

Arup**Fire**

Investment in Arup

**AFAC National Incident
Data Base**

Statistical Assessment -
Preliminary Report

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July 2008

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1 Introduction

Access to accurate fire statistics is regarded as fundamental to a full understanding of fire safety and protection within the built environment. Risk assessment techniques also utilise fire statistics to assist in the design of new buildings and appraisal of existing buildings to support the decision making on upgrade measures. By studying statistics, areas where risks are high can be identified and risk control measures can be implemented to reduce life safety and other fire risks.

To investigate key fire safety parameters on a national basis, a preliminary statistical assessment of the data contained in the Australasian Fire Authorities Council's (AFAC) national incident database has been undertaken. The assessment has been carried out by Arup in a joint effort with AFAC who made this project possible by providing access to national incident data.

The data investigated in this preliminary assessment covers a period from July 1998 to June 2004 based on reports from some fire services across Australia. The total number of non-domestic building fire records included in the data is 62,583. This includes all building fires, except for domestic residential properties such as dwellings, units and flats. Temporary accommodation such as hotels, motels, and inns are included in the data. The data only covers the incidents the fire services attend, which excludes fires that are small and are extinguished without the involvement of the fire service. This must be taken into account when considering use of the statistics, since many fires are not reported to the fire services.

The key statistical fire safety parameters included in this preliminary assessment were:

- Number of non-domestic building fires
- Frequency of fires in office and retail properties
- Distribution of the time of ignition
- Area of fire origin and ignition factors
- Assessment of smoke alarms and detectors
- Assessment of sprinkler performance

These parameters have been investigated for the property types identified in Table 1.

Property type	Examples of property use	Number of fires reported to the fire service during the period 1998-2004
Office property	Commercial offices, banks.	2,355
Retail property	Supermarkets, malls	7,978
Institutional property	Hospitals, prisons.	5,180
Manufacturing property	Manufacturing of food, chemical products	4,502
Storage property	General warehouse, storage of textiles	5,144
Other categories (not analysed)	Public assembly, educational, non-domestic residential, primary industry, special property, unclassified not reported	37,424

Table 1 – Property types investigated

It must be noted that not all fire services in Australia contribute data to the AFAC national database. The study therefore does not include raw data samples from non-contributing agencies.

Readers should also be aware that other statistical fire data is available in the *Report on Government Services 2008*, produced by the Steering Committee for the Review of Government Service Provision, and released on 31 January 2008. The report highlights the performance of the emergency management sector by jurisdictions across the nation. Further information can be obtained from the Productivity Commission's website (www.pc.gov.au).

2 Raw Data Summary

2.1 Background

In Australia, some fire services are working with an information system called AIRS, the Australian Incident Reporting System Data Dictionary. AIRS is a national system, although there are differences concerning laws, strategies, ways of reporting information between states and agencies etc. It is required to make a report after every emergency, regardless of the size or severity, based on the judgement of the fire fighter reporting. This procedure differs between the authorities and is done digitally, by phone or in a written statement. Since not all fire services in Australia contribute data to the AFAC national database, this study does not include raw data samples from non-contributing agencies.

As mentioned in Section 1, the data investigated in this preliminary assessment covers a period from July 1998 to June 2004 based on reports from some fire services across Australia. The total number of non-domestic fire records included in the data is 62,583. This includes all building fires, except for domestic residential properties such as dwellings, apartments, units and flats. However, the data includes rooming-, boarding- and lodging houses, hotels, motels, inns, dormitories, holiday apartments and self-contained units.

Uncertainties and anomalies related to the data have to be taken into consideration. Different authorities use different strategies and routines which may affect the statistics. The data *only* covers the incidents the fire service attend, which excludes fires that are small and are being put out without the fire service. This must be taken into account, since most fires are not reported to fire services.

The following AIRS incident records has been considered during this study.

Block A	Complete for all Incidents
Block B	Automatic Fire Alarms
Block C	Hazardous Materials Incident
Block D	Casualties, Rescue and Evacuation
Block E	Ignition (All Fires)
Block F	Fire Fighting
Block G	Wildfires
Block H	Dollar Loss Fires
Block J	Incidents Involving Mobile Property
Block K	Structure Fires

Table 2 Summary reference table for incident data records

The categories in Table 2 are broken down into the subcategories described in Table 3. Each of these subcategories is then further classified into codes which describe specific parameters such as property type or smoke alarm operation. An example is field A20 'Type of property use' which itself is classified into >560 different individual property type codes. Due to the size of this classification, it is not fully described in this report, but there are explanations given where the classifications has been used.

BLOCK	FIELD	DESCRIPTION
Block A	A8	Alarm time
	A9	Method of notification
	A10	Agency/persons raising alarm
	A11	Jurisdiction of origin
	A13	Location of incident
	A17	Town/suburb
	A18	Post code
	A20	Type of property use
	A21	Type of owner
	A22	Type of occupant
	A23	Type of incident
	A24	Type of action taken
	A26	Control or stop time
	A29	Peak number of fire service personnel at scene
	A36	Weather
	A39	Self contained breathing apparatus used
	A40	Oxygen (closed circuit) breathing apparatus used
	A41	Additional cylinders used
	A42	Problems encountered
	A47	Dispatch date
	A48	Dispatch time
	A49	Mobile date
	A50	Mobile time
	A51	Arrival date
	A52	Arrival time
	A55	Kilometres
	A69	Fire name
BLOCK B	B1	Automatic fire alarm number
	B2	Fire indicator panel circuit number
	B3	Location of detector initiating alarm
	B4	Level of detector initiating alarm
	B5	Type of detector initiating alarm
BLOCK D	D1	Number of brigade personnel injured
	D2	Number of other persons injured
	D3	Number of brigade personnel fatalities
	D4	Number of other fatalities
	D5	Number of persons rescued by the Reporting Authority
	D7	Rescue type
	D8	Number of persons evacuated
	D9	Date evacuation completed
	D10	Time evacuation completed
	D11	Evacuation problems
	D12	Date evacuation commenced
	D13	Time evacuation commenced
	BLOCK E	E1
E2		Occupant of ignition area

BLOCK	FIELD	DESCRIPTION
	E3	Activity in ignition area
	E4	Form of heat of ignition
	E5	Ignition factor
	E6	Type of material ignited first
	E7	Form of material ignited first
	E8	Equipment involved in ignition
BLOCK F	F1	Major fire fighting force
	F2	Initial attack
	F3	Method of initial attack force by Reporting Authority
	F4	Method of initial attack - Other persons
	F5	Major method of extinguishment
	F6	Major extinguishing medium
	F7	Number of portable extinguishers used
	F8	Number of portable pumps used
	F9	Number of hose reels used
	F10	Number of 35-59 mm delivery lines used
	F11	Number of 60-70 mm delivery lines used
	F12	Number of monitors used
	F13	Amount of foam concentrate used
	F14	Amount of dry chemical used
	F15	Water supply
	F16	Water supply method
BLOCK H	H1	Estimated dollar loss
	H2	Estimated value of properties
	H3	Estimated value of contents
	H7	Total number of structures involved in fire
BLOCK K	K1	Structure type
	K2	Construction type
	K3	Building dimensions
	K4	Number of levels
	K5	Wall linings
	K6	Ceiling linings
	K7	Level of fire origin
	K8	Type of material ignited second
	K9	Type of material ignited third
	K10	Type of material ignited fourth
	K11	Form of material ignited second
	K12	Form of material ignited third
	K13	Form of material ignited fourth
	K14	Type of material contributing most to fire intensity
	K15	Type of material generating most smoke
	K16	Form of material contributing most to fire intensity
	K17	Form of material generating most smoke
	K18	Factor contributing to flame spread
	K19	Avenue of smoke travel
	K20	Extent of flame damage
	K21	Extent of smoke and heat damage
	K22	Extent of extinguishing medium damage
	K23	Volume of fire damage in cubic metres
	K24	Smoke alarm/detector performance
	K24i	Presence of smoke alarm/detector
	K24ii	Alarm/detector power supply
	K24iii	Operation of smoke alarm/detector

BLOCK	FIELD	DESCRIPTION
	K24iv	Effectiveness of smoke alarm/ detector
	K24v	Reason for smoke alarm/detector failure
	K25	Sprinkler performance
	K26	Factors degrading sprinkler effectiveness
	K27	Number of heads operated
	K28	Air handling system performance
	K29	Extinguishers installed
	K30	Number of extinguishers used by non-fire personnel
	K31	Hose reels installed
	K32	Number of hose reels used by non-fire personnel
	K33	Hydrants installed
	K34	Number of hydrants used by non-fire personnel
	K35	Estimated percentage of property involved on arrival
	K36	Estimated percentage of property saved due to fire fighting operations
	K37	Building Codes of Australia identifier
	K38	Attack time
	K39	Fire area at attack time
	K40	Extinguishment time
	K41	Compartment size

Table 3 Detailed fire record references

2.2 Contributing Fire Services

The table below shows the fire services (i.e. reporting authorities) that contributed to the data. No data for NSW Rural Fire Services was included in the data sample analysed for this project.

1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004
NSW Fire Brigades	NSW Fire Brigades	NSW Fire Brigades	NSW Fire Brigades	NSW Fire Brigades	NSW Fire Brigades
Melbourne Metropolitan Fire Brigade	Melbourne Metropolitan Fire Brigade	Melbourne Metropolitan Fire Brigade	Melbourne Metropolitan Fire Brigade	Melbourne Metropolitan Fire Brigade	Melbourne Metropolitan Fire Brigade
Country Fire Authority - Victoria	Country Fire Authority - Victoria	Country Fire Authority - Victoria	Country Fire Authority - Victoria	Country Fire Authority - Victoria	Country Fire Authority - Victoria
Queensland Fire & Rescue Service	Queensland Fire & Rescue Service	Queensland Fire & Rescue Service	Queensland Fire & Rescue Service	Queensland Fire & Rescue Service	Queensland Fire & Rescue Service
SA – Metropolitan Fire Service (MFS)	SA - MFS	SA – MFS	SA - MFS	SA - MFS	SA - MFS

1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004
NT – Fire (Police)	Tasmanian Fire Service	Fire and Emergency Services Authority (FESA) – WA	FESA – WA	FESA – WA	Tasmanian Fire Service
	NT – Fire (Police)	Tasmanian Fire Service	Tasmanian Fire Service	Tasmanian Fire Service	NT – Fire (Police)
		NT – Fire (Police)	NT – Fire (Police)	NT – Fire (Police)	

Table 4 Detailed fire record references

3 Data Analysis – Overview

3.1 Key Parameters Investigated

There are a number of key statistical fire safety parameters that have been included in this study. These parameters are:

- Number of non-domestic building fires.. This has been studied for:
 - All building fires(non-domestic)
 - Office property fires
 - Retail property fires
 - Institutional property fires
 - Manufacturing property fires
 - Storage property fires
- Frequency of fire for office and retail properties
- Distribution of the times of ignition during the day. This has been studied for:
 - All building fires (non-domestic)
 - Office property fires
 - Retail property fires
 - Institutional property fires
 - Manufacturing property fires
 - Storage property fires
- Area of fire origin and ignition factors. This has been studied for:
 - All building fires (non-domestic)
 - Office property fires
 - Retail property fires
 - Institutional property fires
 - Manufacturing property fires
 - Storage property fires
- Assessment of detection devices
- Assessment of sprinkler performance

The division of property types into office and retail properties was necessary to be carried out since the data sample classified both office and retail properties under the category “Shop, store, office property”. The reason why some categories were not assessed in further detail (such as special property, public assembly etc), was that these categories were considered too broad. This means that these categories were too broad in their range of

uses to readily be divided into a specific property types. An example is that the class 'public assembly properties' includes properties ranging from golf courses to skating rinks, and from libraries to restaurants and so on.

