of F&F and Other Fires that were detected by alarms and confined to the item first ignited, confined to the room of origin and spread beyond the room of origin. Figure 103 shows that:

- The trends in the rate of fires discovered by smoke detectors were similar for all categories of fires.

Therefore, it was unlikely that the increase use of smoke alarms had a greater impact on any one category of fires.

Figure 103: Fire spread discovered by alarms – 1981 to 2006¹⁵

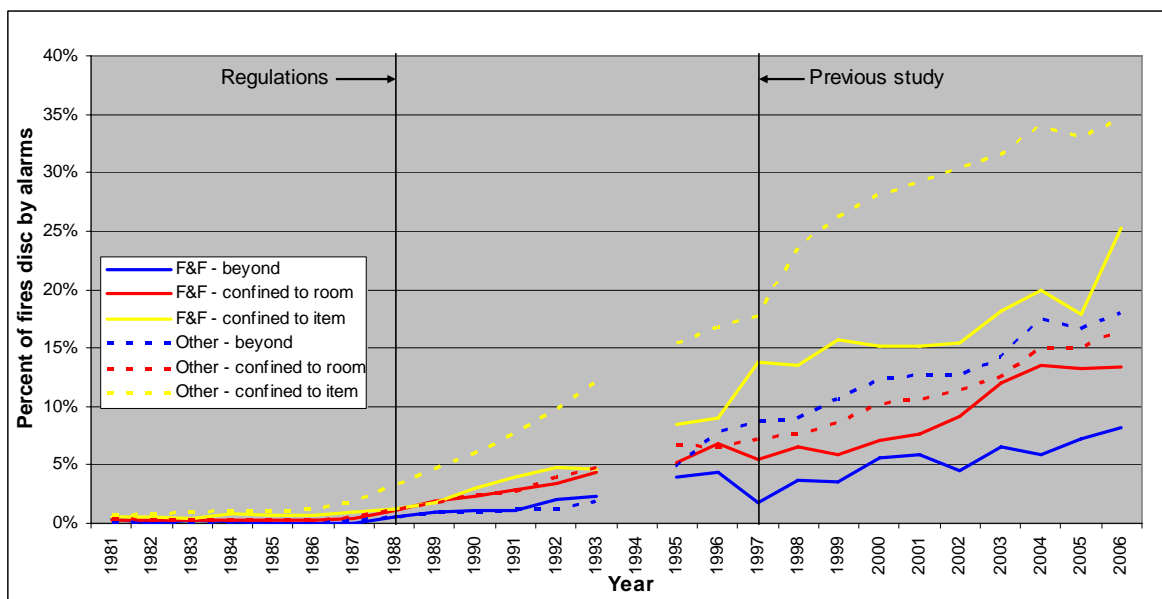


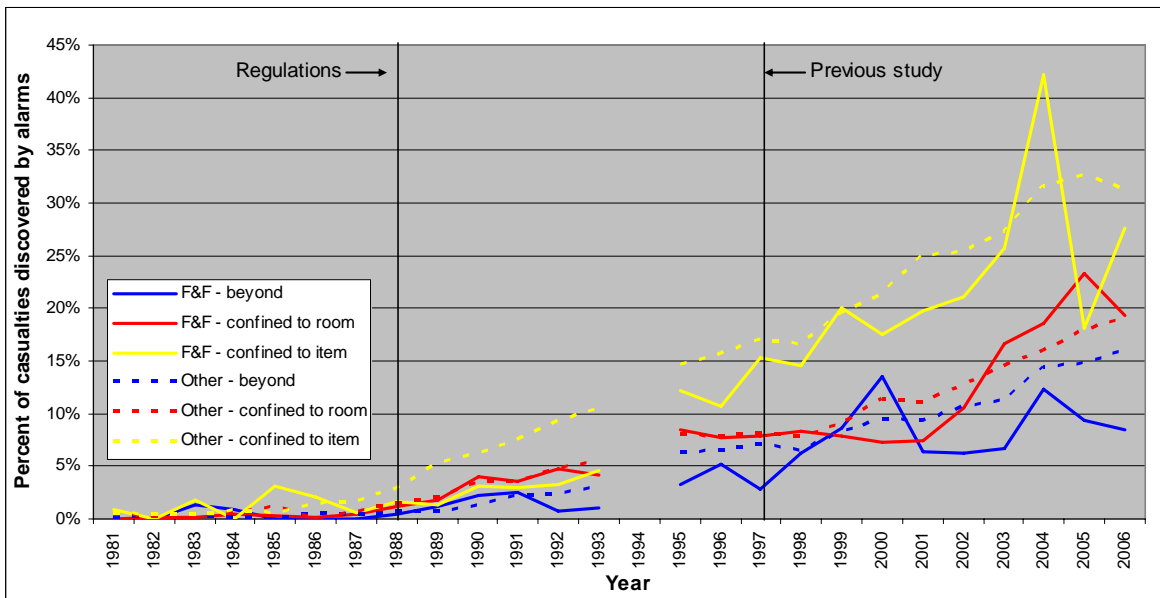
Figure 104 shows the percentage of F&F and Other Fire casualties that were detected by alarms and confined to the item first ignited, confined to the room of origin and spread beyond the room of origin. Figure 104 shows that:

