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New Zealand Fire Risk Data (1986 - 1993)

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NEW ZEALAND FIRE RISK DATA

BRANZ Study Report No. 64 P. Narayanan and P. Whiting

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KEYWORDS

Building Fires; Fire Damage; Fire Losses; Fire Risk; Fire Services; New Zealand; Statistical Data.

ABSTRACT

Traditionally, the effectiveness of fire safety protection in most countries has been presented in forms such as deaths per million population, while the cost of such protection has been shown as a percentage spent in terms of GDP and as a percentage of building costs. Performances of individual countries have then been compared using similar information available for other countries.

The building practices (culture) and socio-economic conditions of individual countries have a significant impact on the fire risk of those countries and make the national fire risk of each country unique. Figures such as percentage of GDP expenditure and percentage of building costs take no account of these unique features and are thus a poor basis for the assessment of risk in any individual country.

An introductory research and analysis of the fire risk in some occupancies in New Zealand has been carried out. The methodology applied and the recommendations made based on the findings are included in this report.

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1. INTRODUCTION

1.1. Performance Based Environment for Building Controls

New Zealand as a nation and as a people is undergoing tremendous change. From the view point of fire safety, there is an urgent need for technical innovation in the area of quantifying the performance requirements of the building codes (Building Industry Authority, 1992). The New Zealand experience with performance-based codes has reached a stage where overseas parallels or models are no longer suitable or as useful. The performance requirements must be based on the unique nature of the risks in this country. To do this the starting point must be to define the national fire risk in a fashion that can be readily translated for use in fire engineering and code development work.

Any study in the area of fire risk must first provide the opportunity to understand the actual levels of risk in buildings in New Zealand. Knowledge of the actual levels of fire risk is central to a rational fire engineering approach, where it forms the framework for the interaction between the various deterministic approaches being developed to describe fire behaviour. Traditional approaches relying on rules of thumb will gradually diminish, to be replaced with more rational fire engineering design.

Traditionally, the effectiveness and cost of fire safety protection in most countries has been presented in forms such as deaths per million population, cost as a percentage spent in terms of GDP and as a percentage of building costs. Performances of individual countries have then been compared. In line with this practice, Table 1 (Narayanan, 1994) shows how New Zealand compares with Australia, Sweden, Japan, UK and USA.

The building practices and socio-economic conditions of individual countries have a significant impact on the fire risk of those countries. Those cultural aspects that are unique to a nation can affect people movement and response to building fires and other similar emergencies. Those features must therefore make the national fire risk in each country unique.

The implication of not considering the unique nature of the fire risk can be expected to be seen in the suitability or otherwise, of fire technology and selection of protection systems. Thus, using figures in decision making for fire protection costs based on GDP or building costs or assessing fire risk tends to downplay the cost of life safety.

Table 1 : Fire Protection Cost and Number of Fire Deaths in Various Countries

Average Values	NZ	Australia	Sweden	Japan	UK	USA
Fire protection cost:						
Percentage of building cost	2.50	n/a	2.50	2.50	2.10	n/a
Percentage of GDP	0.18	0.26	0.23	0.23	0.18	0.31
No. of fire deaths per million population	16.4	10.0	15.4	16.0	18.1	26.3
Some inaccuracies in these figures exist as a result of the different periods over which the averages are measured. These averages are constantly updated by the World Fire Statistics Centre.						

1.2. Use of Fire Risk Data

Fire risk data provide a valuable tool in decision making, for both the fire services and the wider fire protection community. The compilation and presentation of fire risk data in a useful manner empowers the user to:

- evaluate the effectiveness of fire protection
- propose competent protection measures
- marshall protection resources effectively and
- effect new research directions or realign existing ones.

Table 2 (adapted from Hall, 1991) shows potential data users and uses of fire risk data in New Zealand.

Table 2 : Users of Fire Risk Information in New Zealand

User	Use
Fire Protection Engineers	• Defining and quantifying fire scenarios • Evaluating performance of fire protection systems • Evaluating fire safety design alternatives
New Zealand Fire Service	• Determining resource allocation • Measuring effectiveness of fire protection • Developing community fire safety education programmes • Training personnel • Enacting and enforcing fire safety standards
Building Industry Authority (Building Code Development) Standards New Zealand (Standards Development)	• Identifying needs for codes and standards • Updating codes and standards • Measuring performance of codes and standards • Conducting cost-benefit analyses of codes and standards
Fire Safety Researchers	• Establishing fire safety research priorities • Designing research programmes
Insurance Industry	• Planning and loss prevention • Carrying out risk selection and underwriting
Industry	• Establishing health and safety priorities • Planning training
Product Developers	• Identifying needed products and markets • Modifying products to improve fire safety

1.3. Purpose of this Study

Fire statistics are available in New Zealand from records stored in the FIRS database operated by the New Zealand Fire Service. Some modification of the information extracted is required to enable useful engineering data to be obtained. Thus the purpose of this study is twofold:

- to assess the suitability and accuracy of the FIRS fire data available in New Zealand
- to analyse and translate FIRS fire risk data to a form useful in risk assessment modelling.

The approach used to assess fire risk loss statistics for Ontario, Canada (Mailvaganam et al, 1992) has been adopted in part in converting some data for risk assessment modelling in New Zealand.

2. FIRE RISK DATA

2.1. Fire Incident Reporting System (FIRS) at the New Zealand Fire Service

The New Zealand Fire Service publishes the national fire statistics annually (NZFS, 1993). The FIRS database maintained at the New Zealand Fire Service is based on the guidelines of NFPA 902M (NFPA, 1990). The primary objective of FIRS (condensed and paraphrased) is to provide information:

- to facilitate strategic planning and feedback for operations through
  - * the study of trends
  - * measurement of the effectiveness of fire safety practices;
- for statistical purposes.

FIRS was first implemented in 1986 and now maintains 9 full years of records of all incidents attended by the New Zealand Fire Service. Updating of records is carried out centrally at the Headquarters in Wellington. This activity follows strict procedures. These features of FIRS give it the unique characteristic of being able to provide a national profile of fire incidents.

2.2. Data Range

Data from FIRS used in the BRANZ study is based on all structure fires attended by the Fire Service between 1986 and 1993 (excluding false alarms). A structure fire is defined as a fire in a building (NZFS, 1993) attended by the Fire Service.

The data range covers 36 595 structure fires, collected under the following categories:

- Residential
- Places of Assembly
- Institutional
- Commercial
- Health Care
- Educational
- Manufacturing
- Storage

Based on descriptions provided in the coding manual, the data has been reported here under the following categories :

- Dwellings
- Apartments
- Offices
- Rest Homes
- Schools
- Hotels
- Hospitals

The total number of fires under these categories is 22 272. The remaining 14 323 fires fall under other categories such as: Utility, Manufacturing, Storage and other special properties. Information for these has not been processed.

2.3. Methodology

Data from the database was extracted in 8 batches (1 batch per year) and imported into Microsoft Access 2.0 (Microsoft, 1994) where a base table (D8) was developed comprising all 8 batches. The data in D8 maintains the set standard coding as described in the Fire Incident Reporting System Instructions and Coding Manual (NZFS, 1995).

To facilitate the requirements of this project the codes for fixed property use have been interpreted as shown in Table 3.

The category "unknown" and "cannot be classified" in some Tables has been included in the analyses where totals are required.

The "extent of flame damage" category has been used to facilitate the analysis of the various types of fires.

The data for "detector performance" and "sprinkler performance" has been used for the analysis of the effectiveness of early detection and suppression systems. Any "0" coded incidents were removed from these categories to improve the accuracy of the data. This is discussed further in the conclusions.

Table 3 : Interpretation of Coding Manual Categories

Coding Manual Category (NZFS, 1995)	Classification for project
One Family and Two Family Dwellings	Dwellings
Apartments, Home Units, Town Houses, Flats	Apartments
Offices	Offices
Care for the aged	Rest Homes
Non-residential Schools Residential/Boarding Schools Trade, Business Schools	Schools
Rooming, Boarding, Lodging Houses, Hotels, Lodges, Motels, Travel Lodges (Licensed and Unlicensed Restaurant Facilities)	Hotels
Care for the sick and injured	Hospitals

3. ANALYSIS OF DATA

3.1. Use of Data for Analysis

The data from the FIRS database has been used to carry out the evaluation of:

1. The accuracy of the FIRS database
2. The effectiveness of the New Zealand Fire Service response to emergencies
3. The comparative fire risk in the various occupancies listed in Table 2
4. Percentage of types of fires categorised as:
    - smouldering
    - non-flashover
    - flashover fires
5. Effectiveness of early detection and suppression systems.

Raw data has been presented for all these categories. Where simple manipulation of data is made, the basis and arguments supporting such adjustments have also been presented. Caution and engineering judgement must be exercised in using this data.