Section **Error! Reference source not found.** describes the results of the analysis undertaken for this project.

Due to limitations of the data record there were some key parameters that could not be established in a suitable format. Examples of these are:

- Probability of Fire Brigade arrival before onset of flashover conditions
- Percentage of fires limited to the item or compartment of origin
- The average detection time with and without active systems
- Proportion of portable fire extinguishers and fire hose reels used in First Aid Fire Fighting
- Average fatality rate per year for each property type
- Average injury rate per year for each property type

4 Data Analysis – Results

In the data from AIRS, all buildings are divided into property types, which can be classified into ten major subdivisions. A description of the properties analysed as part of this project is given in Table 5. Types of properties that were not further analysed are public assembly buildings, educational properties, residential, industries and all property types that were reported as undetermined.

The reasoning for excluding these property types is the wide spectrum of different building uses sorted into each of the ten property type subdivisions. The subdivision 'public assembly' includes every public place from night clubs and churches to swimming pools, museums and airport terminals. Therefore, it is considered that a general assessment of the subdivision 'public assembly' would not provide representative data but might instead be skewed. Residential properties have not been assessed since the majority of the residential fires recorded in Australia during the time period was excluded from the scope of these works (refer to section 2.1).

Property type	Examples of property use	Number of fires the period 1998-2004
Office property	Engineering offices, banks, post offices, research offices etc.	2,355
Retail property	Supermarkets, malls, beverage store, clothing stores, hardware stores, motor vehicle sale areas etc.	7,978
Institutional property	Care of the aged, child care centres, hospitals, prisons, mental institutions, juvenile detention homes etc.	5,180
Manufacturing property	Manufacturing of food, beverages, textiles, wood products, chemical products, plastics, metals, electrical equipment, vehicles etc.	4,502
Storage property	General warehouse, agricultural products storage. Storage of textiles, flammable materials, industrial chemicals, hardware, machinery, cold storage etc.	5,144

Other categories (not analysed)	All other categories, including public assembly, educational, residential ¹ , primary industry, special property, unclassified not reported	37,424
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Table 5 Property types

Note – the specific properties described above are examples only, and they do not describe all property uses that are included in the data.

4.1 Number of building fires

4.1.1 All non-domestic building fires

To provide some context to the number of fires for the different property types, a first figure is provided on all building fires for the reports examined.

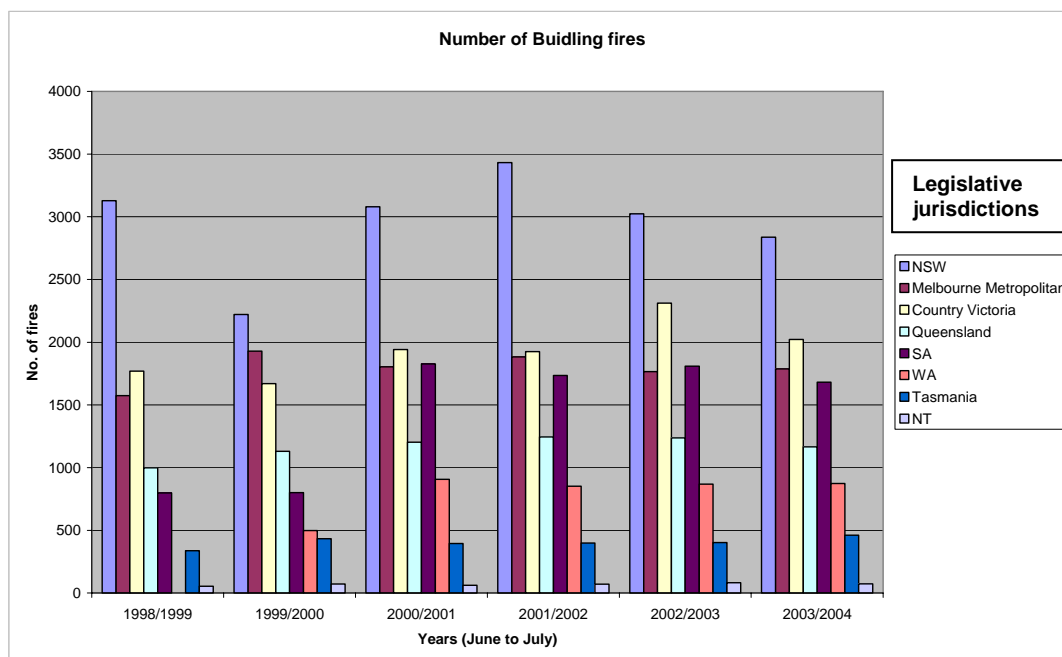


Figure 1 – Number of non-domestic building fires investigated

The legends above correspond to legislative jurisdiction areas of the reporting authority rather than geographic areas (metropolitan or rural). Therefore, the number of building fires cannot be simply classified into metropolitan areas or rural or country areas. The figure shows that the number of building fires is fairly consistent from year to year.

¹ Note – The property type “Residential” excludes domestic residential properties such as (i) one family and two family dwellings, and (ii) apartments/units/flats. However, the residential data includes rooming-, boarding- and lodging houses, hotels, motels, inns, dormitories, holiday apartments and self-contained units

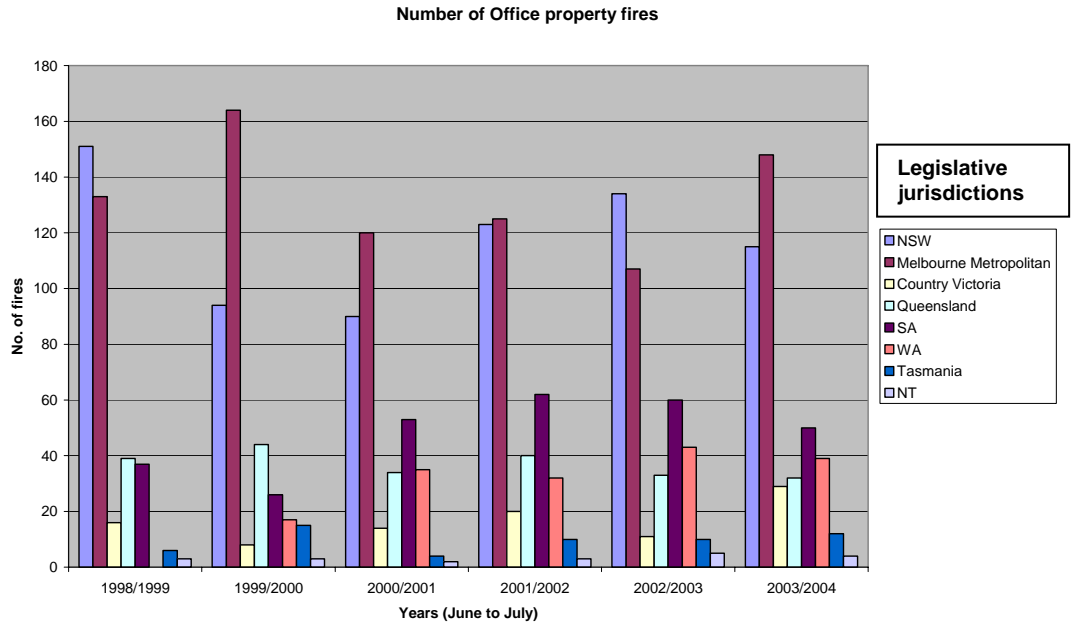


Figure 2 – Office property fires
The total number of office property fires was 2,355.

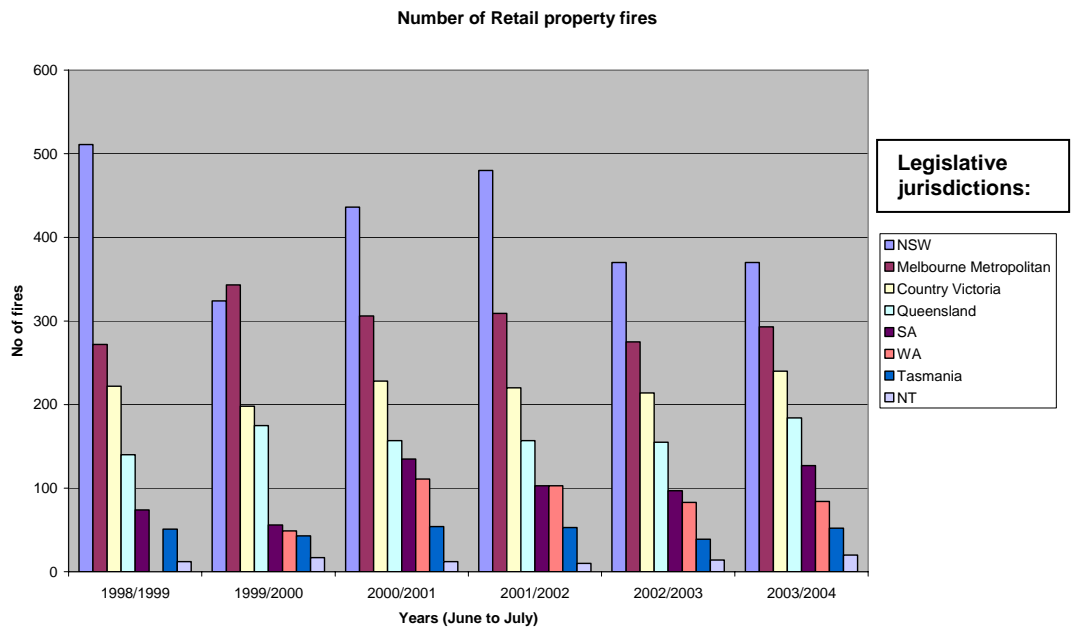


Figure 3 – Retail property fires
The total number of retail property fires was 7,978.