- The trend in the increase in Other Fires discovered by smoke detectors was similar for all sizes of Other Fires; and

¹⁵ FDR1 data for 1994 was incorrect and therefore excluded from the analysis, as detailed in section 2.1.

- The trends for F&F fires are somewhat "noisy" but there was some indication of a slower rate of increase in fires discovered by smoke detectors in the case of fires that spread beyond the room of origin.

Figure 104: Fire spread casualties discovered by alarms – 1981 to 2006



9.5 Type of injury

Furniture and furnishings were thought to be more lethal and cause more injuries due to the production of toxic smoke associated with the foam fillings and a greater spread of fire. This resulted in a greater proportion of deaths that were due to smoke. Therefore, the types of injury that caused fatalities and casualties in F&F and Other Fires were analysed to determine if the FFRs had an impact on the injury type in fires.

F&F fire fatalities

Figure 105 shows the average number of fatalities in F&F fires caused by different injury types between 1981 and 2006. This analysis used fires coded by Material Mainly Responsible, i.e. where F&F was the material mainly responsible for the fire, as opposed to being the item mainly responsible.

Figure 105: Injury type for F&F fire fatalities

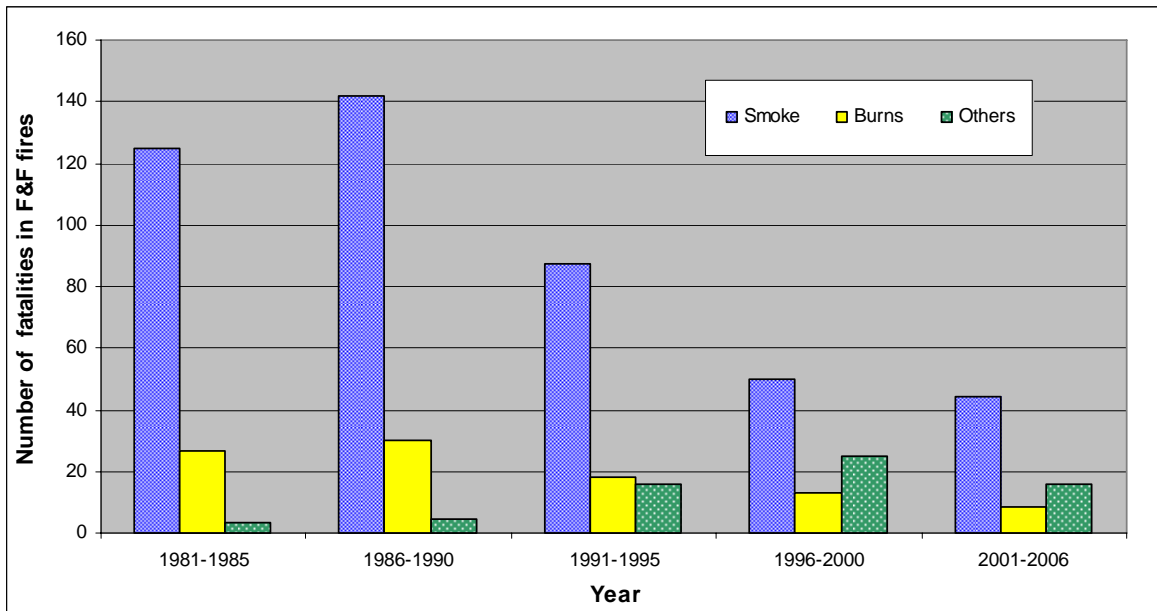


Figure 105 shows that:

- The most common cause of F&F fire fatality was smoke. This increased before the FFRs were introduced; afterwards, it rapidly decreased. For example, the average number of F&F fire fatalities between 1981 and 1985 caused by smoke increased by 13% in 1986 to 1990. Between 1996 to 1990 and 2001 to 2006 the number of F&F fire fatalities caused by smoke decreased by 69%;
- The average number of F&F fire fatalities caused by burns increased slightly in the years before the FFRs, but decreased in the years following; and
- The average number of F&F fire fatalities caused by other injuries increased during the period of 1991 to 1995 and onwards. These injuries include physical injuries such as cuts, sprains and fractures, as well as shock. However, after 1994 this category also included a combination of smoke and burns, which was not included prior to 1994.¹⁶

However, the proportion of deaths involving smoke fell by almost the same amount as for burns, i.e. 65% for smoke and 67% for burns between 1981-85 and 2001-06. Thus, there was no apparent additional fall in smoke-related fire deaths.

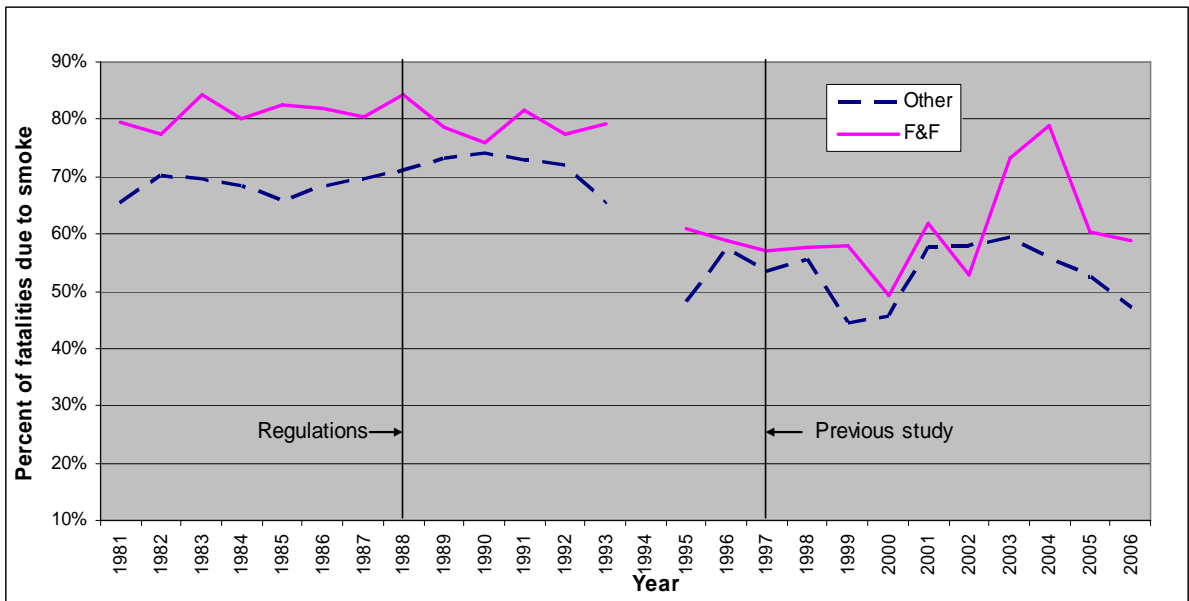
¹⁶ From 1994 onwards FDR1 data includes a code referring to a combination of smoke and burns under the 'other' category. This code is not included before 1994.

Comparison with trends in Other Fire deaths

Further analysis compared the amount of F&F and Other Fire fatalities caused by smoke inhalation to determine if the trends differed. Figure 106 shows the percentage of F&F and Other Fire fatalities caused by smoke inhalation.

There was a very strong correlation of 0.88 between the F&F and Other Fires trends in the percentage of fatalities due to smoke inhalation. A t-test of the rate of change in the proportion of deaths caused by smoke inhalation found no significant difference ($p>0.4$).