3.2. Accuracy of the FIRS Data

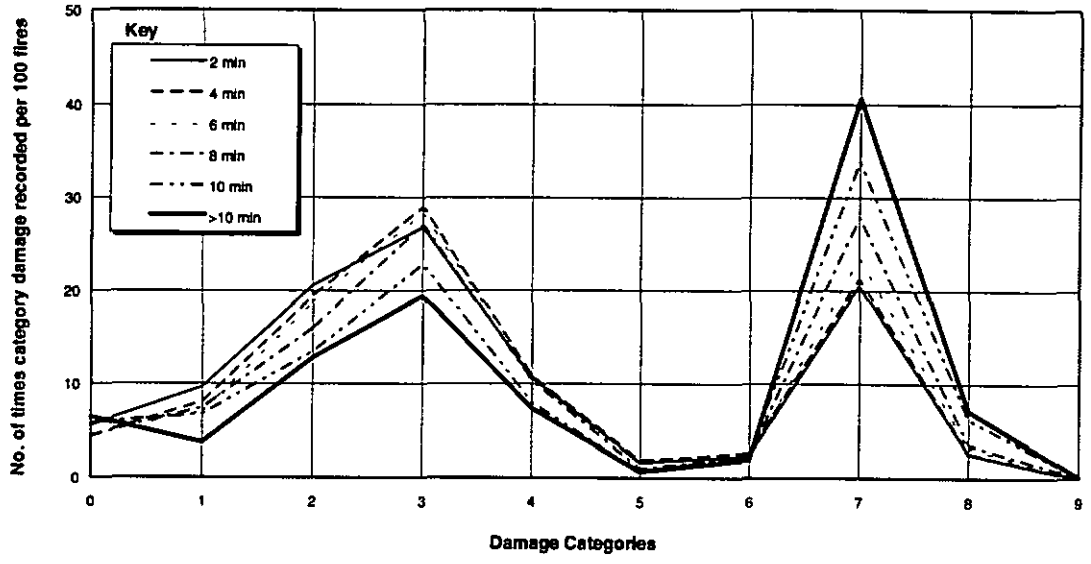
The effectiveness of the inferences drawn from the FIRS data will be greatly influenced by the accuracy with which the data has been collected in the first place.

A simple test was carried out by comparing the distribution of flame damage categories with response time categories (Table 4). A bimodal distribution giving two peaks (Figure 1) was observed, with high rates of incidences with category 3 (flame damage confined to part of room or origin area) or 7 (flame damage extending to structure of origin) being reported.

Table 4 : Percentage of Times Flame Damage Categories Encountered for Various Categories of Response Times

Flame Damage		Response Time Categories					
Code	Category	2 min	4 min	6 min	8 min	10 min	>10 min
0	Flame damage, cannot classify	5.4	4.3	4.5	4.4	5.8	6.4
1	No damage of this type	9.6	8.0	6.9	7.4	6.7	3.6
2	Confined to the object of origin	20.5	19.4	18.8	16.0	13.5	12.8
3	Confined to part of room or origin area	26.8	29.0	28.3	27.1	22.8	19.4
4	Confined to room of origin	10.6	10.8	10.8	10.3	7.9	7.3
5	Confined to the firecell of origin	1.6	1.8	1.7	1.0	0.6	0.6
6	Confined to floor of origin	2.3	2.7	2.2	2.3	2.4	1.9
7	Extended to structure of origin	20.5	21.3	23.6	27.9	33.9	40.7
8	Extended beyond structure of origin	2.6	2.6	3.2	3.5	6.2	7.1
9	Flame damage not classified above	0.0	0.0	0.0	0.2	0.2	0.1
	Total	100.0	100.0	100.0	100.0	100.0	100.0

Figure 1 : Flame Damage Versus Response Time



Low rates of incidents with flame damage categories 5 and 6 have been reported. Discussion with the NZFS and other researchers has led to the belief that this could have resulted from the difficulty in differentiating between categories 5 and 6. This trend is generally accentuated by the large number of domestic fires where the firecell and floor of origin are often one and the same. On the other hand, the differentiation between categories 3 and 7 is relatively distinct.

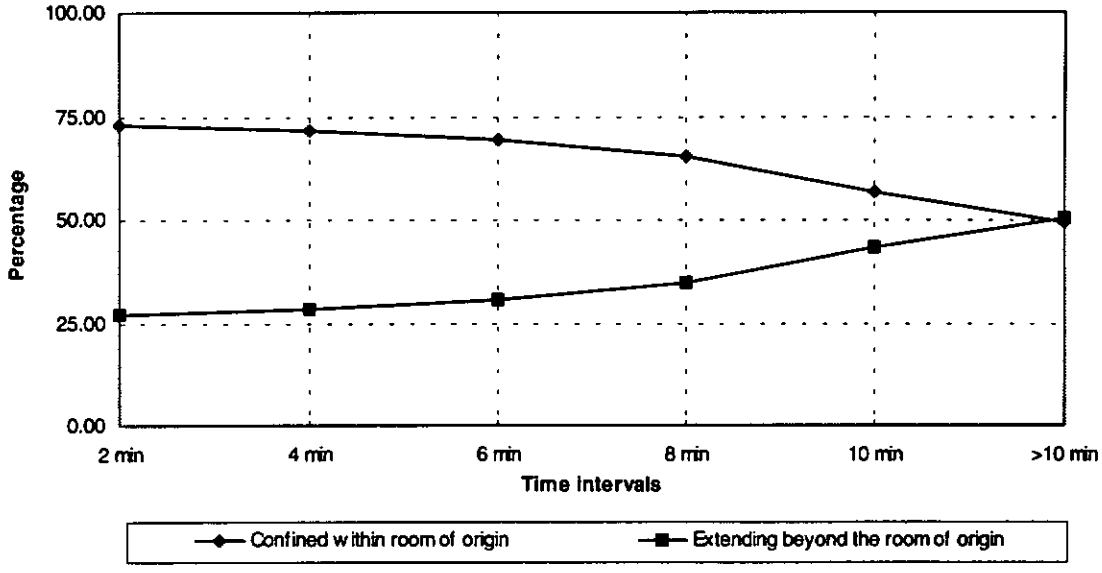
An extensive review of the FIRS database is currently under way at the NZFS. It is expected that the clarity between categories will be improved during this process. This improvement is also expected to filter through to the NZFS training programmes.

The data was reduced to just two broad categories (categories 0 and 9 being ignored for this analysis):

- Flame damage confined to room of origin (categories 1 to 4 combined);
- Flame damage extending beyond room of origin (categories 5 to 8 combined).

The usefulness of this information becomes more apparent, as shown by the plots in Figure 2. The figure shows that there is at least a 65% chance of containing the fire within the room of origin if the Fire Service attends the fire call within the maximum 8 minute response time. The 8 minute maximum response time is used extensively in the design of services by the New Zealand Fire Service.

Figure 2 : Extent of Flame Damage With Response Time



3.3. Fire Service Response Times

The response times are measured from the time the NZFS receives the emergency callout to the time the appliances and firefighters arrive at the fire scene. The maximum response time of 8 minutes is used as the benchmark to measure the effectiveness of Fire Service response to fires. The cumulative frequency curve represented in Figure 3, derived from Table 5, shows the effectiveness and efficiency of the NZFS in responding to fires; 85% of all fires are responded to within the critical 8 minutes.

Another important feature that was observed from the comparison of the number of deaths per hundred fires responded to by the Fire Service with the response times (Figure 4) was that response times had little impact on the number of deaths and injuries. This observation suggests that most deaths and injuries occur before the Fire Service arrives at the scene. This result emphasises the need to reduce the notification time (from the time of fire initiation to the time the emergency services are alerted).

Figure 3 : New Zealand Fire Service Response Times to all Structure Fires (Cumulative)

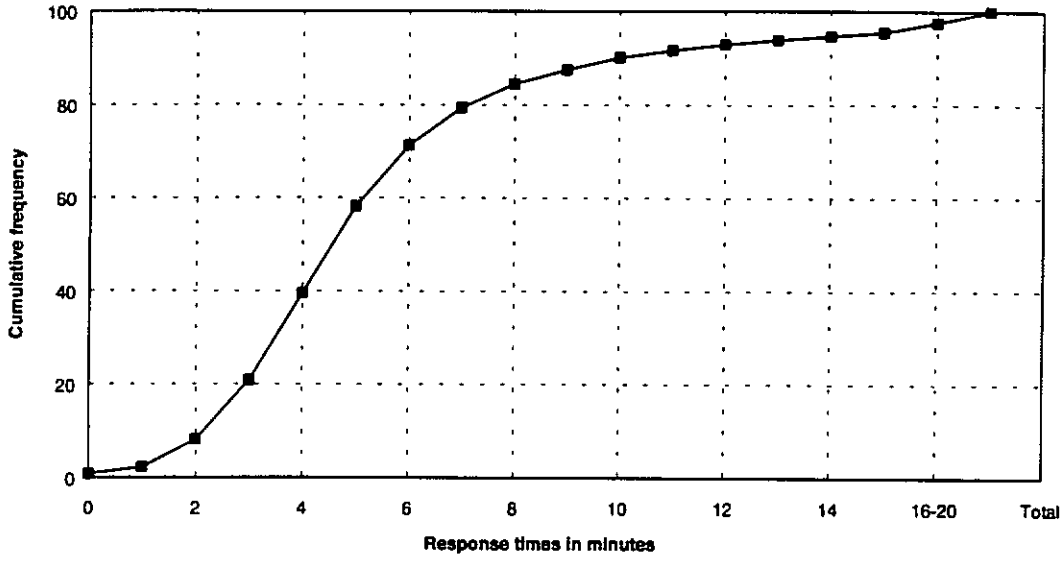


Table 5 : Response Times For All Structure Fires

Response Time	No. of Fires	Cumulative Frequency
0 [<1]	274	0.8
1	565	2.3
2	2151	8.2
3	4619	20.8
4	6874	39.6
5	6780	58.1
6	4828	71.3
7	2981	79.4
8	1859	84.5
9	1101	87.5
10	956	90.1
11	552	91.7
12	472	92.9
13	343	93.9
14	293	94.7
15	293	95.5
16-20	786	97.6
>20	868	100.0
Total	36 595	

Figure 4 : Deaths and Injuries in Fires versus Fire Service Response Time

3.4. Fire Risk Analysis

Results from the analysis carried out for the various occupancies is presented in this report in the following format:

- Fire risk in terms of flame damage
- Fire risk based on types of fire
- Effectiveness of early detection and suppression systems
- The comparative fire risk based on time of day, number of fires and floor areas in individual occupancies

3.5. Presentation of Fire Risk Data

Risk by flame damage: Flame damage categories have been presented in a form that includes:

- The percentage of fires that fall in that category (Figure 1);
- The number of deaths in fires that fall in that category .