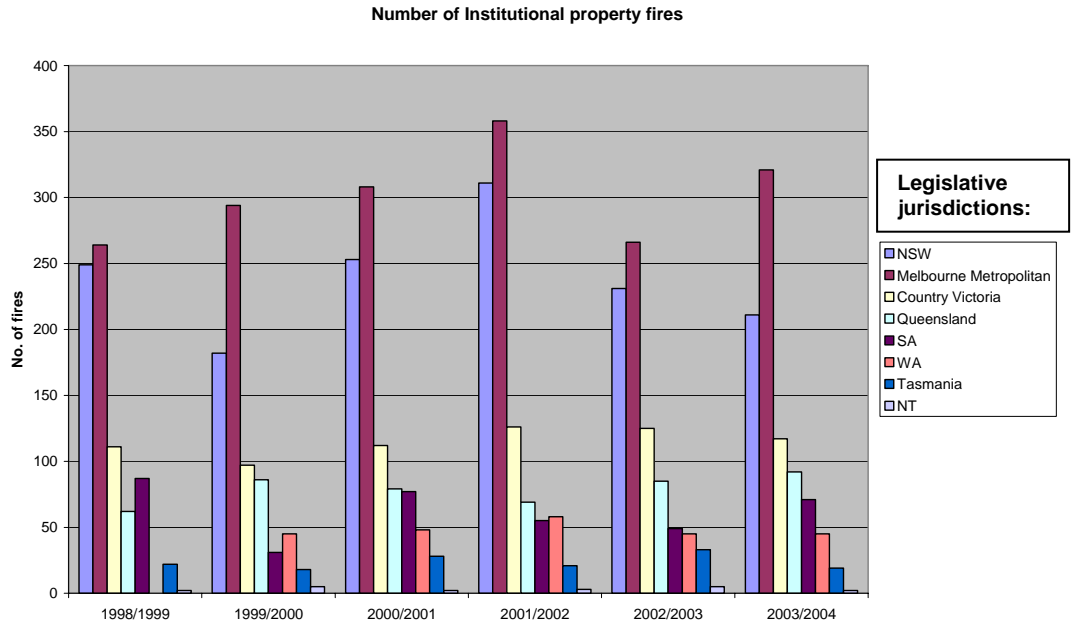


Figure 4 – Institutional property fires
The total number of institutional property fires was 5,180.

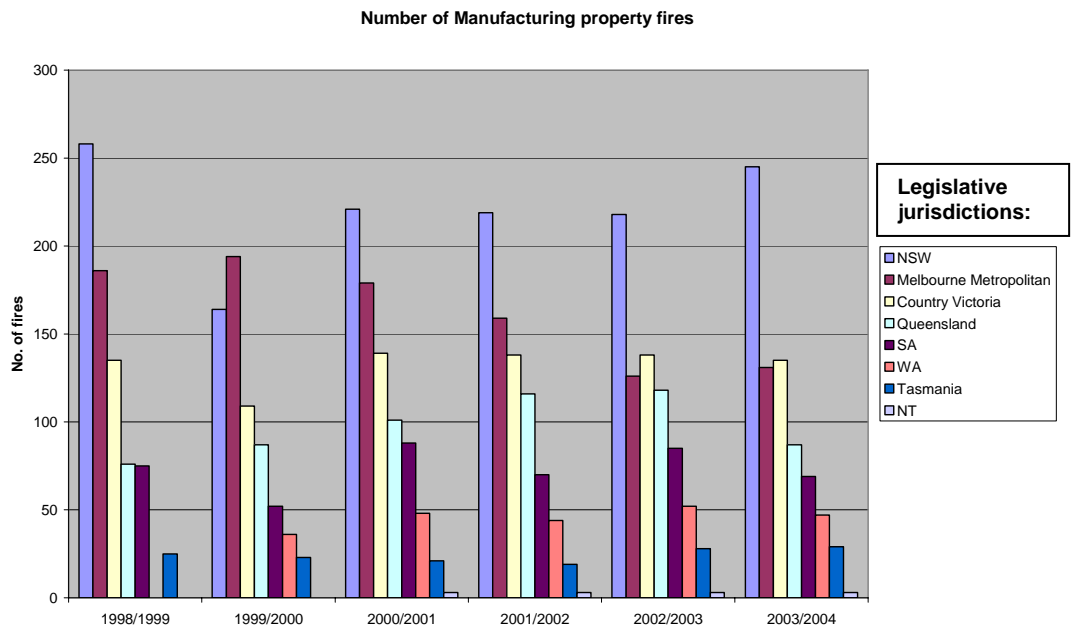


Figure 5 – Manufacturing property fires
The total number of manufacturing property fires was 4,502.

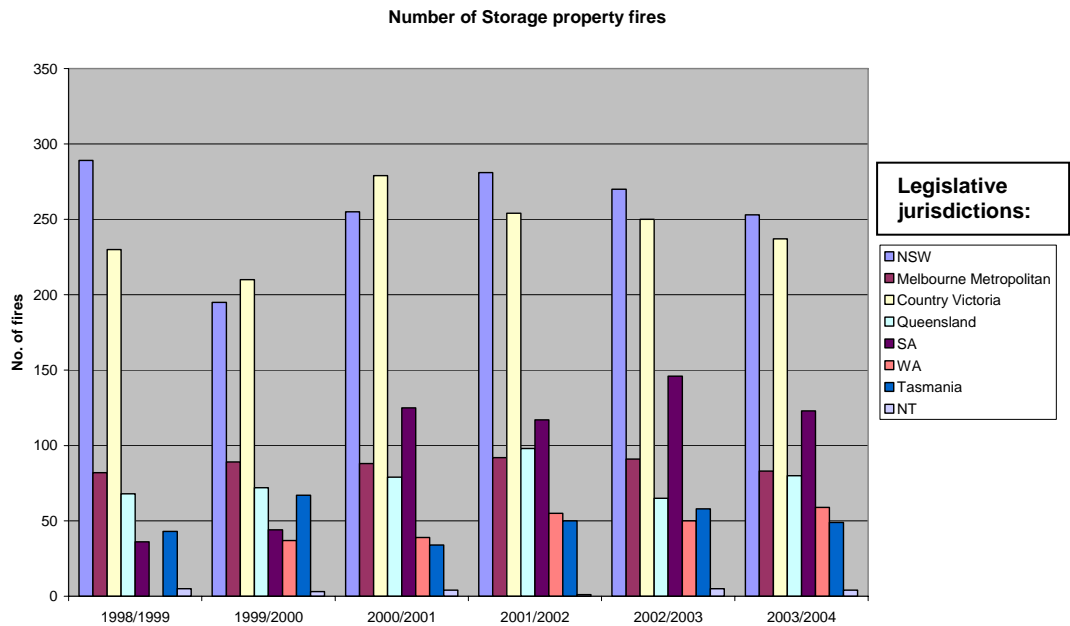


Figure 6 – Storage property fires

The total number of office property fires was 5,144.

These figures show that the number of fires in the property types investigated is also relatively consistent from year to year with no major or significant deviations. However there are some variations as seen in the above graphs.

4.2 Frequency of Fire

4.2.1 Retail and Office Areas in Australia

The frequency of fire per unit area is useful for fire risk assessments, as if you know the area of an office or shopping centre, you can get some estimate of the number of expected fires per year. To derive the fire frequency per square metre for retail space and offices it was necessary to establish the total area of such premises in Australia. The following information has been derived from the Office Market Report, dated January 2007, prepared by Property Council of Australia, and a combination of two documents prepared for the Shopping Centre Council of Australia. These two documents are Australian Shopping Centre Industry – Information Update, dated March 2007, and Shopping Centres in Australia -Vital Statistics, dated April 2001.

Total Office Floor Area	20,394,475 sq m
Total Shopping Centre Floor Area	17,800,000 sq m

Table 6 - Office and shopping centre areas in Australia (2007)

4.2.2 Fire frequency per annum per square metre

Based on the number of retail and office fires reported during the time period, a yearly frequency of ignition per square metre has been calculated for office and retail premises in Australia. These frequencies have thereafter been used to derive an average value of the fire frequencies for office premises and retail occupancies which yields the following results.

	Average number of fires per year per m ²
Office	0.0000219
Retail	0.000108

Table 7 – Fire frequencies per square metre

4.2.3 Comparison to British Standards

A comparison against frequency of ignition values has been carried out, based on methods outlined in the British Standards for the application of fire engineering principles to the design of buildings. The name of the standard is BSI PD 7974 Part 7:2003. Two different methods for office and retail premises are described in BSI PD 7974 Part 7:2003 (methods are described in Appendix A, Tables A1 and A3 respectively). The method based on Table A1 assumes that the relation between floor area and fire frequency is directly proportional for retail, but not for offices. However, the method based on Table A3 assumes a directly proportional relation between floor area and fire frequency for office premises. The method based on Table A3 does not provide any input for retail floor space.

The fire frequency results indicate that based on Method A1 of BSI PD 7974 Part 7:2003, there is a reasonable similarity between the Australian and UK data. This suggests that the Australian data is probably of the right order although more research is needed in terms of validation and testing of some of the key assumptions underpinning this analysis, including more specific data on floor areas.

The results of the comparison are displayed below.