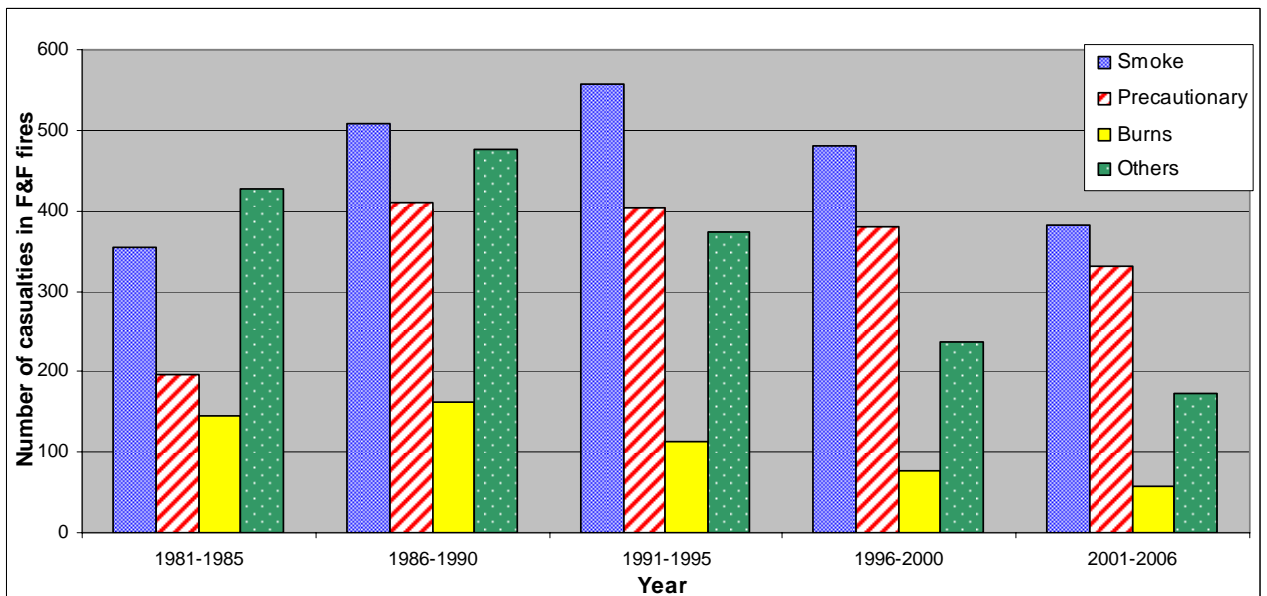
Figure 106: F&F and Other Fire fatalities caused by smoke – 1981 to 2006



Casualties

Figure 107 shows the number of F&F fire casualties caused by different injury types.

Figure 107: Type of injury for F&F fire casualties



Care must be taken in interpreting Figure 107. It is possible that the trends are skewed by a change in reporting practices. That is, there may be a switch from Other types of injury to smoke and precautionary checks. The number of Other types of injuries fall after 1986-90, coinciding with the change in coding practices in 1994. Nonetheless it shows that:

- Smoke was the largest cause of F&F fire casualties (apart from between 1981 to 1985);
- This increased until 1991-1995 before decreasing, as did casualties caused by other types of injury, precautionary check-ups and burns; and
- Burns remained the lowest cause of F&F fire casualties.

Over the entire period, smoke injuries rose as a proportion of the total, and the 2001-06 number of smoke casualties actually exceeded the number of smoke casualties in 1981-85. Burns and other injuries fell as a proportion and in actual numbers between 1981-85 and 2001-06.

Comparison with Other Fire casualties

Further analysis looked at F&F and Other Fire casualties caused by smoke to determine if there were any differences in the trends. Figure 108 shows the percentage of F&F and Other Fire casualties caused by smoke.