Risk by types of fires: In ascertaining the risk by types of fires, the classification as shown in Table 6 was adopted.

Table 6 : Types of Fires

Flame Damage Category	Type of Fire
0 and 9	Omitted for this study
1 and 2	Smouldering
3 and 4	Non-flashover fire
5 to 8 (inclusive)	Flashover fire

Risk by floor area: The use of floor area of the various occupancies is a good measure and also gives another perspective to the way the risk in individual occupancies may be defined. The normalised values in Table 7 illustrate the relative risk of each occupancy type. By far the majority of fire deaths, however, occur in dwellings.

Table 7 : Fire Risk in Various Occupancies Normalised by Results for Dwellings

Occupancy Type	By Number of Fires	By Floor Area
Dwellings	1.00	1.00
Apartments	1.60	1.50
Office	0.13	0.05
Rest Homes	8.28	18.88
Schools	0.00	0.00
Hotels	1.82	1.97
Hospitals	0.18	0.15

Risk by effectiveness of early detection and suppression systems: Fire deaths and injuries are shown against the effectiveness of early detection and suppression systems in the following manner:

- Number of fire incidents, deaths and injuries in each occupancy against the percentage of property damage;
- Number of fire incidents, deaths and injuries in each occupancy with or without sprinklers against the presence of alarm systems.

Risk by time of day: The breakdown of all fires into 4 broad time categories of 6-hourly intervals is shown in Table 8. There is little variation observed between the categories. This indicates that the likelihood of fires occurring in any occupancy is the same within these broad time intervals. The simple inference that can be drawn is that there is a slightly greater likelihood (60% chance) of fires occurring between noon and midnight.

Table 8 : Fire Occurrence by Time (in hours) of Day (1986 to 1993)

Occupancy type	Total No. of Fires	Proportion Occurring 00:00 to 05:59	Proportion Occurring 06:00 to 11:59	Proportion Occurring 12:00 to 17:59	Proportion Occurring 18:00 to 23:59
Dwellings	17 339	0.2	0.2	0.3	0.3
Apartments	1604	0.2	0.2	0.3	0.3
Office	956	0.2	0.2	0.3	0.3
Rest Homes	177	0.2	0.2	0.3	0.3
Schools	1038	0.2	0.2	0.3	0.3
Hotels	469	0.2	0.2	0.3	0.3
Hospitals	689	0.2	0.2	0.3	0.3
Total	**22 272**				

Risk by number of fires and available floor area in individual occupancy types: Table 9 shows the casualty rates in fires between 1986 and 1993 for the various occupancies and the average floor areas for the occupancies.

The casualty rate is analysed in the following forms:

1. Number of deaths per 1000 fires in each occupancy type.
2. Number of deaths per million m^2 of floor area (average) in each occupancy type.
3. Number of injuries per 1000 fires in each occupancy type.
4. Number of injuries per million m^2 of floor area (average) in each occupancy type.

The total casualty rates for all occupancy types were:

- 8.3 deaths per 1000 fires
- 73 injuries per 1000 fires
- 1.17 deaths per million m^2 of floor area.
- 10.32 injuries per million m^2 of floor area.

Table 9 : Fire Casualty Rate (1986 to 1993 inclusive)

Occupancy Type	Total No. of Fires	Percentage of Total	Average Floor Area (million sq. metres)	No. of Deaths	No. of Deaths per 1000 Fires	No. of Deaths per million sq. metres	No. of Injuries	No. of Injuries per 1000 Fires	No. of Injuries per million sq. metres
Dwellings	17339	77.8	111.7	142	8.2	1.3	1286	74.2	11.5
Apartments	1604	7.2	11.0	21	13.1	1.9	159	99.1	14.5
Office	956	4.3	16.3	1	1.0	0.1	34	35.6	2.1
Rest Homes	177	0.8	0.5	12	67.8	24.0	29	163.8	58.0
Schools	1038	4.7	10.0	0	0.0	0.0	77	74.2	7.7
Hotels	469	2.1	2.8	7	14.9	2.5	16	34.1	5.7
Hospitals	689	3.1	5.1	1	1.5	0.2	24	34.8	4.7
Total	**22272**	**100.0**	**157.4**	**184**	**8.3**	**1.2**	**1625**	**73.0**	**10.3**

3.6. Dwellings

3.6.1. Flame Damage

Conclusions that may be drawn from the tables 10 and 11, based on a confidence interval of 95%, are:

- Most deaths in this category were associated with flashover fires (total dwelling fires = 17 339).
- 67-68 % of all dwelling fires between 1986 and 1993 were confined to the room of origin and were either smouldering or non-flashover fires;
- 64-79 % of all deaths in dwelling fires occur when the fire spreads beyond the room of origin.

Table 10 : Extent of Flame Damage in Dwellings

Flame Damage	Flame Damage Code	No. of Fires	Percentage of Fires	No. of Deaths	No. of Deaths per 1000 Fires in Flame Damage Category
0	Flame damage cannot classify	632	3.6	5	7.9
1	No damage of this type	972	5.6	2	2.1
2	Con fined to the object of origin	2628	15.2	2	0.8
3	Confined to part of the room of origin	5427	31.3	13	2.4
4	Confined to room of origin	2217	12.8	18	8.1
5	Confined to firecell of origin	172	1.0	2	11.6
6	Confined to floor of origin	549	3.2	7	12.8
7	Extended to structure of origin	4237	24.4	77	18.2
8	Extended beyond structure of origin	498	2.9	16	32.1
9	Flame damage not classified above	7	0.0	0	0.0
	Total	17339	100.0	142	8.2

Figure 5 : Casualty Profile for Dwellings Compared With Flame Damage

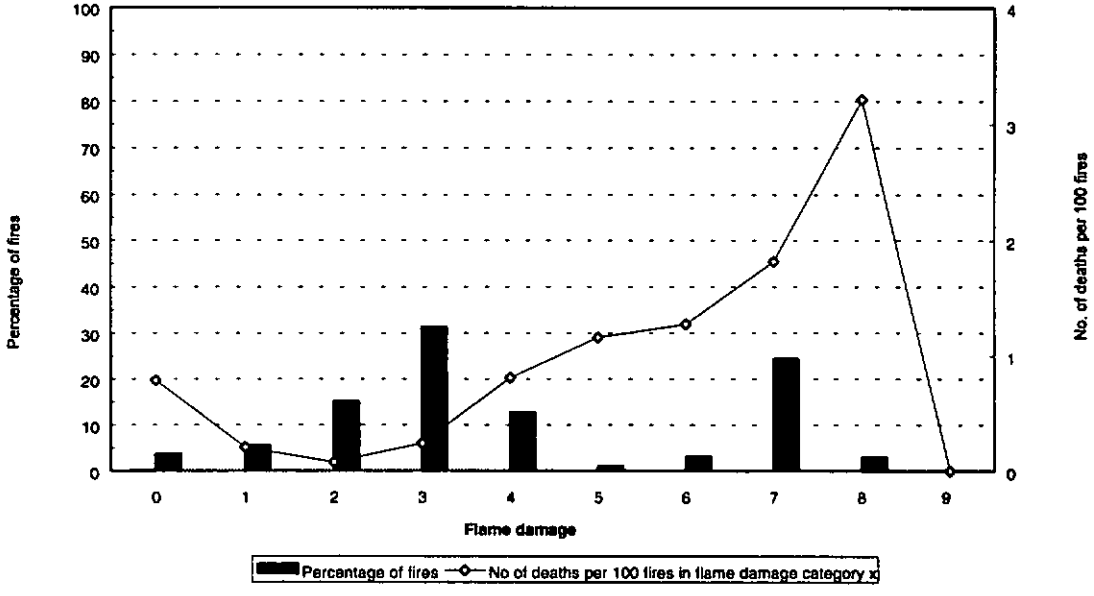


Table 11 : Dwellings

Types of Fires	No. of Fires	Percentage of Fires	No. of Deaths	No. of Deaths per 1000 Fires of Given Type
Unknown Fire	639	3.6	5	7.8
Smouldering Fire	3600	20.8	4	1.1
Non-flashover Fire	7644	44.1	31	4.1
Flashover Fire	5456	31.5	102	18.7
Total	**17339**	**100.0**	**142**	**8.2**

3.6.2. Effectiveness of Early Detection and Suppression Systems

Conclusions that may be drawn from the tables 12 to 14, based on a confidence interval of 95%, are:

- 62-63 % of all fire incidents in dwellings without sprinklers had 10% or less property damage;
- 16-30 % of fire incidents in dwellings without sprinklers where death occurred, had 10% or less property damage;
- 39-84 % of all fire incidents in dwellings with sprinklers had 10% or less property damage;
- 97-100 % of all deaths in fire incidents in dwellings occurred where there were no early detection or suppression systems.

Table 12 : Fires in Dwellings Without Sprinklers

Percentage Damage	Number of Fires	Percentage of Fires	Number of Injuries	Injuries/1000 Fires in Damage Category	Number of Deaths	Deaths/1000 Fires in Damage Category
0 - 10%	9922	62.7	437	44.0	31	3.1
11 - 20%	1438	9.1	118	82.1	9	6.3
21 - 30%	751	4.8	82	109.2	11	14.6
31 - 40%	525	3.3	69	131.4	3	5.7
41 - 50%	407	2.6	80	196.6	10	24.6
51 - 60%	395	2.5	77	194.9	8	20.3
61 - 70%	350	2.2	60	171.4	13	37.1
71 - 80%	430	2.7	89	207.0	10	23.3
81 - 100%	1592	10.1	222	139.4	41	25.7
misc	5	0.0	1	200.0	0	0.0
All	**15815**	**100.0**	**1235**	**78.1**	**136**	**8.6**

Table 13 : Fires in Dwellings With Sprinklers

Percentage Damage	Number of Fires	Percentage of Fires	Number of Injuries	Injuries/1000 Fires in Damage Category	Number of Deaths	Deaths/1000 Fires in Damage Category
0 - 10%	11	64.7	0	0.0	0	0.0
11 - 100%	6	35.3	0	0.0	0	0.0
All	**17**	**100.0**	**0**	**0.0**	**0**	**0.0**

The difference between the sum of the number of fires from Tables 12 (non-sprinklered) and 13 (sprinklered), and the total number of fires given in Table 9 for dwellings, is the number of occasions the presence or not of a sprinkler system was unable to be identified from the fire incident report.