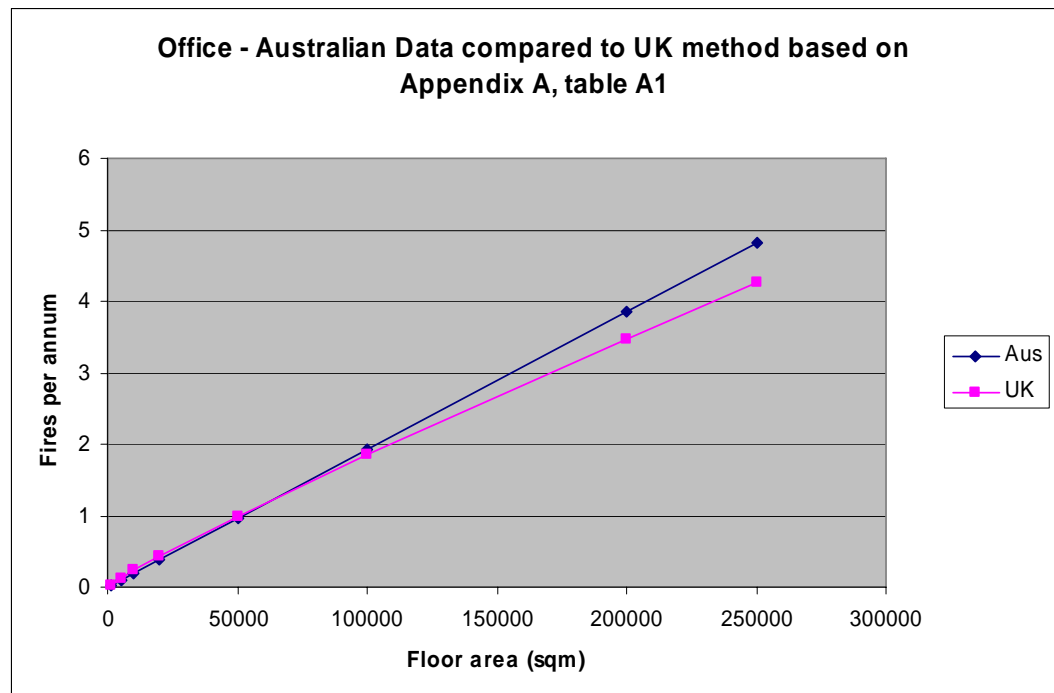


Figure 7 - Office, Comparison to Method A1

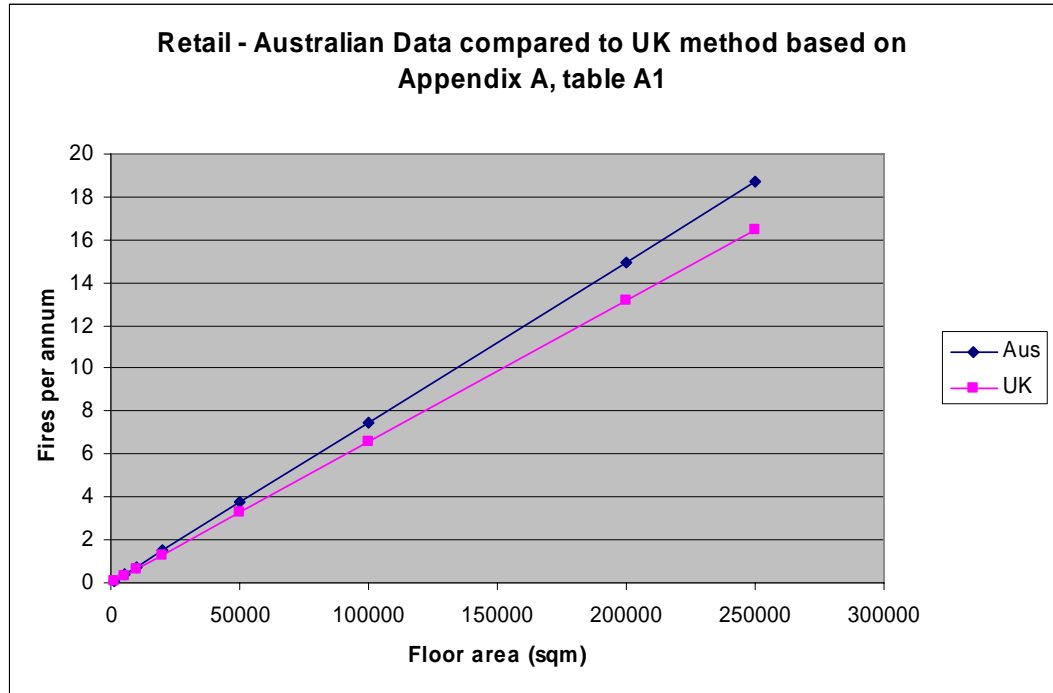


Figure 8 – Retail, Comparison to Method A1

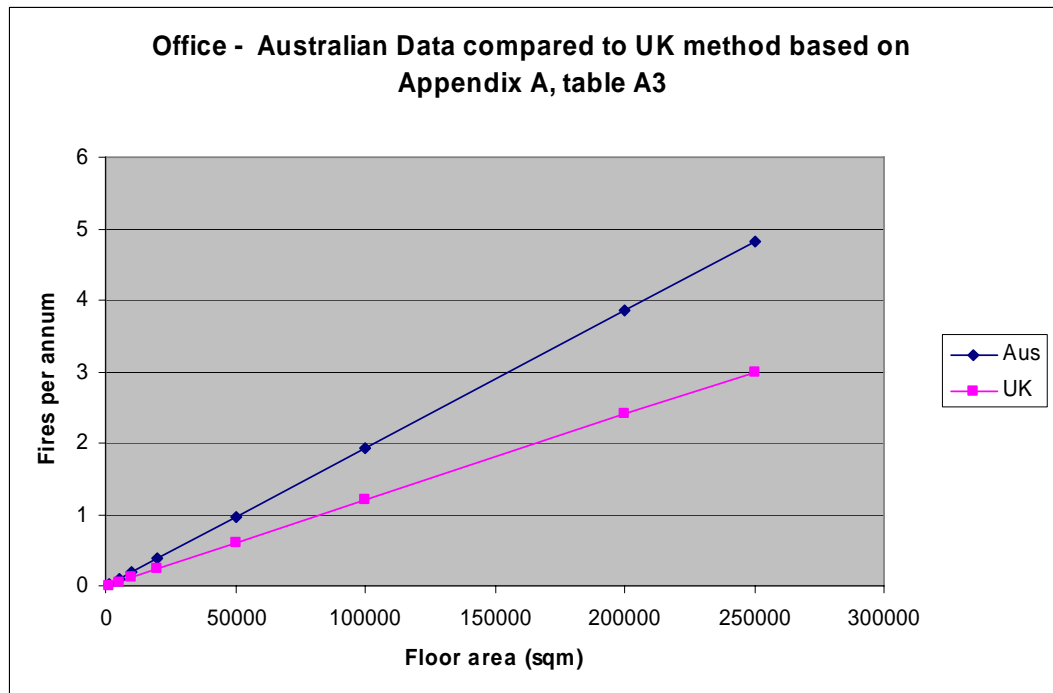


Figure 9 – Office, Comparison to Method A3

4.3 Distribution of Times of Ignition

The distribution of times of ignition during a day based on the 24 hour clock is related to the time when the alarm reaches the reporting authority. This may mean that inherent in the data there is a slight delay in the times. This delay would constitute of the time from ignition until the alarm reaches the reporting authority (e.g. automatically via an alarm panel, or manually when the reporting person is calling 000). However, since this delay would be expected to be similar for all the reported fires, it is considered that it does not adversely affect the reliability of the statistics. All 62,583 non-domestic building fires reported have been included in this assessment.

4.3.1 Distribution of times of ignition - All non-domestic building fires

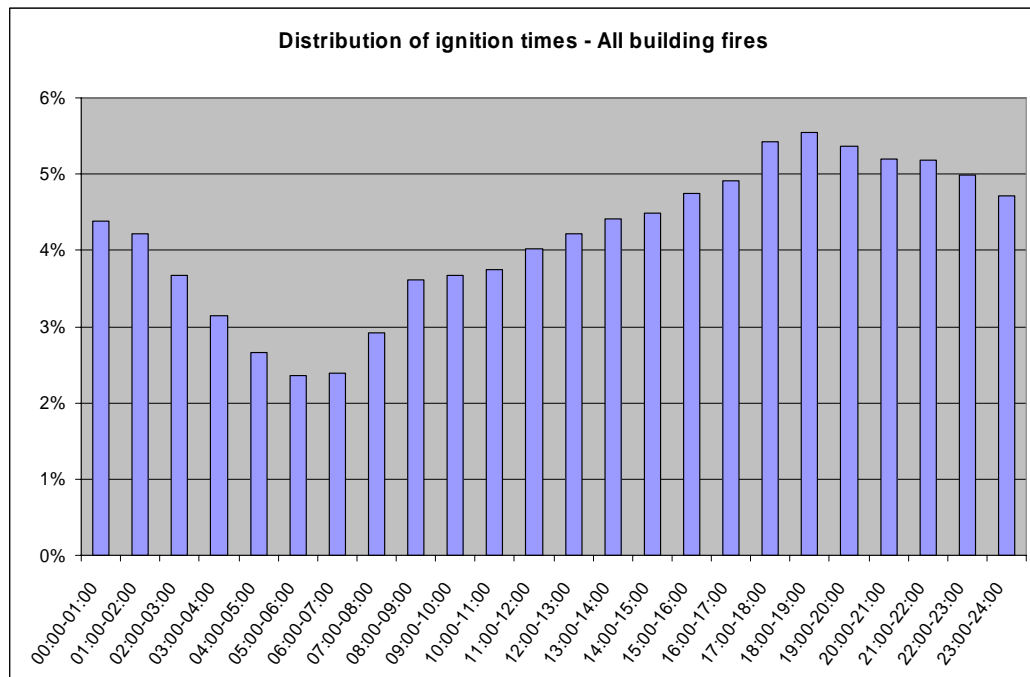


Figure 10 – All non-domestic building fires: Distribution of times of ignition

Figure 10 shows that the number of fires grow from a minimum around 5-7am to a peak around 6-7pm and then steadily reduce. This suggests more fires occur in what is the occupied hours for many buildings, with less fires at night overall.

4.3.2 Distribution of times of ignition - Office property fires

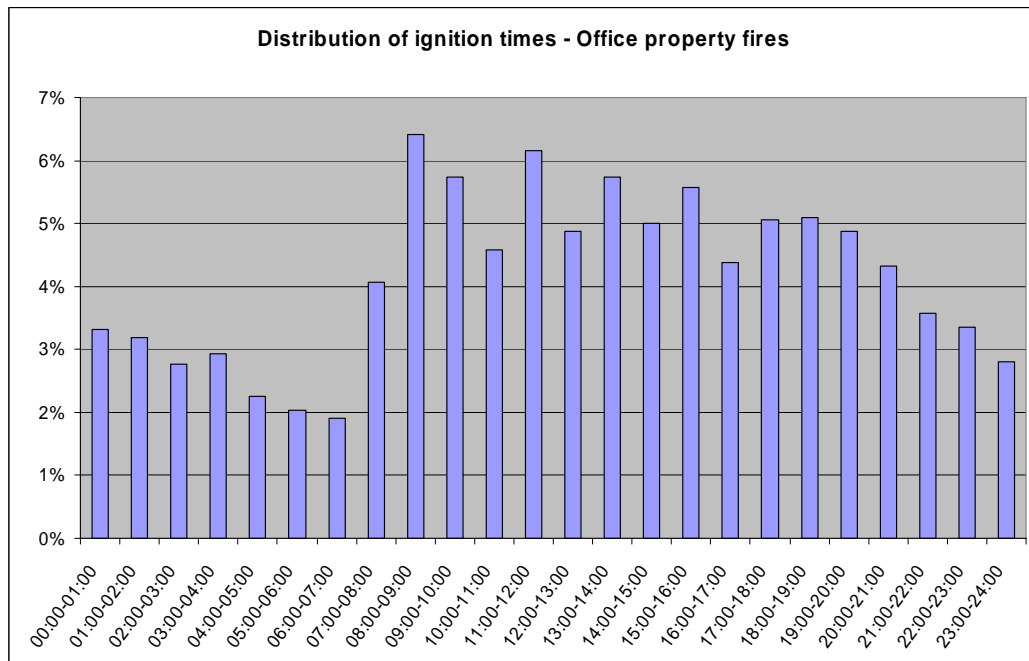


Figure 11 – Office: Distribution of times of ignition

Figure 11 shows that most fires occur in offices during the working day. The increase in fire starts for offices from around 7am-9am may be related to the normal operating hours of an office property. That is, in the morning people arrive at their workplace and start up their office equipment, such as computer and printers, as well as other plant equipment, and as a result the number of fire starts increase.

The total number of office property fires included for this assessment was 2,355.