Figure 108: F&F and Other Fire casualties caused by smoke – 1981 to 2006

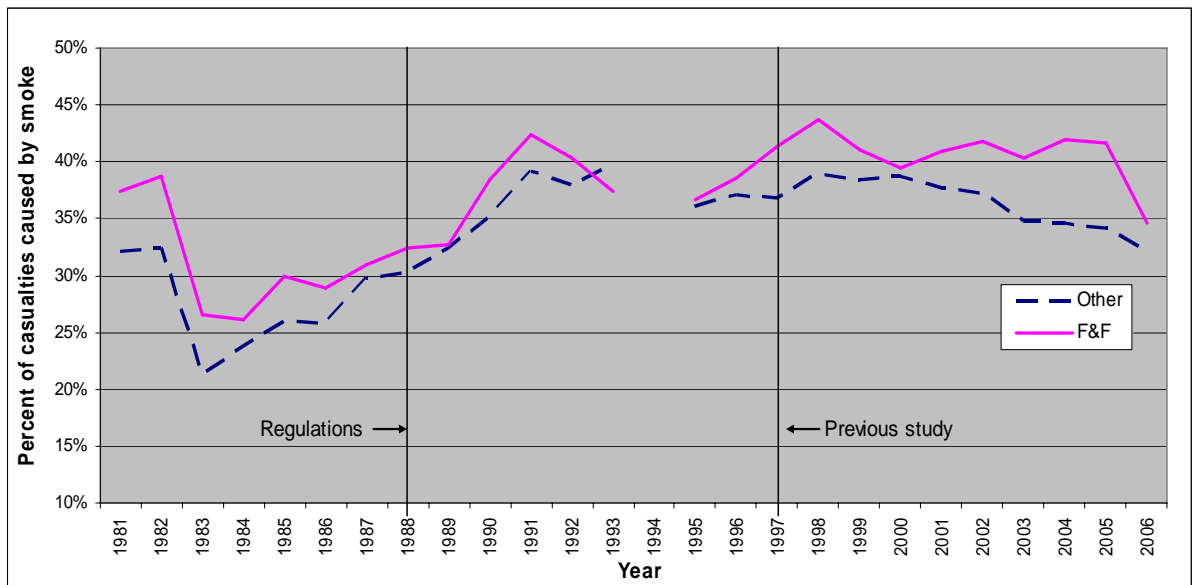


Figure 108 shows that F&F fire casualties caused by smoke remained slightly higher than Other Fire casualties. They followed a similar trend, as they continued to increase in the years after the FFRs were introduced. They then levelled off from 1995 to 1999 before slowly decreasing.

Thus:

- There were no significant differences in the trends of F&F and Other Fire casualties caused by smoke over the study period; and

- Smoke was the largest cause of F&F fire fatalities and one of the main causes of F&F fire casualties.

The proportion of F&F and Other Fire casualties involving burns fell across this period at approximately the same rate.

Figure 109 and Figure 110 show the trends in the number of each type of injury for F&F and Other Fires. It can be seen that the main differences are:

- Precautionary checks rose for Other Fires and remained higher, but remained level then fell for F&F fires;
- Smoke injuries rose for Other Fires, but far less so for F&F fires, and F&F smoke injuries started to fall earlier than Other Fire smoke injuries; and
- F&F other, burns and smoke types of injuries appear to follow similar trends.

Thus:

- Remembering the number of Other Fire injuries rose over the study period, this appears to be related to precautionary checks;
- There was some evidence of an earlier decrease in F&F than Other Fire smoke injuries; and
- No additional decline in F&F smoke injuries over and above burn or other types of F&F injuries.