Table 14 : Fire Injuries and Deaths in Dwellings

	Non - Sprinklered			Sprinklered		
	No. of Fires	No. of Injuries	No. of Deaths	No. of Fires	No. of Injuries	No. of Deaths
Alarm						
actual	174	17	1	8	0	0
rate per 1000 fires		97.7	5.7		0.0	0.0
No Alarm						
actual	15617	1218	135	9	0	0
rate per 1000 fires		78.0	8.6		0.0	0.0
TOTAL	**15791**	**1235**	**136**	**17**	**0**	**0**
rate per 1000 fires		**78.2**	**8.6**		**0.0**	**0.0**

The difference between the total sum of the number of fires for non-sprinklered and sprinklered dwellings in Table 14, and the total number of fires given in Table 9 is the number of occasions the presence or not of a sprinkler or alarm system was not able to be identified from the fire incident report.

3.7. Apartments

3.7.1. Flame Damage

Conclusions that may be drawn from the tables 15 and 16, based on a confidence interval of 95%, are:

- Most deaths in this category were associated with flashover fires (total apartment fires = 1604);
- 75-79 % of all apartment fires between 1986 and 1993 were confined to the room of origin and were either smouldering or non-flashover fires;
- 41-83 % of all deaths in apartment fires occurred where the fire had spread beyond the room of origin.

Table 15 : Extent of Flame Damage in Apartments

Flame Damage	Flame Damage Code	No. of Fires	Percentage of Fires	No. of Deaths	No. of Deaths per 1000 Fires in Flame Damage Category
0	Flame damage cannot classify	59	3.7	2	33.9
1	No damage of this type	132	8.2	0	0.0
2	Confined to the object of origin	285	17.8	2	7.0
3	Confined to part of the room of origin	515	32.1	2	3.9
4	Confined to room of origin	255	15.9	2	7.8
5	Confined to firecell of origin	110	6.9	4	36.4
6	Confined to floor of origin	63	3.9	3	47.6
7	Extended to structure of origin	169	10.5	3	17.8
8	Extended beyond structure of origin	16	1.0	3	187.5
9	Flame damage not classified above	0	0.0	0	0.0
	Total	**1604**	**100.0**	**21**	**13.1**

Table 16 : Apartments

Types of Fires	No. of Fires	Percentage of Fires	No. of Deaths	No. of Deaths per 1000 Fires of Given Type
Unknown Fire	59	3.7	2	33.9
Smouldering Fire	417	26.0	2	4.8
Non-flashover Fire	770	48.0	4	1.3
Flashover Fire	358	22.3	13	2.8
Total	**1604**	**100.0**	**21**	**13.1**

3.7.2. Effectiveness of Early Detection and Suppression Systems

Conclusions that may be drawn from the tables 17 to 19, based on a confidence interval of 95%, are:

- 68-72 % of all fire incidents in apartments without sprinklers had 10% or less property damage;
- 3-39 % of fire incidents in apartments without sprinklers where death occurred, had 10% or less property damage;
- Three of the five fire incidents in apartments with sprinklers had 10% or less property damage. This sample size is too small to calculate a useful statistical range;

- 76-100 % of all deaths in fire incidents in apartments occurred where there were no early detection or suppression systems.

Figure 6 : Casualty Profile for Apartments Compared with Flame Damage

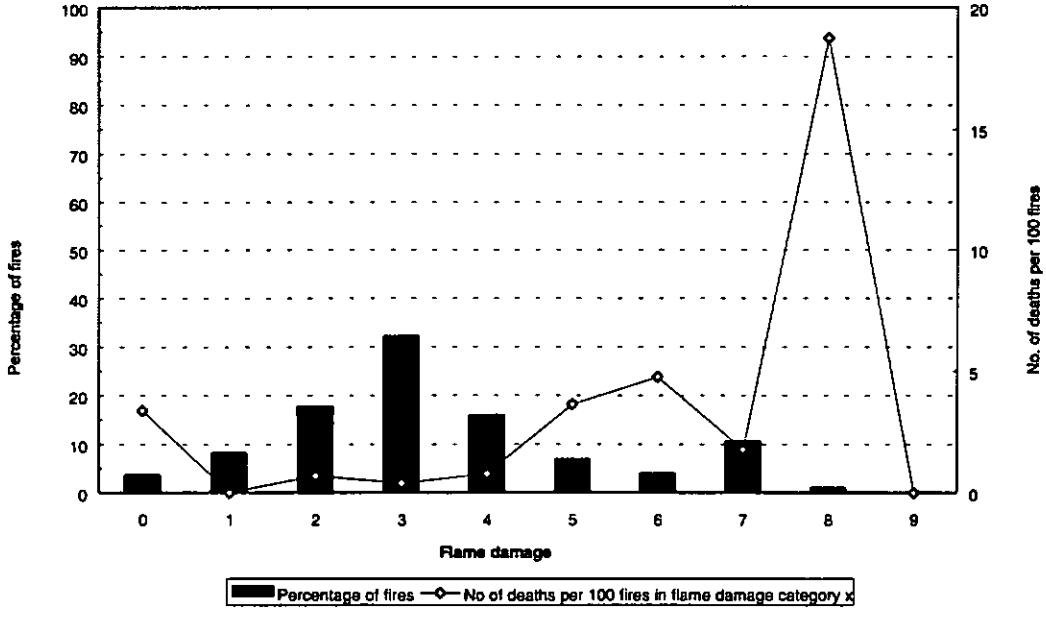


Table 17 : Fires in Apartments Without Sprinklers

Percentage Damage	Number of Fires	Percentage of Fires	Number of Injuries	Injuries/1000 Fires in Damage Category	Number of Deaths	Deaths/1000 Fires in Damage Category
0 - 10%	1042	70.1	76	72.9	4	3.8
11 - 20%	144	9.7	21	145.8	5	34.7
21 - 30%	81	5.4	17	209.9	2	24.7
31 - 40%	53	3.6	5	94.3	1	18.9
41 - 50%	38	2.6	6	157.9	1	26.3
51 - 60%	24	1.6	3	125.0	0	0.0
61 - 70%	23	1.5	6	260.9	2	87.0
71 - 80%	26	1.7	8	307.7	2	76.9
81 - 100%	56	3.8	6	107.1	2	35.7
All	**1487**	**100.0**	**148**	**99.5**	**19**	**12.8**

Table 18 : Fires in Apartments With Sprinklers

Percentage Damage	Number of Fires	Percentage of Fires	Number of Injuries	Injuries/1000 Fires in Damage Category	Number of Deaths	Deaths/1000 Fires in Damage Category
0 - 10%	3	60.0	0	0.0	0	0.0
11 - 20%	1	20.0	0	0.0	0	0.0
21 - 30%	1	20.0	0	0.0	0	0.0
31 - 100%	0	0.0	0	0.0	0	0.0
All	**5**	**100.0**	**0**	**0.0**	**0**	**0.0 ***

* Sample size too small for meaningful comparison with Table 17.

The difference between the sum of the number of fires from Tables 17 (non-sprinklered) and 18 (sprinklered), and the total number of fires given in Table 9 for apartments, is the number

of occasions the presence or not of a sprinkler system was unable to be identified from the fire incident report.

Table 19 : Fire Injuries and Deaths in Apartments

	Non - Sprinklered			Sprinklered		
	No. of Fires	No. of Injuries	No. of Deaths	No. of Fires	No. of Injuries	No. of Deaths
Alarm						
actual	44	6	2	0	0	0
rate per 1000 fires		136.4	45.5		0.0	0.0
No Alarm						
actual	1441	142	17	5	0	0
rate per 1000 fires		98.5	11.8		0.0	0.0
TOTAL	**1485**	**148**	**19**	**5**	**0**	**0**
rate per 1000 fires		**99.7**	**12.8**		**0.0**	**0.0 ***

*See Table 18

The difference between the total sum of the number of fires for non-sprinklered and sprinklered apartments in Table 19, and the total number of fires given in Table 9 is the number of occasions the presence or not of a sprinkler or alarm system was not able to be identified from the fire incident report.

3.8. Offices

3.8.1. Flame Damage

Conclusions that may be drawn from the tables 20 and 21, based on a confidence interval of 95%, are:

- Most deaths in this category were associated with flashover fires (total office fires = 956);
- 83-87 % of all office fires between 1986 and 1993 were confined to the room of origin and were either smouldering or non-flashover fires;
- Only one death in an office fire between 1986 and 1993 occurred, and the fire spread beyond the room of origin.