4.3.3 Distribution of times of ignition - Retail property fires

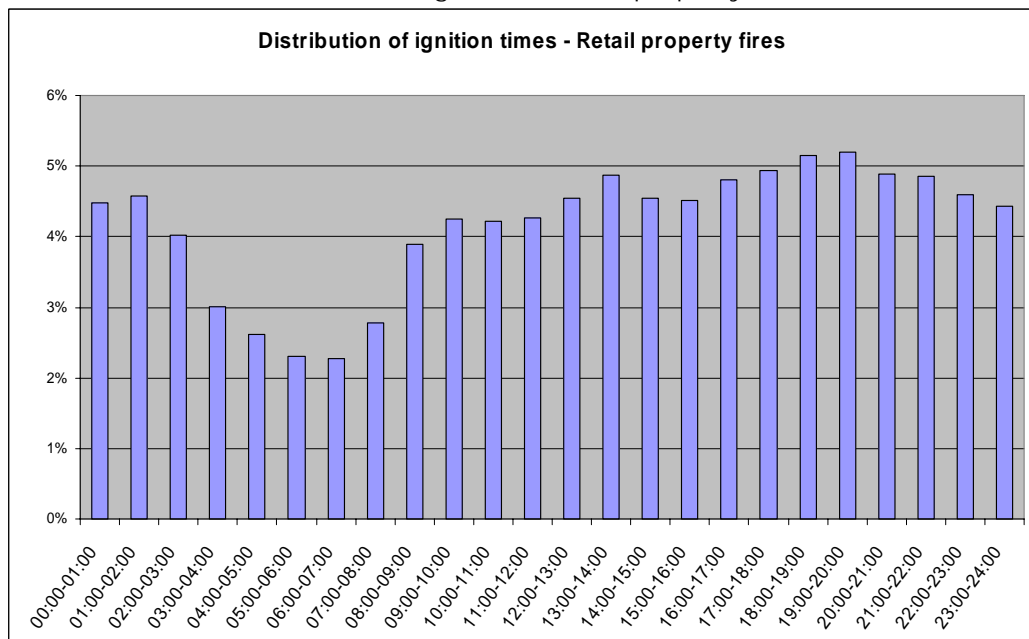


Figure 12 – Retail: Distribution of times of ignition

Figure 12 shows that the ignition time for retail fires is fairly consistent throughout the day. However, there is a significant reduction in the early morning hours. Reasons for a fairly high number of fire starts even during the evening may be related to malicious activities after retail premises have ceased trading for the day.

The total number of retail property fires included for this assessment was 7,978.

4.3.4 Distribution of times of ignition - Institutional property fires

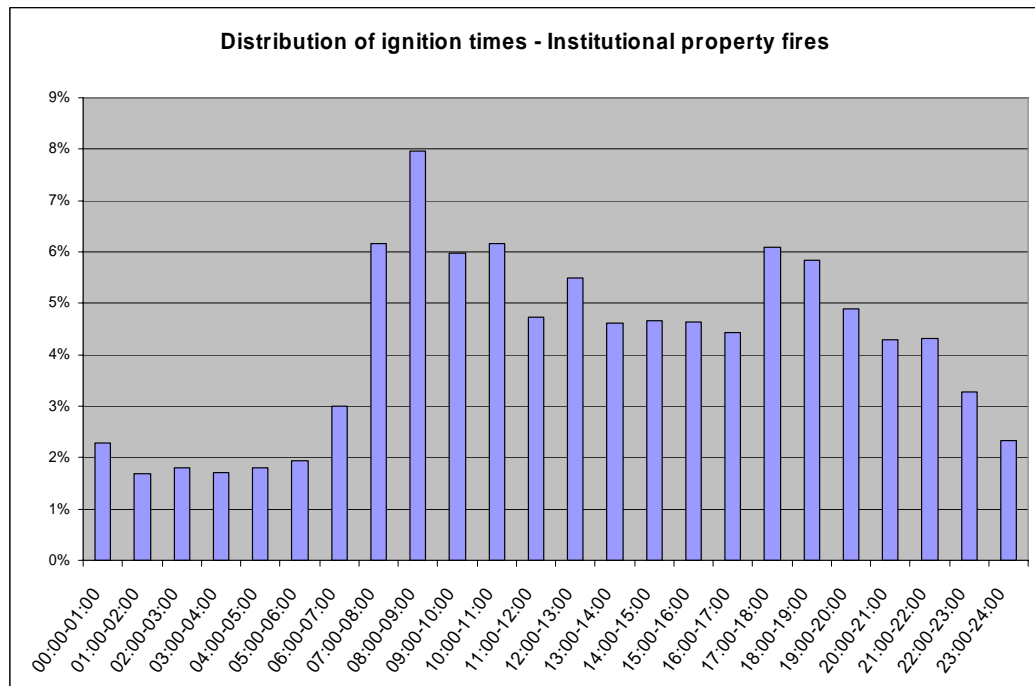


Figure 13 – Institutional: Distribution of times of ignition

For institutional buildings, the number of fires starting at night time is clearly lower than the ones during day time. Given the type of occupancy in institutional properties, this suggests that a majority of the fires are related to some kind of human activity. There is a second peak at 5-6pm, which might be the results of dinner cooking activities, although further investigation would be required to confirm this hypothesis.

The total number of institutional property fires included for this assessment was 5,180.

4.3.5 Distribution of times of ignition - Manufacturing property fires

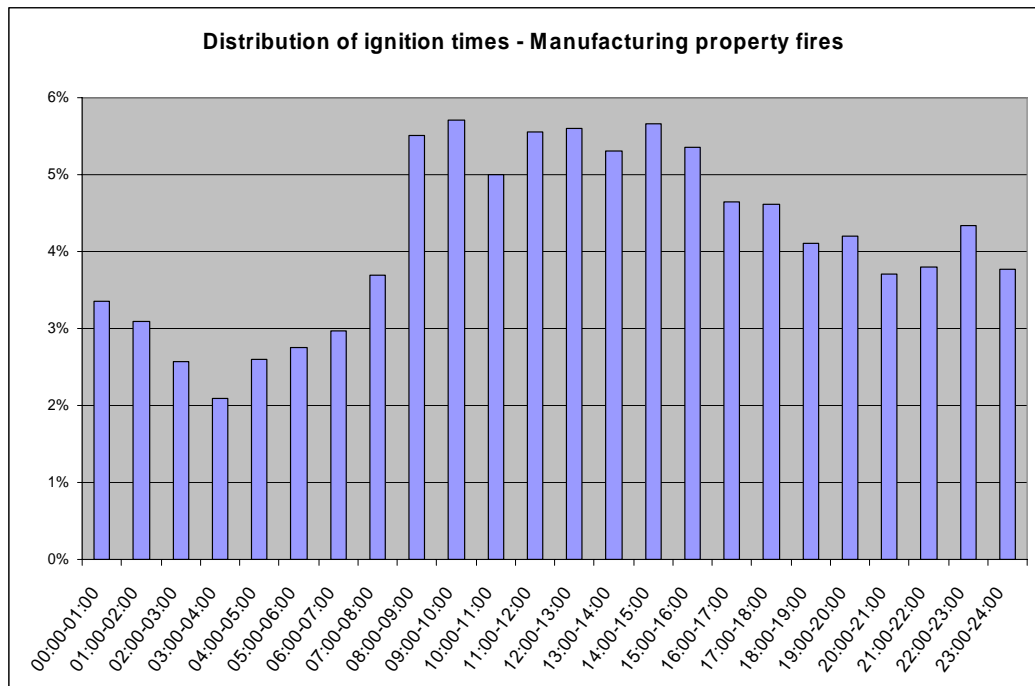


Figure 14 – Manufacturing: Distribution of times of ignition

The decrease in fire starts at night time suggests that the majority of manufacturing properties mainly operate during daytime hours with a higher ignition frequency as a result.

The total number of manufacturing property fires included for this assessment was 4,502.

4.3.6 Distribution of times of ignition - Storage property fires

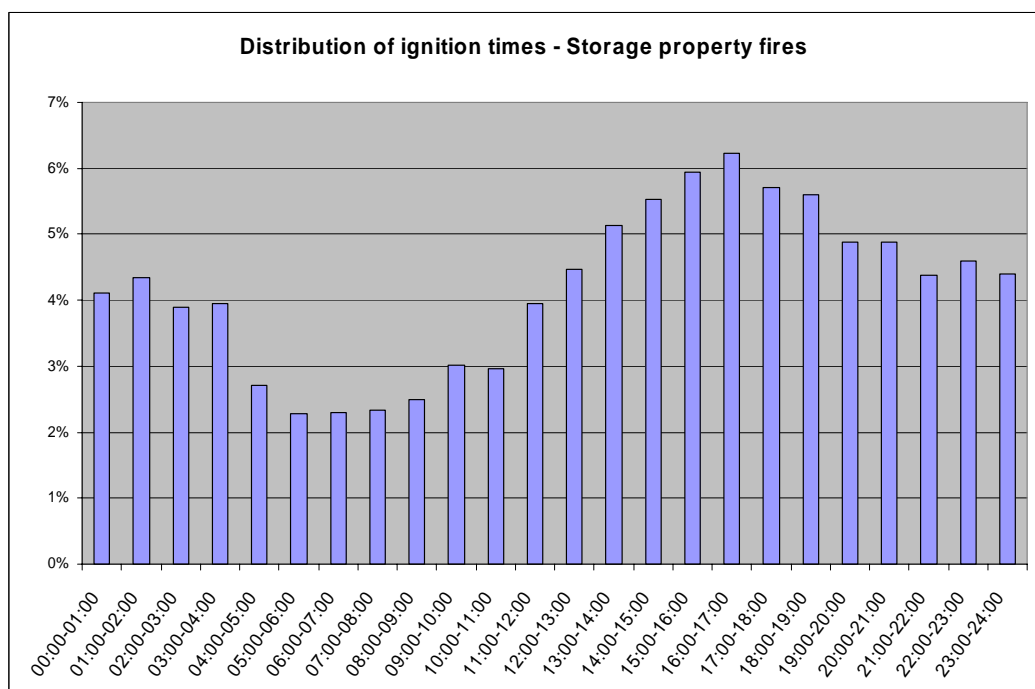


Figure 15 – Storage: Distribution of times of ignition

For storage properties, the number of fire starts decreases during night time. Given the type of occupancy, it may be that a majority of the fires relating to storage properties are related to human activities during day time.

The total number of storage property fires included for this assessment was 5,144.

4.4 Area of Fire Origin and Ignition Factors

In the statistical data base, the area of the fire origin describes the area within a property where the fire originated. It is defined by its use at the time of the fire ignition. The use of the different areas (of fire origin) is briefly described in the following table.

Area of fire origin	Examples of Type of Use
Functional areas	Cooking areas, cafeterias, performance areas, electronic equipment rooms, printing rooms, process areas
Storage areas	Product and supplies storage room, loading areas.
Service, equipment areas	Machinery rooms, heating equipment rooms, maintenance
Structural areas	Substructure space, exterior walls and roofs, concealed wall spaces
Assembly, sales areas	Show-room areas, lounge areas, shops.
Means of egress	Hallways, stairways, corridors
Service facilities	Lifts, shafts, machinery rooms
Transportation, vehicle areas	Passenger areas of transportation, luggage compartments
Other locations	Courts, patios, vacant structural areas with no current use

Table 8 – Areas of fire origin

To further investigate the circumstances leading to ignition, the ignition factors have been investigated as part of this project. The ignition factor in many instances can be attributed to human activity, whether through malicious acts, mishandling of equipment, or inadequate operational procedures. The ignition factors are categorised by the type of action causing the incident. The category “other” consists of actions such as different types of misuse of heat sources, as a result of falling asleep, children playing, and alcohol or drug effects. Failures related to the design, construction or operational mistakes are sorted into this category. The assessments of the area of fire origin and ignition factors have been carried out independently from each other. Hence, the number of incidents included in each assessment differs.