Figure 109: Trend in number of Other Fire casualties by type of injury

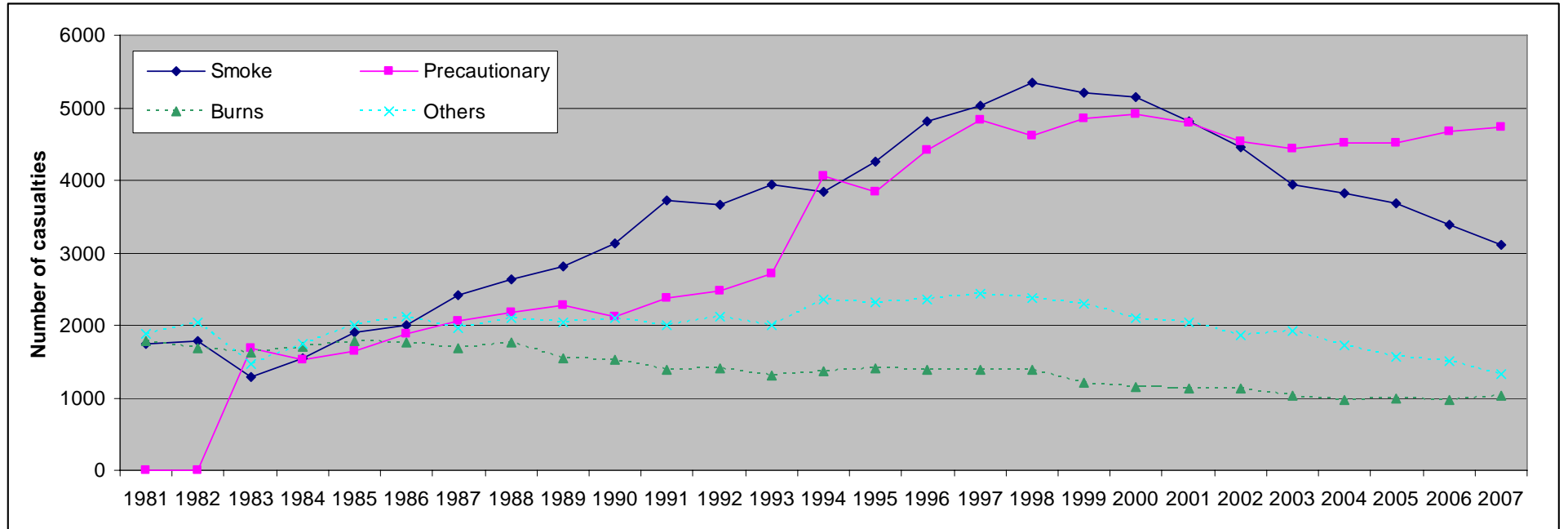
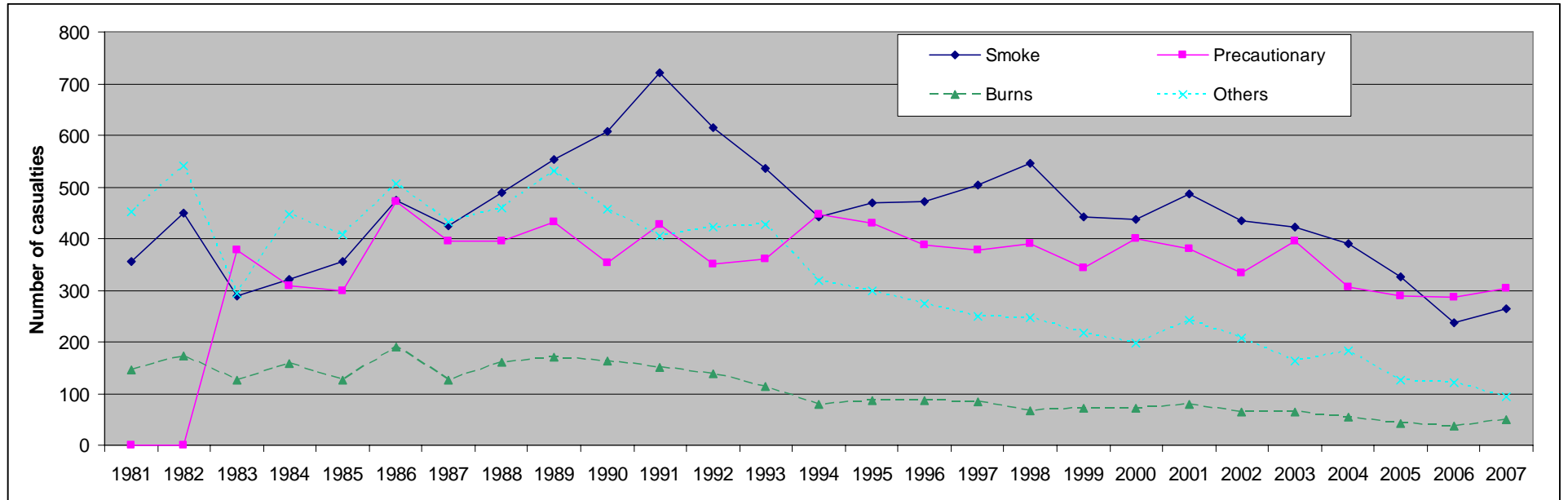


Figure 110: Trends in number of F&F casualties by type of injury



9.6 Calculation of averted incidents

9.6.1 Reduction in lethality (deaths per fire)

The analysis had three stages:

1. To assess the reduction in lethality due to smoke detectors;
2. To assess the reduction in deaths due to fall in lethality for F&F and Other Fires, after controlling for smoke alarms; and
3. To assess the difference in the reduction in lethality between F&F and Other Fires.

The data for this analysis is shown in Table 24 and Table 25.