Table 20 : Extent of Flame Damage in Offices

Flame Damage	Flame Damage Code	No. of Fires	Percentage of Fires	No. of Deaths	No. of Deaths per 1000 Fires in Flame Damage Category
0	Flame damage cannot classify	44	4.6	0	0.0
1	No damage of this type	170	17.8	0	0.0
2	Confined to the object of origin	303	31.7	0	0.0
3	Confined to part of the room of origin	253	26.5	0	0.0
4	Confined to room of origin	51	5.3	0	0.0
5	Confined to firecell of origin	16	1.7	0	0.0
6	Confined to floor of origin	18	1.9	0	0.0
7	Extended to structure of origin	92	9.6	1	10.9
8	Extended beyond structure of origin	9	0.9	0	0.0
9	Flame damage not classified above	0	0.0	0	0.0
	Total	**956**	**100.0**	**1**	**1.0**

Table 21: Offices

Types of Fires	No. of Fires	Percentage of Fires	No. of Deaths	No. of Deaths per 1000 Fires of Given Type
Unknown Fire	44	4.6	0	0.0
Smouldering Fire	473	49.5	0	0.0
Non-flashover Fire	304	31.8	0	0.0
Flashover Fire	135	14.1	1	7.4
Total	**956**	**100.0**	**1**	**1.0**

3.8.2. Effectiveness of Early Detection and Suppression Systems

Conclusions that may be drawn from the tables 22 to 24, based on a confidence interval of 95%, are:

- 83-88 % of all fire incidents in offices without sprinklers had 10% or less property damage;
- The only death in fire incidents in offices occurred in an office without sprinklers where property damage exceeded 80%;
- 91-100 % of all fire incidents in offices with sprinklers had 10% or less property damage;

- The one death that occurred in an office fire occurred where no early detection or suppression system was present.

Figure 7 : Casualty Profile for Offices Compared with Flame Damage

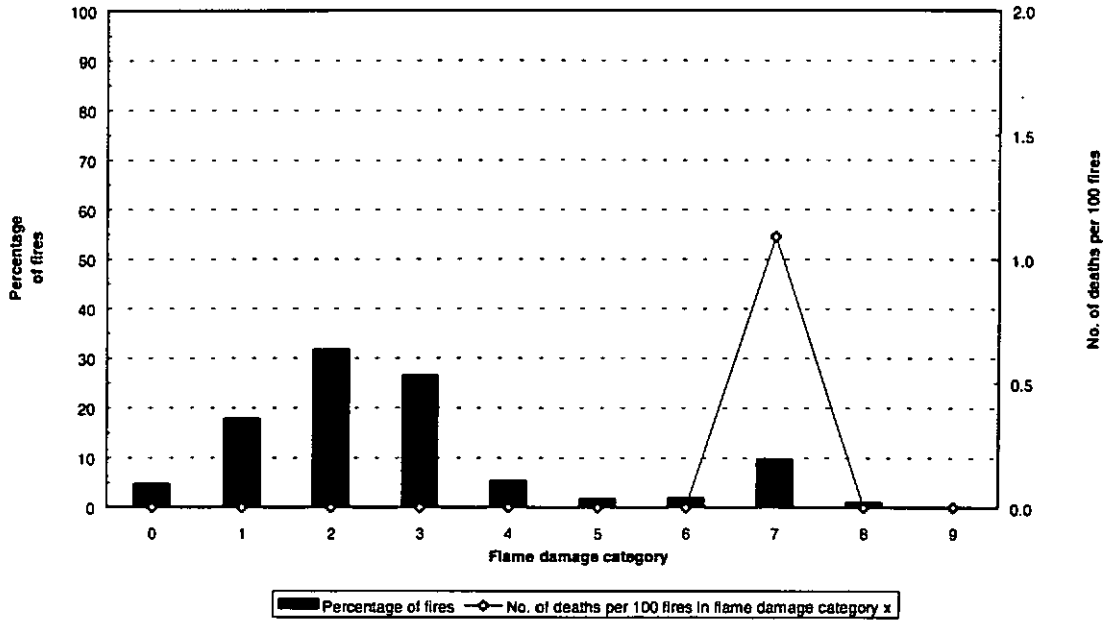


Table 22 : Fires in Offices Without Sprinklers

Percentage Damage	Number of Fires	Percentage of Fires	Number of Injuries	Injuries/1000 Fires in Damage Category	Number of Deaths	Deaths/1000 Fires in Damage Category
0 - 10%	677	85.3	12	17.7	0	0.0
11 - 20%	34	4.3	4	117.6	0	0.0
21 - 30%	22	2.8	5	227.3	0	0.0
31 - 40%	4	0.5	0	0.0	0	0.0
41 - 50%	11	1.4	1	90.9	0	0.0
51 - 60%	5	0.6	1	200.0	0	0.0
61 - 70%	5	0.6	0	0.0	0	0.0
71 - 80%	7	0.9	1	142.9	0	0.0
81 - 100%	29	3.6	8	275.9	1	34.5
All	**794**	**100.0**	**32**	**40.3**	**1**	**1.3**

Table 23 : Fires in Offices With Sprinklers

Percentage Damage	Number of Fires	Percentage of Fires	Number of Injuries	Injuries/1000 Fires in Damage Category	Number of Deaths	Deaths/1000 Fires in Damage Category
0 - 10%	80	95.2	1	12.5	0	0.0
11 - 40%	2	2.4	0	0.0	0	0.0
41 -70%	0	0.0	0	0.0	0	0.0
71 - 100%	2	2.4	1	500.0	0	0.0
All	**84**	**100.0**	**2**	**23.8**	**0**	**0.0**

The difference between the sum of the number of fires from Tables 22 (non-sprinklered) and 23 (sprinklered), and the total number of fires given in Table 9 for offices, is the number of occasions the presence or not of a sprinkler system was unable to be identified from the fire incident report.

Table 24 : Fire Injuries and Deaths in Offices

	Non - Sprinklered			Sprinklered		
	No. of Fires	No. of Injuries	No. of Deaths	No. of Fires	No. of Injuries	No. of Deaths
Alarm						
actual	216	16	0	25	2	0
rate per 1000 fires		4.6	0.0		80.0	0.0
No Alarm						
actual	575	16	1	57	0	0
rate per 1000 fires		27.8	1.7		0.0	0.0
TOTAL	**791**	**32**	**1**	**82**	**2**	**0**
rate per 1000 fires		**40.5**	**1.3**		**24.4**	**0.0**

The difference between the total sum of the number of fires for non-sprinklered and sprinklered offices in Table 24, and the total number of fires given in Table 9 is the number of occasions the presence or not of a sprinkler or alarm system was not able to be identified from the fire incident report.

3.9. Rest Homes

3.9.1. Flame Damage

Conclusions that may be drawn from the tables 25 and 26, based on a confidence interval of 95%, are:

- Most deaths in this category were associated with flashover fires (total rest home fires = 177);
- 80-90 % of all rest home fires between 1986 and 1993 were confined to the room of origin and were either smouldering or non-flashover fires;
- 51-100 % of all deaths in rest home fires occurred when the fire spread beyond the room of origin.

Table 25 : Extent of Flame Damage in Rest Homes

Flame Damage	Flame Damage Code	No. of Fires	Percentage of Fires	No. of Deaths	No. of Deaths per 1000 Fires in Flame Damage Category
0	Flame damage cannot classify	10	5.7	0	0.0
1	No damage of this type	45	25.4	0	0.0
2	Confined to the object of origin	44	24.9	0	0.0
3	Confined to part of the room of origin	39	22.0	0	0.0
4	Confined to room of origin	13	7.3	3	230.8
5	Confined to firecell of origin	2	1.1	0	0.0
6	Confined to floor of origin	2	1.1	0	0.0
7	Extended to structure of origin	17	9.6	9	529.4 (i)
8	Extended beyond structure of origin	4	2.3	0	0.0
9	Flame damage not classified above	1	0.6	0	0.0
	Total	**177**	**100.0**	**12**	**67.8**

(i) Seven of the deaths occured in one fire

Table 26: Rest Homes

Types of Fires	No. of Fires	Percentage of Fires	No. of Deaths	No. of Deaths per 1000 Fires of Given Type
Unknown Fire	11	6.2	0	0.0
Smouldering Fire	89	50.3	0	0.0
Non-flashover Fire	52	29.4	3	57.7
Flashover Fire	25	14.1	9	360.0
Total	**177**	**100.0**	**12**	**67.8**

3.9.2. Effectiveness of Early Detection and Suppression Systems

Conclusions that may be drawn from the tables 25 to 29, based on a confidence interval of 95%, are:

- 73-87 % of all fire incidents in rest homes without sprinklers had 10% or less property damage;
- 0-26 % of fire incidents in rest homes without sprinklers where death occurred, had 10% or less property damage;

- 84-100 % of all fire incidents in rest homes with sprinklers had 10% or less property damage;
- 76-100 % of deaths in fire incidents in rest homes occurred where there were no early detection or suppression systems.