4.4.1 Area of fire origin - All non-domestic buildings fires

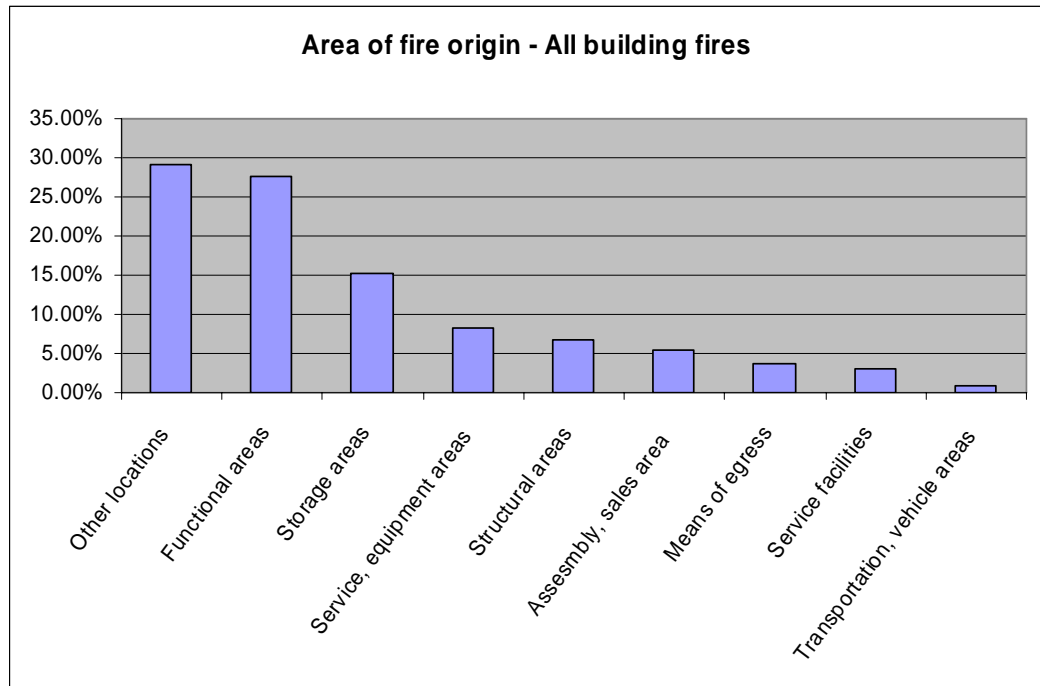


Figure 16 – All non-domestic building fires: Area of fire origin

A total of 87% of the 62,583 building fires reported were included in the assessment of the area of fire origin. Functional, storage and service areas dominate as areas of origin.

4.4.1.1 Ignition factors – All buildings

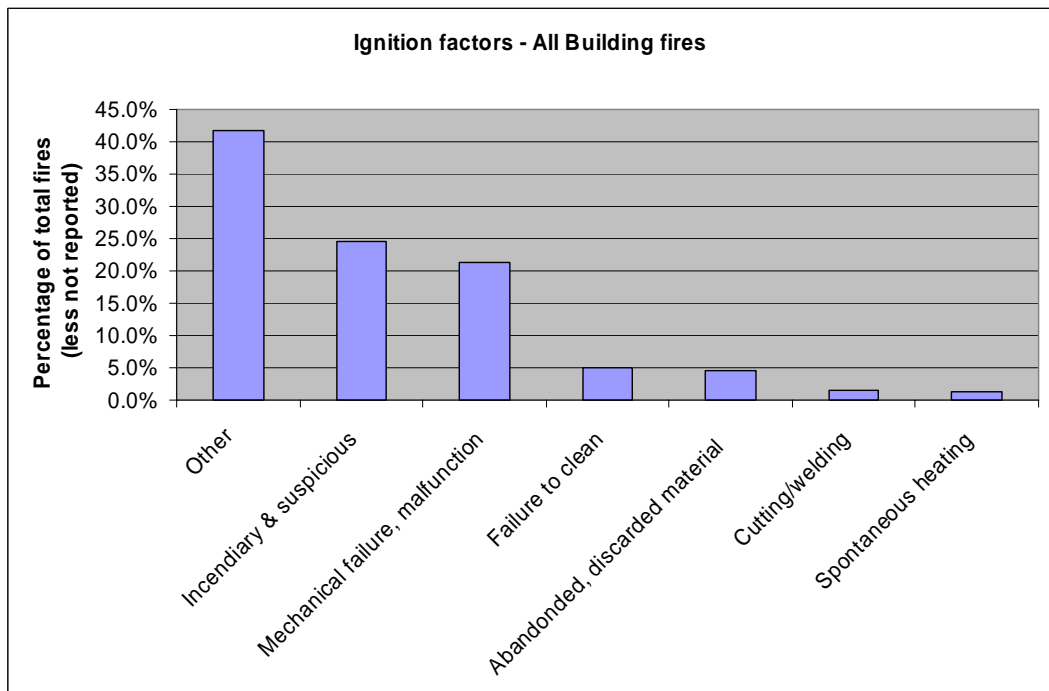


Figure 17 – All non-domestic building fires: Ignition factors

From Figure 17 it is noted that:

- 73% of the ignition factor category 'Abandoned, discarded material' was directly related to smoker's material such as cigarettes, cigars and pipes.
- 58% of the ignition factor category 'Mechanical failure, malfunction' was directly related to short circuits or other electrical failures.
- 75% of the 62,583 building fires reported were included in the assessment of the ignition factors.

4.4.2 Area of fire origin – Office property

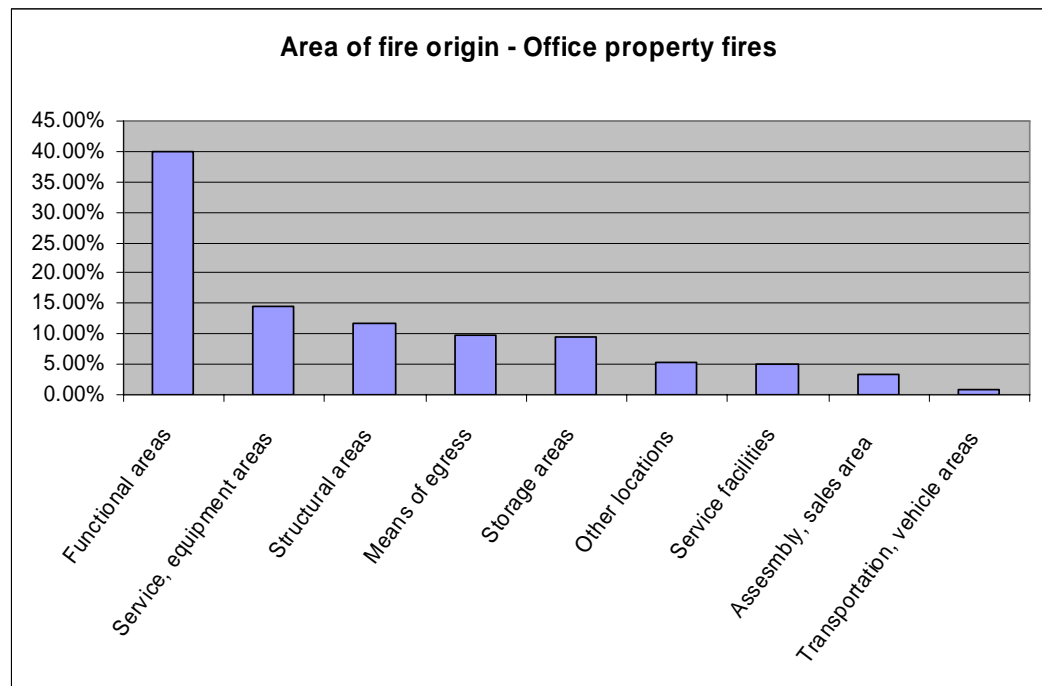


Figure 18 – Office: Area of fire origin

The data in Figure 18 on area of fire origin shows that the largest percentage of office fires occur in functional areas, meaning areas such as work spaces, where computers, photocopiers and other office equipment are likely to be present, as well as cooking areas and electronic equipment rooms.

4.4.2.1 Ignition factors - Office property

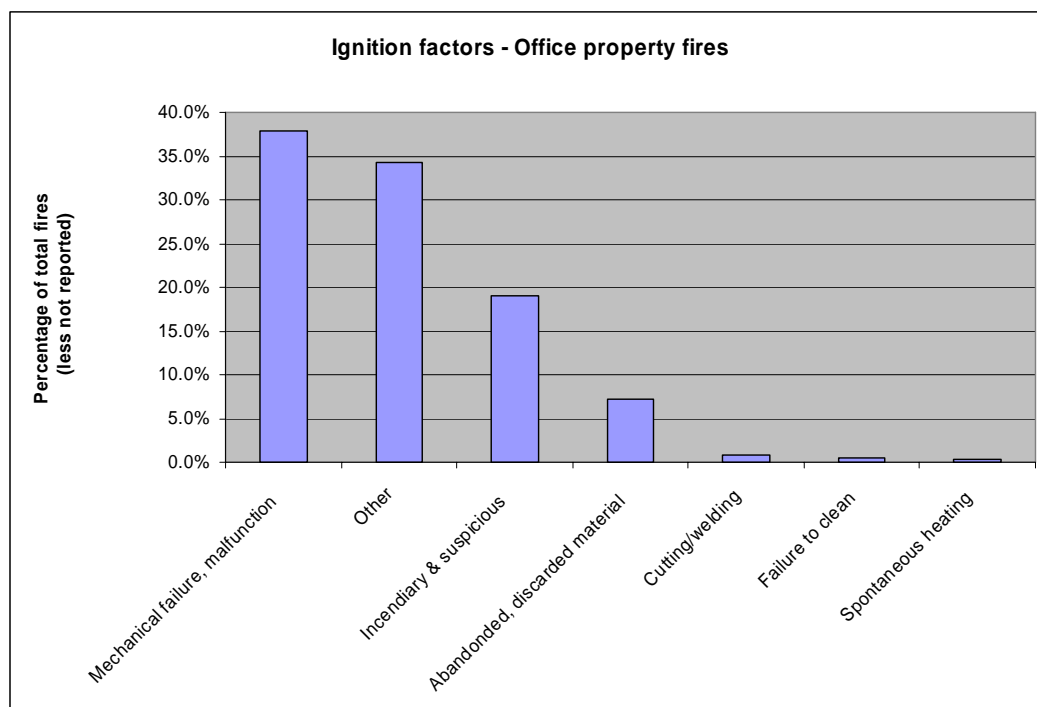
**Figure 19 – Office: Ignition factors**

Figure 19 shows that for offices the two largest fire ignition categories represent more than 70% of all fires and occur due to mechanical fault incidents or other causes, which includes electrical equipment causes. Incendiary and malicious fires also represent a significant factor at nearly 20%.