Table 24: Furniture and furnishings

	1981-1985			2003-2007		
Discovered by	Fire discovered by	Deaths in fire discovered by	Deaths per fire	Fire discovered by	Deaths in fire discovered by	Deaths per fire
Alarm	59	4	0.068	1,705	28	0.016
Person	18,049	783	0.043	10,615	262	0.025
		Difference	-0.024		Difference	0.008

Table 25: Other fires

	1981-1985			2003-2007		
Discovered by	Fire discovered by	Deaths in fire discovered by	Deaths per fire	Fire discovered by	Deaths in fire discovered by	Deaths per fire
Alarm	1,525	9	0.006	65,940	126	0.002
Person	270,085	2,756	0.010	198,751	1,458	0.007
		Difference	0.003		Difference	0.005

Step 1: Impact of smoke alarms

The analysis involved first controlling for the impact of smoke alarms on the number of deaths. This entailed:

- Assuming the proportion of fires discovered by alarms in 2003-07 equalled that of 1981-1985;

- F&F = $(59/59+18049) \times 100 = 0.326\%$ of fires discovered by alarms in 1981-85;
- Other Fires = $(1525/1525+270085) \times 100 = 0.561\%$ of fires discovered by alarms in 1981-85;
- Multiplying the latter proportion of fires discovered by alarms by number of fires and the fatality rate per fire when discovered by alarms (0.016 for F&F and 0.0019 for Other Fires) to give deaths in fires discovered by alarms;
 - F&F fires = $0.326\% \times (1705+10615) \times 0.016 = 0.659$ deaths in fires discovered by alarms in 2002-07;
 - Other Fires = $0.561\% \times (65940+198751) \times 0.0019 = 2.8$ deaths in fires discovered by alarms in 2002-07.
- Multiplying the fires discovered by people by the number of fires and by the fatality rate per fire when discovered by people (0.025 for F&F and 0.007 for Other Fires) to give estimated deaths in fires discovered by people;
 - F&F fires = $99.674\% \times (1705+10615) \times 0.025 = 303$ deaths in fires discovered by alarms in 2002-07;
 - Other Fires = $99.439\% \times (65940+198751) \times 0.007 = 1931$ deaths in fires discovered by alarms in 2002-07.
- Adding together the number of deaths when discovered by alarms and by people to give a "what if" (the number of alarms did not increase) prediction for 2003-07;
 - F&F = $0.659 + 303 = 303.7$
 - Other Fires = $2.8 + 1931 = 1934$
- Comparing the "what if" estimate with the actual number of deaths in 2003-07;
 - F&F = $303.7-290 = 13.7$ lives saved by smoke detectors in 2002-07;
 - Other Fires = $1934 - 1584 = 349$ lives saved by smoke detectors in 2002-07.
- Dividing this by 5 years gives:
 - F&F = 2.754 lives saved per year by smoke detectors;
 - Other Fires = 69.93 lives saved per year by smoke detectors.

The results can also be presented in terms of lethality rates, as follows:

Predicted deaths per fire if there had not been an increase in smoke detectors

- 0.0247 deaths per F&F fire;
- 0.0073 deaths per Other Fires.

The actual deaths per fire were:

- 0.0235 for F&F;
- 0.006 for Other Fires.

Therefore, the reduction in lethality of fires associated with smoke alarms was:

- F&F = $0.0247 - 0.0235 = 0.0011$;

- Other Fires = $0.0073 - 0.006 = 0.00132$.

This equates to:

- 5.61% fewer deaths in F&F fires due to smoke detectors;
- 31.48% reduction in Other Fires due to smoke detectors.

Step 2: Reduction in lethality after controlling for impact of alarms

The next step was to assess the reduction in lethality after controlling for the impact of smoke alarms.

The actual reduction in lethality was:

- F&F = $((4+783)/(59+18049)-(28+262)/(1706+10615)) = 0.0199$ fewer deaths per fire;
- Other Fires = $((9+2756)/(1525+270085)-(126+1458)/(65940+198751)) = 0.004$ fewer deaths per fire.

The reduction in lethality after controlling for smoke alarms is given by:

- F&F = $0.0199 - 0.0011 = 0.0188$ fewer deaths per fire;
- Other Fires = $0.004 - 0.00132 = 0.0029$ fewer deaths per fire.

The actual reduction in lethality was:

- F&F fires = $(0.0235 / 0.0435) \times 100 = 54\%$;
- Other Fires = $(0.006 / 0.0102) \times 100 = 59\%$.

The reduction in lethality after controlling for smoke detectors was therefore:

- F&F = $54\% - 5.61\% = 48.5\%$
- Other Fires = $59\% - 31.48\% = 27.3\%$.