Figure 8 : Casualty Profile for Rest Homes Compared with Flame Damage

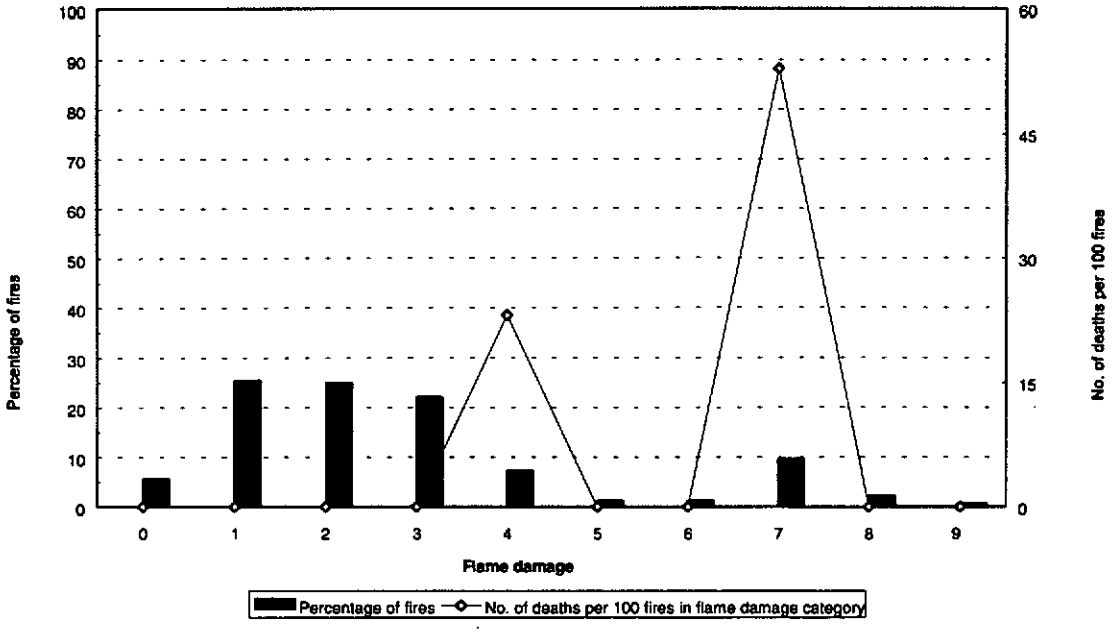


Table 27 : Fires in Rest Homes Without Sprinklers

Percentage Damage	Number of Fires	Percentage of Fires	Number of Injuries	Injuries/1000 Fires in Damage Category	Number of Deaths	Deaths/1000 Fires in Damage Category
0 - 10%	96	80.0	5	52.1	1	10.4
11 - 20%	9	7.5	7	777.8	3	333.3
21 - 100%	15	12.5	14	933.3	7	466.7
All	**120**	**100.0**	**26**	**216.7**	**11**	**91.7**

Table 28 : Fires in Rest Homes With Sprinklers

Percentage Damage	Number of Fires	Percentage of Fires	Number of Injuries	Injuries/1000 Fires in Damage Category	Number of Deaths	Deaths/1000 Fires in Damage Category
0 - 10%	36	92.3	2	55.6	1	27.8
11 - 20%	3	7.7	1	333.3	0	0.0
21 - 100%	0	0.0	0	0.0	0	0.0
All	**39**	**100.0**	**3**	**76.9**	**1**	**25.6**

The difference between the sum of the number of fires from Tables 27 (non-sprinklered) and 28 (sprinklered), and the total number of fires given in Table 9 for rest homes, is the number of occasions the presence or not of a sprinkler system was unable to be identified from the fire incident report.

Table 29 : Fire Injuries and Deaths in Rest Homes

	Non - Sprinklered			Sprinklered		
	No. of Fires	No. of Injuries	No. of Deaths	No. of Fires	No. of Injuries	No. of Deaths
Alarm						
actual	44	7	0	9	1	0
rate per 1000 fires		159.1	0.0		111.1	0.0
No Alarm						
actual	76	19	11	28	2	1
rate per 1000 fires		250.0	144.7		71.4	35.7
TOTAL	**120**	**26**	**11**	**37**	**3**	**1**
rate per 1000 fires		**216.7**	**91.7**		**81.1**	**27.0**

The difference between the total sum of the number of fires for non-sprinklered and sprinklered rest homes in Table 29, and the total number of fires given in Table 9 is the number of occasions the presence or not of a sprinkler or alarm system was not able to be identified from the fire incident report.

3.10. Schools

3.10.1. Flame Damage

Conclusions that may be drawn from the tables 30 and 31, based on a confidence interval of 95%, are:

- There were no deaths in any school fires (total school fires = 1038);
- 62-67 % of all school fires between 1986 and 1993 were confined to the room of origin and were either smouldering or non-flashover fires.

Table 30 : Extent of Flame Damage in Schools

Flame Damage	Flame Damage Code	No. of Fires	Percentage of Fires	No. of Deaths	No. of Deaths per 1000 Fires in Flame Damage Category
0	Flame damage cannot classify	28	2.7	0	0.0
1	No damage of this type	51	4.9	0	0.0
2	Confined to the object of origin	169	16.3	0	0.0
3	Confined to part of the room of origin	302	29.1	0	0.0
4	Confined to room of origin	129	12.4	0	0.0
5	Confined to firecell of origin	23	2.2	0	0.0
6	Confined to floor of origin	29	2.8	0	0.0
7	Extended to structure of origin	267	25.7	0	0.0
8	Extended beyond structure of origin	40	3.9	0	0.0
9	Flame damage not classified above	0	0.0	0	0.0
	Total	**1038**	**100.0**	**0**	**0.0**

Table 31: Schools

Types of Fires	No. of Fires	Percentage of Fires	No. of Deaths	No. of Deaths per 1000 Fires of Given Type
Unknown Fire	28	2.7	0	0.0
Smouldering Fire	220	21.2	0	0.0
Non-flashover Fire	431	41.5	0	0.0
Flashover Fire	359	34.6	0	0.0
Total	**1038**	**100.0**	**0**	**0.0**

3.10.2. Effectiveness of Early Detection and Suppression Systems

Conclusions that may be drawn from the tables 32 to 34, based on a confidence interval of 95%, are:

- 58-64 % of all fire incidents in schools without sprinklers had 10% or less property damage;
- 84-100 % of all fire incidents in schools with sprinklers had 10% or less property damage.

Figure 9 : Casualty Profile for Schools Compared with Flame Damage

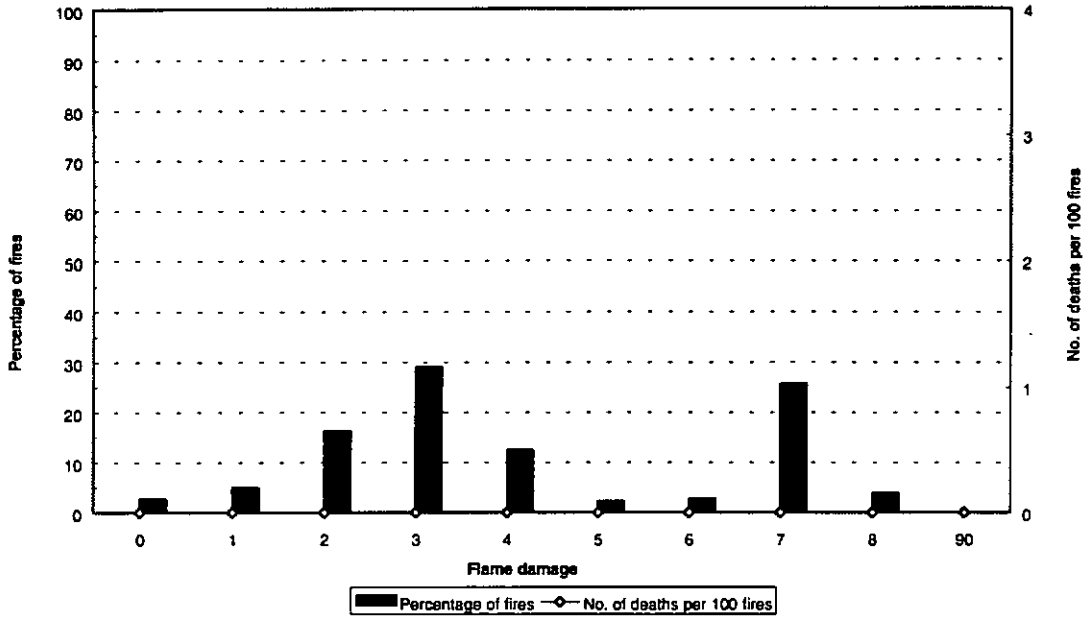


Table 32 : Fires in Schools Without Sprinklers

Percentage Damage	Number of Fires	Percentage of Fires	Number of Injuries	Injuries/1000 Fires in Damage Category	Number of Deaths	Deaths/1000 Fires in Damage Category
0 - 10%	578	61.3	16	27.7	0	0.0
11 - 20%	82	8.7	8	97.6	0	0.0
21 - 30%	56	5.9	9	160.7	0	0.0
31 - 40%	33	3.5	6	181.8	0	0.0
41 - 50%	33	3.5	5	151.5	0	0.0
51 - 60%	24	2.6	2	83.3	0	0.0
61 - 70%	23	2.4	13	565.2	0	0.0
71 - 80%	26	2.8	3	115.4	0	0.0
81 - 100%	88	9.3	14	159.1	0	0.0
All	**943**	**100.0**	**76**	**80.6**	**0**	**0.0**

Table 33 : Fires in Schools With Sprinklers

Percentage Damage	Number of Fires	Percentage of Fires	Number of Injuries	Injuries/1000 Fires in Damage Category	Number of Deaths	Deaths/1000 Fires in Damage Category
0 - 10%	17	94.4	0	0.0	0	0.0
11 - 20%	1	5.6	0	0.0	0	0.0
21 - 100%	0	0.0	0	0.0	0	0.0
All	**18**	**100.0**	**0**	**0.0**	**0**	**0.0**

The difference between the sum of the number of fires from Table 32 (non-sprinklered), Table 33 (sprinklered) and Table 34 (non-sprinklered and sprinklered), and the total number of fires given in Table 9 for schools, is the number of occasions the presence or not of a sprinkler system was unable to be identified from the fire incident report.

Table 34 : Fire Injuries and Deaths in Schools

	Non - Sprinklered			Sprinklered		
	No. of Fires	No. of Injuries	No. of Deaths	No. of Fires	No. of Injuries	No. of Deaths
Alarm						
actual	56	4	0	5	0	0
rate per 1000 fires		71.4	0.0		0.0	0.0
No Alarm						
actual	887	72	0	13	0	0
rate per 1000 fires		81.2	0.0		0.0	0.0
TOTAL	**943**	**76**	**0**	**18**	**0**	**0**
rate per 1000 fires		**80.6**	**0.0**		**0.0**	**0.0**

3.11. Hotels

3.11.1. Flame Damage

Conclusions that may be drawn from the tables 35 and 36, based on a confidence interval of 95%, are:

- Most deaths in this category were associated with flashover fires (total number of hotel fires = 469);
- 76-84 % of all hotel fires between 1986 and 1993 were confined to the room of origin and were either smouldering or non-flashover fires;
- All deaths in hotel fires occurred when the fire spread beyond the room of origin.