In undertaking this assessment it was also noted that:

- 85% of the ignition factor category 'Abandoned, discarded material' was directly related to smoker's materials such as cigarettes, cigars and pipes
- 62% of the ignition factor category 'Mechanical failure, malfunction' was directly related to short circuits or other electrical failures

4.4.3 Area of fire origin – Retail property

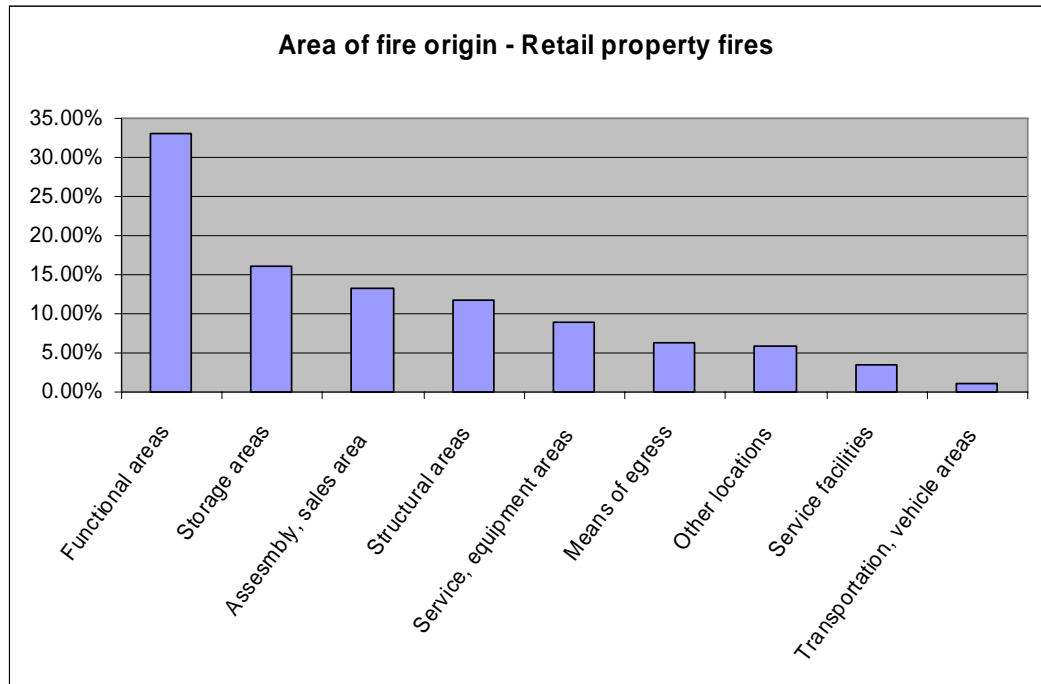


Figure 20 – Retail: Area of fire origin

Figure 20 shows it is not in general public sales areas where the majority of fires occur in retail premises, but in functional areas and storage areas. Functional areas include cafeterias, electronic equipment rooms and printing areas, and storage areas include loading docks and storage rooms.

89% of the 7,978 retail property fires reported were included in the assessment of the area of fire origin.

4.4.3.1 Ignition factors - Retail property

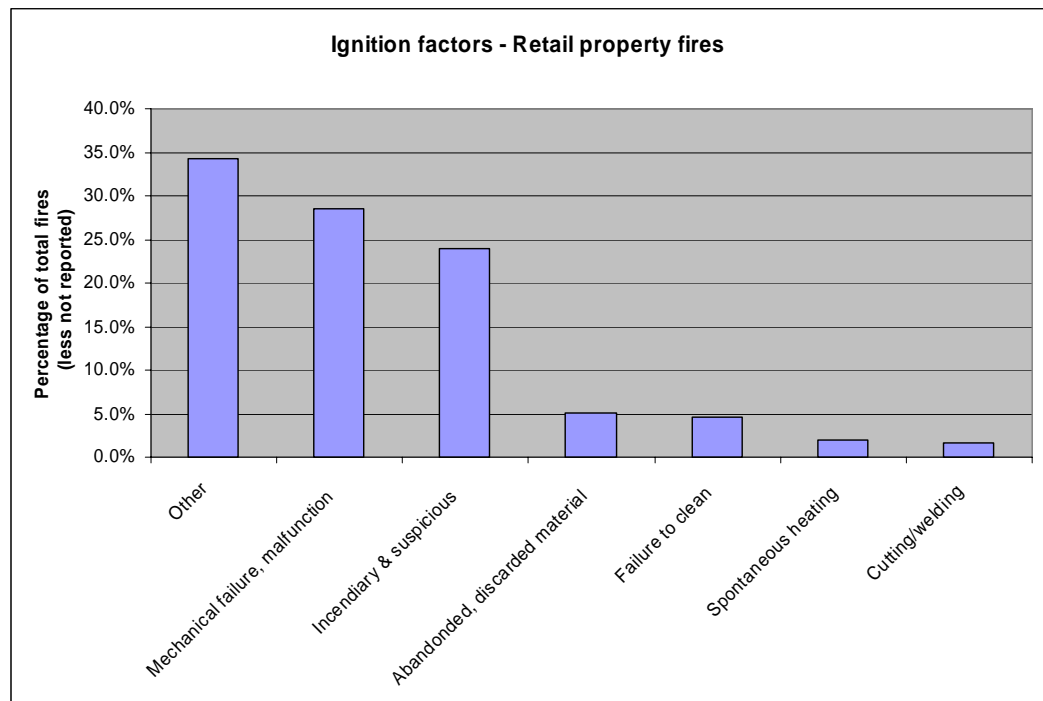


Figure 21 – Retail: Ignition factors

Figure 21 shows that mechanical failure, malfunction and other causes make up over 60% of all fire ignitions. However it also shows that the number of incendiary and malicious fires is contributing almost a quarter of all fire starts in retail properties. This may be part of the explanation as to why there appears to be a larger proportion of retail fires that occur outside normal opening hours.

In undertaking this assessment the following should be noted:

- 72% of the ignition factor category 'Abandoned, discarded material' was directly related to smoker's materials such as cigarettes, cigars and pipes
- 62% of the ignition factor category 'Mechanical failure, malfunction' was directly related to short circuits or other electrical failures

Some 76% of the 7,978 retail property fires reported were included in the assessment of the ignition factors.

4.4.4 Area of fire origin - Institutional property

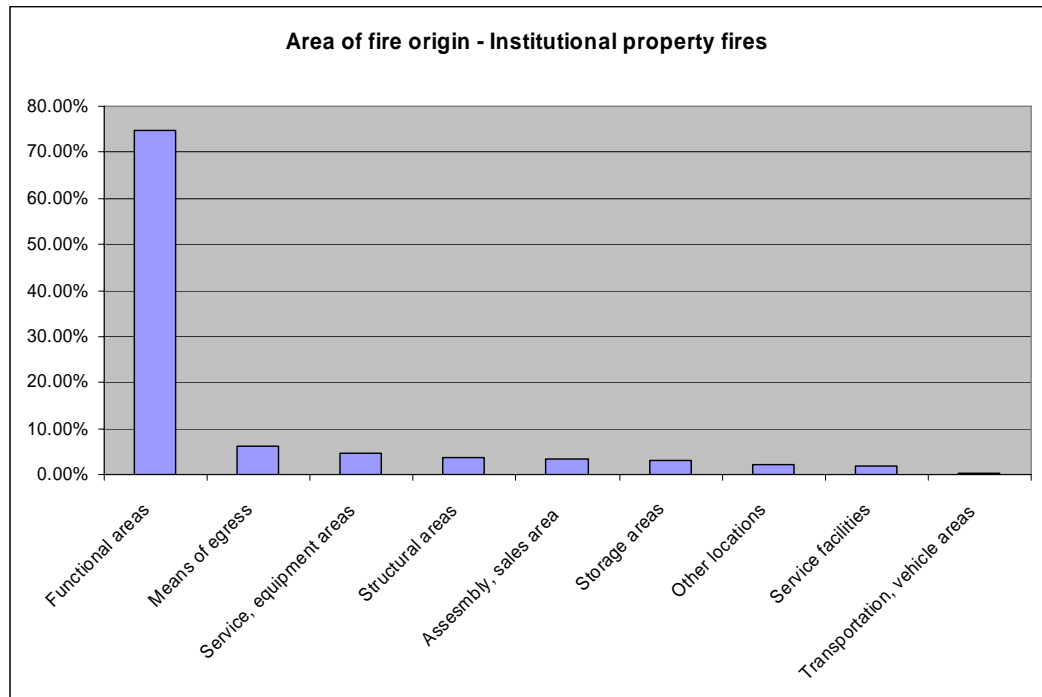
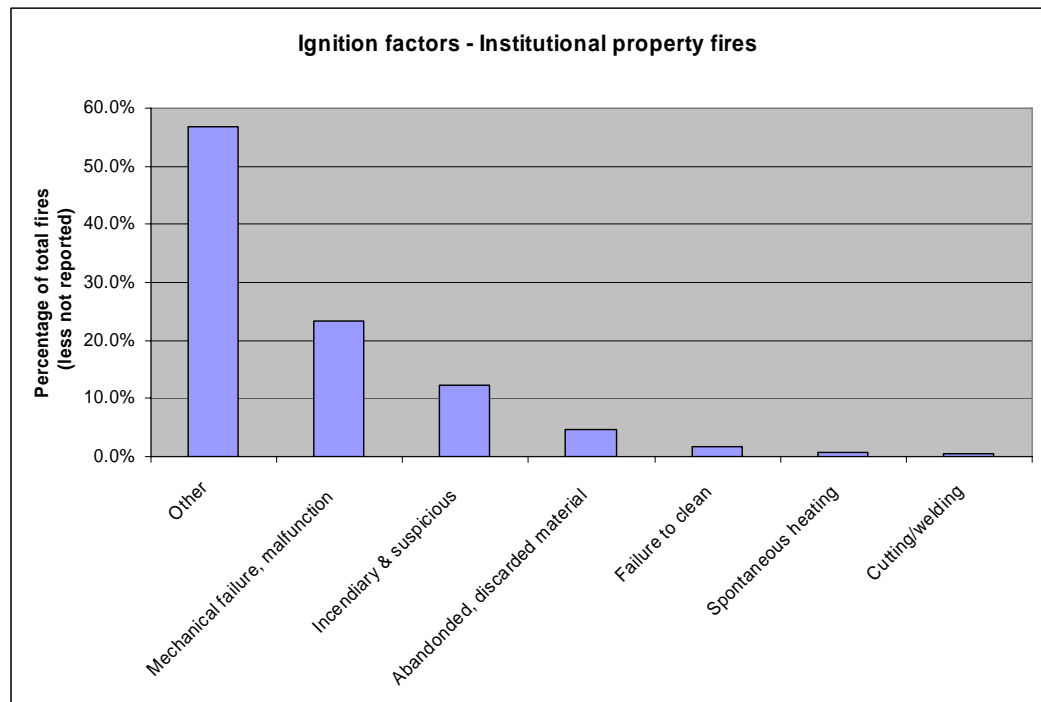


Figure 22 – Institutional: Area of fire origin

It is shown that in institutional properties, the majority of fires start in functional areas where there is considerable human activity. It should be noted that included in functional areas are cells and lock-ups.

A total of 89% of the 5,180 institutional property fires reported was included in the assessment of the area of fire origin.

4.4.4.1 Ignition factors- Institutional property

**Figure 23 – Institutional: Ignition factors**

The majority of the ignition factors in institutional property fires was classified as 'other', which includes misuse of heat sources. Therefore, it is difficult to establish the main contributor to the ignition factor data. However, it is shown that more than a fifth of the fires are related to mechanical failure, a category which included electrical causes.