Step 3: Difference in reduction in lethality rates

The difference in the reduction in lethality was:

- $48.5\% - 27.3\% = 21.2\%$

Therefore, a 21.2% fall in lethality of F&F remains after controlling for smoke alarms and the decline in lethality of Other Fires. 21.2% of the 1981-85 fatality rate is $0.212 \times 0.0435 = 0.0092$ fewer deaths per fire. It was assumed that this related to the impact of the FFRs, particularly the Crib 5 test and associated requirements.

With 12321 F&F fires in 2002-07 this equates to:

- 12321×0.0092 lives saved = 114 lives saved (over 5 years).

Dividing this by 5 years gives 22.7 lives saved per year in 2002-07.

This value allows for the impact of smoke detectors, the relative decline in lethality of Other Fires and the reduction in the number of F&F fires.

9.6.2 Fewer deaths due to fewer fires

The number of F&F fires fell more than for Other Fires. The difference in these two rates of decline was assumed to be related to the FFRs.

The assessment involved:

1. Calculating rates of death per million population in 1981-85 and 2002-07 for F&F and Other Fires;
2. Calculating the fall in fatality rates;
3. Calculating the difference in the amount of reduction in fatal fires; and
4. Multiplying the 1981-85 F&F fatality rate by the difference in the fall in rates.

The fatality rates assumed:

- 56,291,000 people in 1981-85
- 61,000,000 people in 2002-07.

The estimated fatality rates are shown in Table 24.

Table 26: Fatality rates per million population for F&F and Other Fires

	Fatality rate pmp		03-07 as a % of 81-85
	1981-1985	2003-07	
F&F	2.83	0.95	34%
Other	9.99	5.2	52%

The F&F fatality rate fell by 18% more than for Other Fire fatality rate,

18% of the 1981-85 F&F fatality rate was:

- $0.18 \times 2.83 = 0.52$

With 61,000,000 people in 2002-07 this equates to $0.52 * (61,000,000/1,000,000) = 32$ fewer deaths per year.

This value controls for the difference in the decline in fatal Other Fires and the growth in the UK population.

As matches accounted for 11%, other sources for 24%, smokers' materials for 65% of fatal fires, it was assumed that the 1, 0 and Crib 5 tests respectively accounted for 11%, 24% and 65% of these lives saved.

9.6.3 Fire casualties

The number of F&F non fatal casualties fell by 26% whilst Other Fire casualties rose by 75% across the review period.

A number of methods were considered including:

- Assuming that F&F casualties would have risen by 1.75 as per Other Fires (which would give 1,967 F&F casualties per year in 2002-07), then assessing the difference between the actual (829 per year) and estimated number of casualties, i.e. $1,967 - 829 = 1,137$ fewer F&F casualties; and
- Basing the estimated averted casualties on the ratio of casualties per death, multiplied by the estimated reduction in F&F deaths.

The estimate was based on the latter ratio of casualties per death, multiplied by the estimated reduction in deaths associated with the FFRs.

The total lives saved was estimated $32 + 22.7 = 54.5$ per year.

There were 14.3 F&F non fatal casualties per F&F death in 2002-07.

Therefore, $14.3 \times 54.5 = 780$ fewer non-fatal casualties due to the FFRs.

Clearly there was uncertainty in this estimate, with the possibility that the number of casualties averted could be higher, if the first method was adopted.

As matches accounted for 15% of F&F casualties, other sources for 23% and smokers' materials for 62%, it was assumed that the 1, Crib 5 and 0 tests respectively accounted for 11%, 23% and 65% of these averted non-fatal casualties.

9.6.4 Fires

The rate of F&F fires fell more than the rate of Other Fires. The change in rates of fire per million population (pmp) are shown in Table 27. The rate of F&F fires fell 27% more than the rate of Other Fires.

27% of the 1981-85 rate of 65 pmp is 17.46 fewer fire pmp. With 61,000,000 people in 2002-07 this is 1,065 fewer F&F fires per year.

Table 27: Rates of fire per million population

	Fires pmp		Decline
	1981-85	2003-07	
F&F	65	40	37%
Other	971	869	10%

As matches accounted for 14.5% of F&F fires, other sources for 24% and smokers' materials for 62%, it was assumed that the 1, Crib 5 and 0 tests respectively accounted for 11%, 23% and 65% of these averted fires.