Table 35 : Extent of Flame Damage in Hotels

Flame Damage	Flame Damage Code	No. of Fires	Percentage of Fires	No. of Deaths	No. of Deaths per 1000 Fires in Flame Damage Category
0	Flame damage cannot classify	17	3.6	0	0.0
1	No damage of this type	43	9.2	0	0.0
2	Confined to the object of origin	107	22.8	0	0.0
3	Confined to part of the room of origin	149	31.8	0	0.0
4	Confined to room of origin	63	13.4	0	0.0
5	Confined to firecell of origin	15	3.2	2	133.3
6	Confined to floor of origin	9	1.9	1	111.1
7	Extended to structure of origin	58	12.4	4	69.0
8	Extended beyond structure of origin	8	1.7	0	0.0
9	Flame damage not classified above	0	0.0	0	0.0
	Total	**469**	**100.0**	**7**	**14.9**

Table 36: Hotels

Types of Fires	No. of Fires	Percentage of Fires	No. of Deaths	No. of Deaths per 1000 Fires of Given Type
Unknown Fire	17	3.6	0	0.0
Smouldering Fire	150	32.0	0	0.0
Non-flashover Fire	212	45.2	0	0.0
Flashover Fire	90	19.2	7	77.8
Total	**469**	**100.0**	**7**	**14.9**

3.11.2. Effectiveness of Early Detection and Suppression Systems

Conclusions that may be drawn from the tables 37 to 39, based on a confidence interval of 95%, are:

- 73-81 % of all fire incidents in hotels without sprinklers had 10% or less property damage;
- 0-40 % of fire incidents in hotels without sprinklers where death occurred, had 10% or less property damage;
- 92-100 % of all fire incidents in hotels with sprinklers had 10% or less property damage;
- No deaths occurred in hotels with sprinklers;

- All deaths in hotels occurred where no early detection or suppression systems were present.

Figure 10 : Casualty Profile for Hotels Compared with Flame Damage

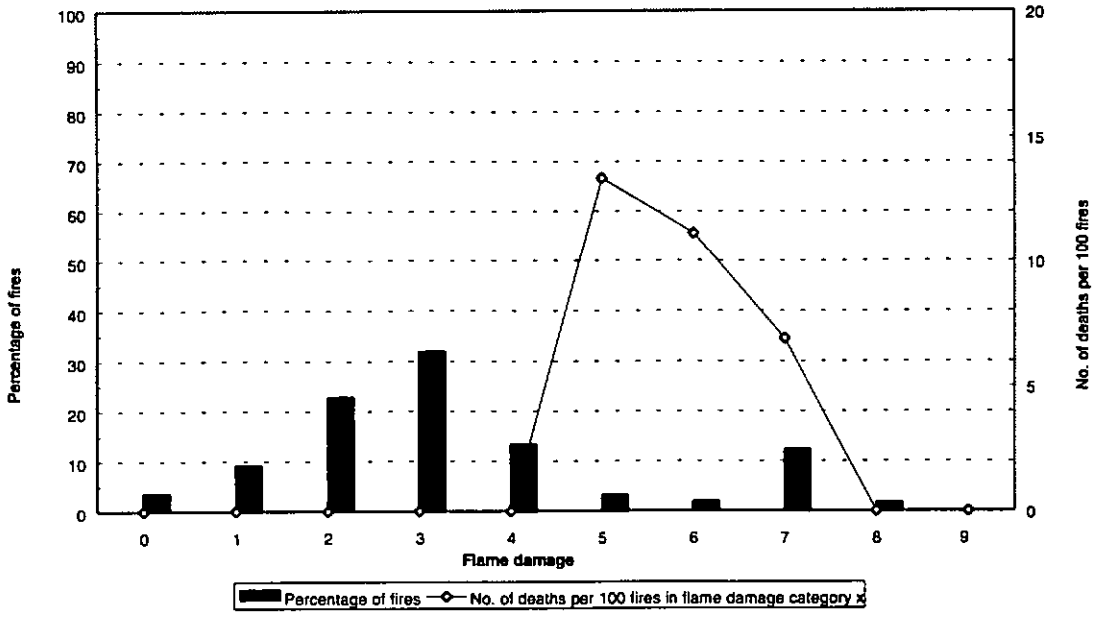


Table 37 : Fires in Hotels Without Sprinklers

Percentage Damage	Number of Fires	Percentage of Fires	Number of Injuries	Injuries/1000 Fires in Damage Category	Number of Deaths	Deaths/1000 Fires in Damage Category
0 - 10%	294	77.2	3	10.2	1	3.4
11 - 20%	27	7.1	2	74.1	0	0.0
21 - 80%	37	9.7	5	135.1	3	81.1
81 - 100%	23	6.0	3	130.4	3	130.4
All	**381**	**100.0**	**13**	**34.1**	**7**	**18.4**

Table 38 : Fires in Hotels With Sprinklers

Percentage Damage	Number of Fires	Percentage of Fires	Number of Injuries	Injuries/1000 Fires in Damage Category	Number of Deaths	Deaths/1000 Fires in Damage Category
0 - 10%	37	97.4	2	54.1	0	0.0
11 - 20%	1	2.6	0	0.0	0	0.0
11 - 100%	0	0.0	0	0.0	0	0.0
All	**38**	**100.0**	**2**	**52.6**	**0**	**0.0**

The difference between the sum of the number of fires from Tables 37 (non-sprinklered) and 38 (sprinklered), and the total number of fires given in Table 9 for hotels, is the number of occasions the presence or not of a sprinkler system was unable to be identified from the fire incident report.

Table 39 : Fire Injuries and Deaths in Hotels

	Non - Sprinklered			Sprinklered		
	No. of Fires	No. of Injuries	No. of Deaths	No. of Fires	No. of Injuries	No. of Deaths
Alarm						
actual	108	6	0	10	0	0
rate per 1000 fires		55.6	0.0		0.0	0.0
No Alarm						
actual	272	7	7	28	2	0
rate per 1000 fires		25.7	25.7		71.4	0.0
TOTAL	380	13	7	38	2	0
rate per 1000 fires		34.2	18.4		52.6	0.0

The difference between the total sum of the number of fires for non-sprinklered and sprinklered hotels in Table 39, and the total number of fires given in Table 9 is the number of occasions the presence or not of a sprinkler or alarm system was not able to be identified from the fire incident report.

3.12. Hospitals

3.12.1. Flame Damage

Conclusions that may be drawn from the tables 40 and 41, based on a confidence interval of 95%, are:

- The only death in this category was associated with a non-flashover fire (total number of hospital fires = 689);
- 92-95 % of all hospital fires between 1986 and 1993 were confined to the room of origin and were either smouldering or non-flashover fires;
- The only death that occurred in any hospital fire occurred when the fire spread beyond the room of origin.

Table 40 : Extent of Flame Damage in Hospitals

Flame Damage	Flame Damage Code	No. of Fires	Percentage of Fires	No. of Deaths	No. of Deaths per 100 Fires in Flame Damage Category
0	Flame damage cannot classify	40	5.8	0	0.0
1	No damage of this type	118	17.1	0	0.0
2	Confined to the object of origin	252	36.6	0	0.0
3	Confined to part of the room of origin	172	25.0	0	0.0
4	Confined to room of origin	65	9.4	1	15.4
5	Confined to firecell of origin	7	1.0	0	0.0
6	Confined to floor of origin	8	1.2	0	0.0
7	Extended to structure of origin	22	3.2	0	0.0
8	Extended beyond structure of origin	5	0.7	0	0.0
9	Flame damage not classified above	0	0.0	0	0.0
	Total	**689**	**100.0**	**1**	**1.5**

Table 41: Hospitals

Types of Fires	No. of Fires	Percentage of Fires	No. of Deaths	No. of Deaths per 1000 Fires of Given Type
Unknown Fire	40	5.8	0	0.0
Smouldering Fire	370	53.7	0	0.0
Non-flashover Fire	237	34.4	1	4.2
Flashover Fire	42	6.1	0	0.0
Total	**689**	**100.0**	**1**	**1.5**

3.12.2. Effectiveness of Early Detection and Suppression Systems

Conclusions that may be drawn from the tables 42 to 44, based on a confidence interval of 95%, are:

- 87-93 % of all fire incidents in hospitals without sprinklers had 10% or less property damage;
- 89-96 % of all fire incidents in hospitals with sprinklers had 10% or less property damage;
- The only death that occurred in a hospital fire occurred where there was no early detection or suppression system.

Figure 11 : Casualty Profile for Hospitals Compared with Flame Damage

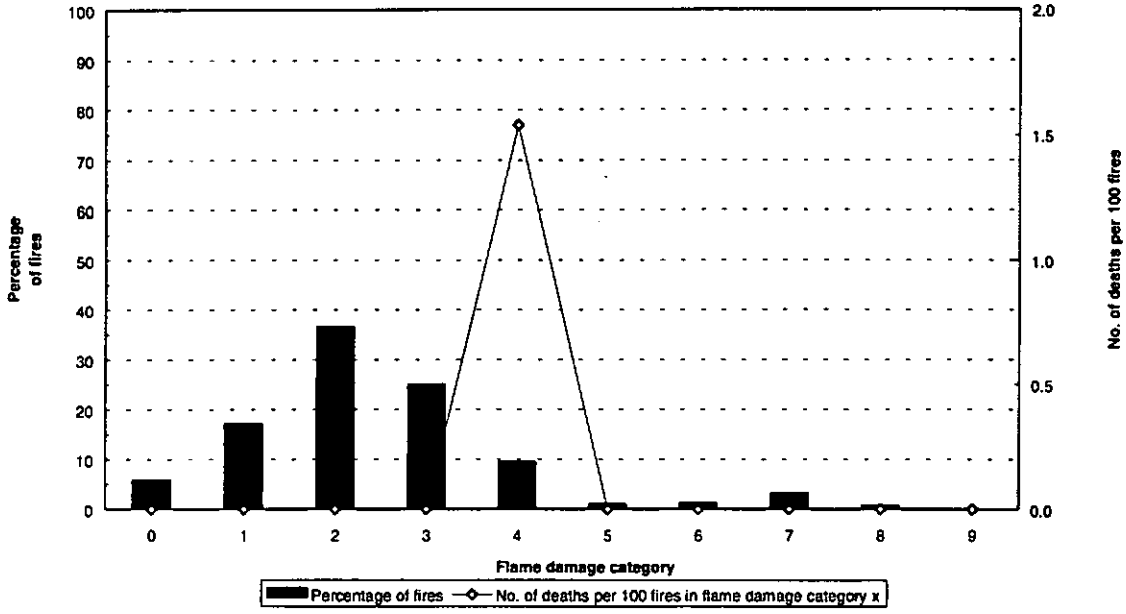


Table 42 : Fires in Hospitals Without Sprinklers

Percentage Damage	Number of Fires	Percentage of Fires	Number of Injuries	Injuries/1000 Fires in Damage Category	Number of Deaths	Deaths/1000 Fires in Damage Category
0 - 10%	365	89.7	4	11.0	1	2.7
11 - 20%	13	3.2	2	153.8	0	0.0
21 - 30%	12	2.9	1	83.3	0	0.0
31 - 100%	17	4.2	3	176.5	0	0.0
All	**407**	**100.0**	**10**	**24.6**	**1**	**2.5**

Table 43 : Fires in Hospitals With Sprinklers

Percentage Damage	Number of Fires	Percentage of Fires	Number of Injuries	Injuries/1000 Fires in Damage Category	Number of Deaths	Deaths/100 Fires in Damage Category
0 - 10%	191	92.7	12	62.8	0	0.0
11 - 20%	11	5.3	1	90.9	0	0.0
21 - 100%	4	2.0	1	250.0	0	0.0
All	**206**	**100.0**	**14**	**68.0**	**0**	**0.0**

The difference between the sum of the number of fires from Tables 42 (non-sprinklered) and 43 (sprinklered), and the total number of fires given in Table 9 for hospitals, is the number of occasions the presence or not of a sprinkler system was unable to be identified from the fire incident report.

Table 44 : Fire Injuries and Deaths in Hospitals

	Non - Sprinklered			Sprinklered		
	No. of Fires	No. of Injuries	No. of Deaths	No. of Fires	No. of Injuries	No. of Deaths
Alarm						
actual	104	4	0	40	6	0
rate per 1000 fires		38.5	0.0		150.0	0.0
No Alarm						
actual	303	6	1	164	8	0
rate per 1000 fires		19.8	3.3		48.8	0.0
TOTAL	**407**	**10**	**1**	**204**	**14**	**0**
rate per 1000 fires		**24.6**	**2.5**		**68.6**	**0.0**

The difference between the total sum of the number of fires for non-sprinklered and sprinklered hospitals in Table 44, and the total number of fires given in Table 9 is the number of occasions the presence or not of a sprinkler or alarm system was not able to be identified from the fire incident report.

3.13. Summary

The information for the various occupancies is summarised in Table 45.

Table 45 : Summary of Fire Risk Data

Item	Dwellings	Apartments	Offices	Rest Homes	Schools	Hotels	Hospitals
Total number of fires in category	17339	1604	956	177	1038	469	689
Number of fires by Sprinkler Performance (a)	15832	1492	878	159	961	419	613
Number of fires by Detector Performance (a)	15881	1496	889	159	966	428	621
Number of deaths	142	21	1	12	0	7	1
Type of fire most deaths were associated with	Flashover	Flashover	Flashover	Flashover	Flashover	Flashover	Non-flashover
Percentage of all incidents where fire was confined to the room of origin	67-78%	75-79%	83-87%	80-90%	62-67%	76-84%	92-95%
Percentage of all deaths which occur when fire had spread beyond the room of origin	64-79%	41-83%	100%	51-100%	n/a	100%	100%
Percentage of fire incidents in buildings without sprinklers that had 10% or less property damage	62-63%	68-72%	83-88%	73-87%	58-64%	73-81%	87-93%
Percentage of fire incidents in buildings without sprinklers where death occurred, that had 10% or less property damage	16-30%	3-39%	(c)	0-26%	n/a	0-40%	(d)
Percentage of times where sprinklers were present and property damage was 10% or less	39-84%	(b)	91-100%	84-100%	84-100%	92-100%	89-96%
Percentage of all deaths in fires in buildings where there was no early detection or suppression system	97-100%	76-100%	100%	76-100%	n/a	100%	100%

* % ranges given represent the 95% confidence interval within which the mean value is expected to fall.
(a) number of incidents in category excluding the "0" (unknown) coded incidents
(b) insufficient data available
(c) the only death occurred in a building without sprinklers where the property damage exceeded 80%
(d) the only death occurred in a building without sprinklers that had 10% or less property damage

4. CONCLUSIONS, FINDINGS AND RECOMMENDATIONS

4.1. Conclusions

The conclusions arrived at in this section are based on the analysis of data (for the years between 1986 and 1993) for the following occupancies:

- Dwellings
- Apartments
- Offices
- Rest Homes
- Schools
- Hotels
- Hospitals

It is emphasised that the results presented and the conclusions made in this report are based only on buildings that have had fires which were attended by the New Zealand Fire Service. These buildings form only a small subset of the total building stock available in New Zealand. Thus the analysis carried out in this report is of a relatively small sample. In some cases the sample size is too small to allow meaningful statistical analysis.

The general conclusions based on observations made from this study are that:

1. New Zealand has a generally good track record with fires. The number of fires is small and the overall casualty rates are generally low.
2. The Fire Service response time target to fires is generally met and the target response time is statistically reasonable.

Some specific conclusions reached as a result of this study are that:

1. The ability of the FIRS database to reproduce accurately the fire scenario encountered at any incident is greatly influenced by the manner in which the data is categorised, and by the degree of training given to those persons recording and coding the data. In addition the difference between categories is sometimes not readily evident in the associated Coding Manual. This was no more evident than when analysing data from the detector and sprinkler performance categories. Various contradictory interpretations of the "0" code were found to have been used, such as:
   - to record as intended in the coding manual ie., "a system was present and performed, however there was insufficient information available to classify further", or
   - to record the category as "not applicable", or
   - to complete the database entry when the form had been returned with no code entered for the category.

   Further anomalies were found when the data from the detector and sprinkler performance categories was compared to the results from the alarm and sprinkler model categories. In many instances these figures contradicted each other, ie., stating that there was no detector present in the performance category while identifying a specific brand of detector in the model category.

2. Most deaths (between 77 and 100%, depending on the type of occupancy) occurred when the fire extended beyond the room of origin (Table 45). It is also evident from the analysis that there is between 65 and 95% likelihood (based on the type of occupancy) that fires attended by the Fire Service can be contained within the room of origin. This leads to the conclusion that high casualty rates result from the small number of flashover fires. This information combined with the following facts leads to the conclusion that the critical aspect that requires urgent attention is notification time (time from fire initiation to the time the emergency services are alerted).
    - That the New Zealand Fire Service attends nearly 85% of the fires within the 8 minute maximum response time; and
    - The death rates in fires are relatively constant irrespective of the Fire Service's response times;
    - The likelihood of fires occurring is relatively independent of the time of day.
3. Most deaths are associated with flashover fires. This observation suggests that improved safety of life and property is closely linked with effective (early) detection and notification of fires.
4. High casualty rates are observed in all occupancies where early detection or suppression systems are absent. It should be noted that nearly 50 % of all structure fires occur in dwellings where such systems are not mandatory.
5. The observation that stands out most distinctly from the analysis carried out in this report is the higher relative fire risk in Rest Homes. The observation for this category was that most deaths occurred in premises that did not have effective early detection and suppression systems.
6. Death rates are higher in buildings without sprinklers.

4.2. Findings

The following finding is made:

Improvement to Fire Service response time may not directly improve life safety (but could significantly improve property safety). The little influence response time has on life safety is a clear indication that many deaths occur before the fire brigades arrive. Further study is required to assess the impact of early detection or suppression systems on notification times.

4.3. Recommendations

The following recommendations are made:

1. That further study be made of the following :
    - Fire risk in Rest Homes and institutions of care for the elderly;
    - Effectiveness of Fire Service notification times.
2. That an effective public education programme should be set in place to:
    - Increase public awareness of fire safety;
    - Improve (reduce) notification time.
3. That the review of the data collation procedures of the FIRS database at the NZFS must include improvements to data categorisation.

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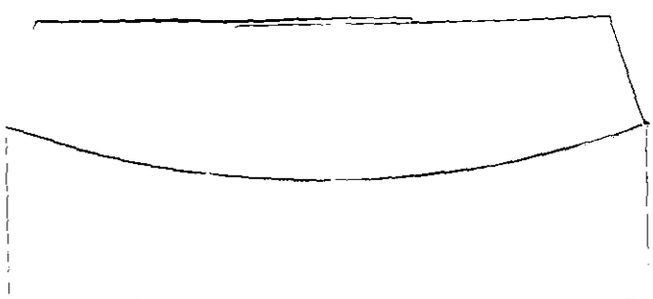

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