In undertaking this assessment it was also noted that:

- 60% of the ignition factor category 'Abandoned, discarded material' was directly related to smoker's material such as cigarettes, cigars and pipes.
- 55% of the ignition factor category 'Mechanical failure, malfunction' was directly related to short circuits or other electrical failures.
- 83% of the 5,180 institutional property fires reported were included in the assessment of the ignition factors.

4.4.5 Area of fire origin – Manufacturing property

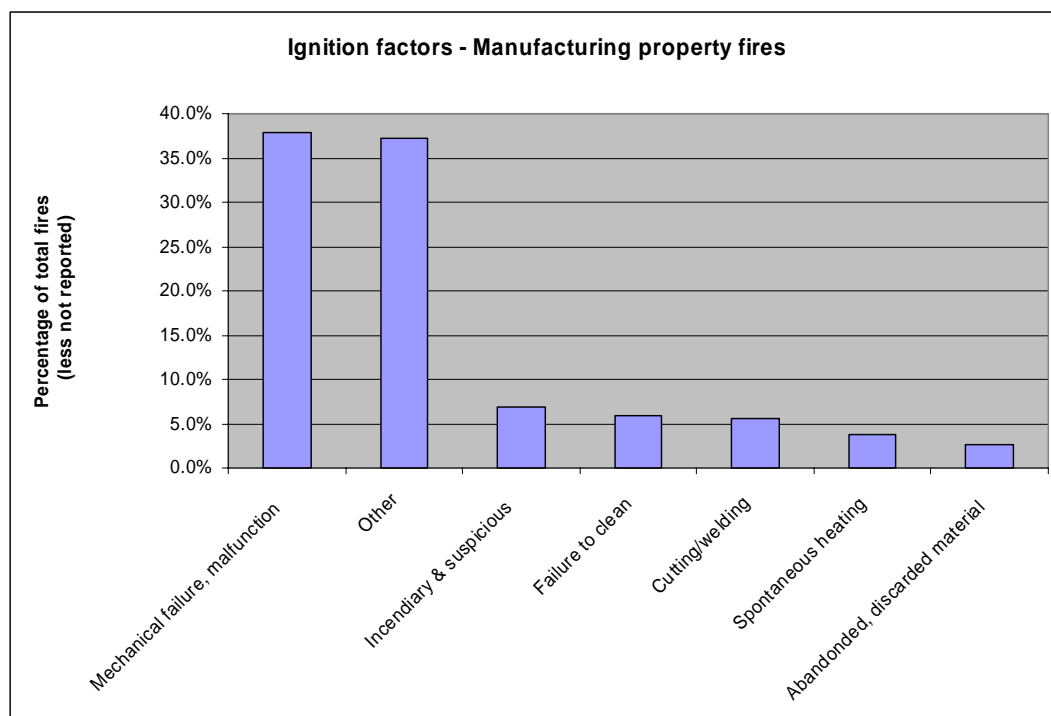


Figure 24 – Manufacturing: Area of fire origin

It can be seen that a major part of the manufacturing property fires start within service and equipment areas. This includes machinery rooms.

A total of 88% of the 4,502 manufacturing property fires reported was included in the assessment of the area of fire origin.

4.4.5.1 Ignition factors – Manufacturing property

**Figure 25 – Manufacturing: Ignition factors**

With regards to the ignition factors a significant proportion of fires is related to mechanical failure and malfunctions. This could be read in conjunction with the area of fire origin, which indicate that most fires in manufacturing properties start in service and equipment areas.

In undertaking the assessment it was noted that:

- 77% of the ignition factor category 'Abandoned, discarded material' was directly related to smoker's material such as cigarettes, cigars and pipes.
- 34% of the ignition factor category 'Mechanical failure, malfunction' was directly related to short circuits or other electrical failures.
- 74% of the 4,502 manufacturing property fires reported were included in the assessment of the ignition factors.

4.4.6 Area of fire origin – Storage property

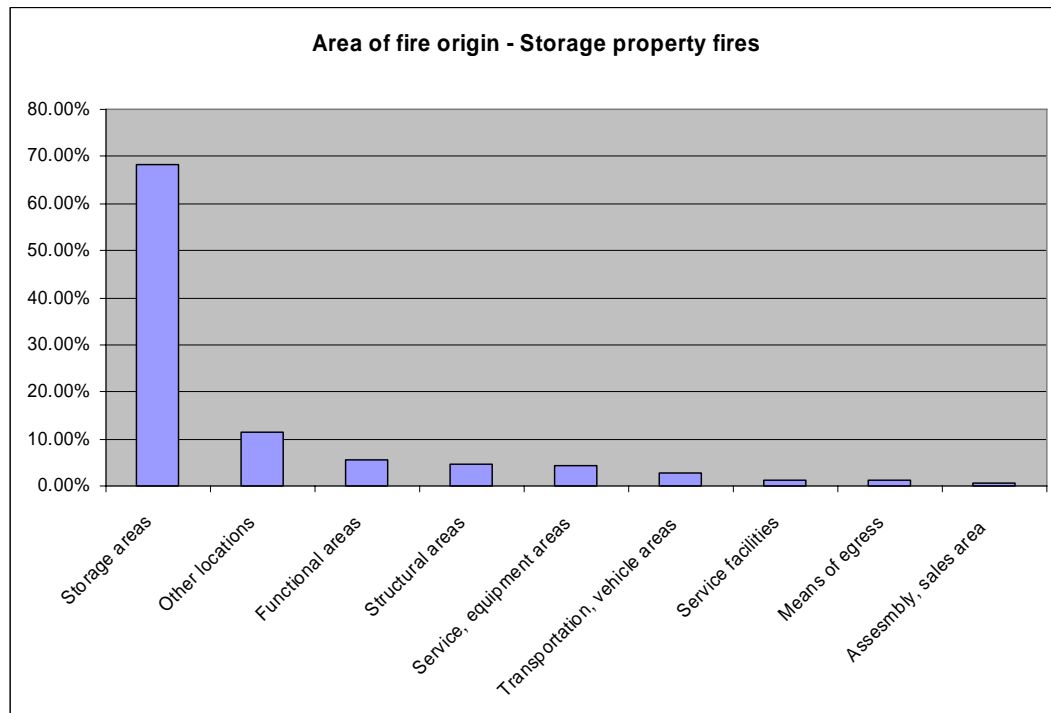
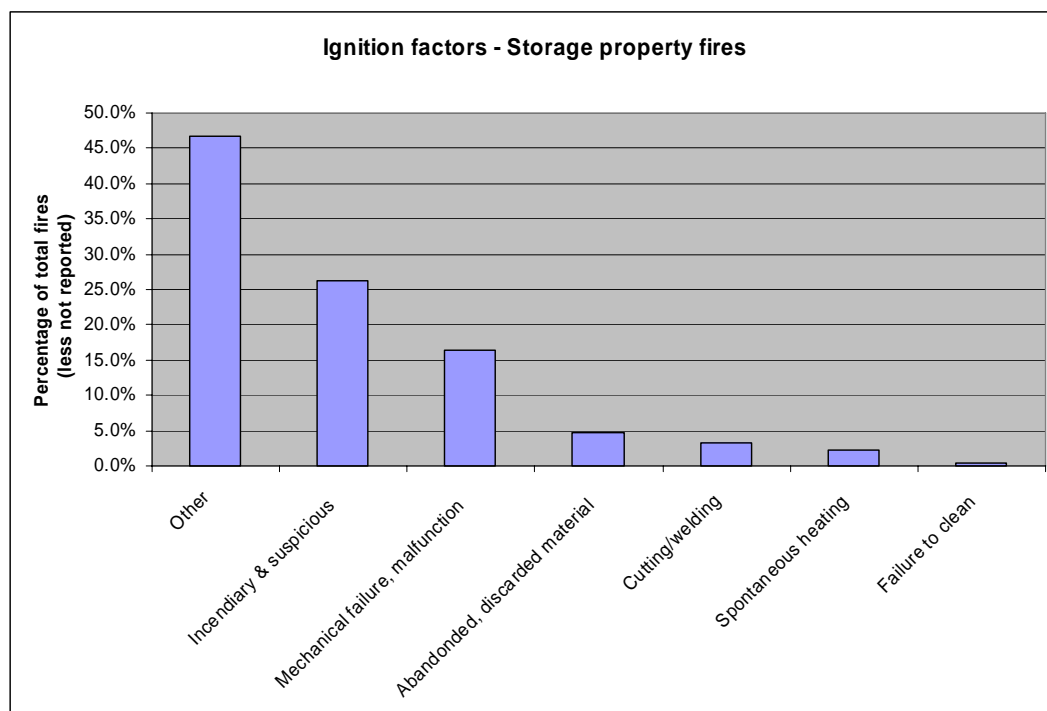


Figure 26 – Storage: Area of fire origin

As could be expected, a clear majority of fires in storage properties start in storage areas. This implies that the reported data has been appropriately recorded.

Some 90% of the 5,144 storage property fires reported was included in the assessment of the area of fire origin.

4.4.6.1 Ignition factors – Storage property

**Figure 27 – Storage: Ignition factors**

A major part of the ignition factors in storage property fires has been classified as 'other'. However, it is shown that >25% of the fires were regarded as incendiary and suspicious.

In undertaking the assessment it was noted that:

- 62% of the ignition factor category 'Abandoned, discarded material' was directly related to smoker's material such as cigarettes, cigars and pipes.
- 66% of the ignition factor category 'Mechanical failure, malfunction' was directly related to short circuits or other electrical failures
- 71% of the 5,144 storage property fires reported were included in the assessment of the ignition factors.

4.5 Assessment of Detection Devices

In the assessment of detection devices, the data includes smoke alarms, smoke detectors, heat detectors, and sprinkler heads that act as detectors only. The method of notification of the fire service is not included in this analysis, meaning that the overall system performance from activation of detector device to notification of the fire service is not included in this assessment.

Included in the assessment are premises with a direct connection to the fire service, a local alarm only, or a connection to a fire indicator panel. As a result the assessment is limited to the operation of the detection device only. It should be noted that for all fires included in this assessment, the fire service arrived at the scene. Alarms due to fire or false alarms, all of which were not reported to the fire service, have not been included in this assessment.

Two of the data categories reported in the fire data record have been simultaneously investigated to assess the operation of detection devices, namely (i) the presence of detection devices, and (ii) the operation of detection devices.

For 6,667 of the 62,583 fires it was reported that the fire was within 'the designed range' of the detection devices. It is understood that this is a reporting parameter used to describe the location of the detection device in relation to the fire, not the sensitivity range of the detection device. In order to properly assess the operation of detection devices, only the incidents where the fire was within the designed range of the detection device has been included.

4.5.1 Results of Detection Devices Assessment

The assessment shows that:

- Approximately 88% of the detection devices operated when the fire was within the designed range of the detection devices, i.e. there was a detection device in the location of fire origin.
- The remaining percentages were reported as detection device failed to operate, fire was too small to operate the device, or reporting of the operation was not applicable or not reported
- An uncertainty associated with this assessment is the parameter describing if the fire was within the designed range of the detector device. Could this mean that there was insufficient smoke or heat to set off a particular detection device at its normal sensitivity, or was the detection device exposed to the combustion by-product due to construction, airflows or some other factor. This limits the reliability of the assessment to some extent.

4.6 Assessment of Sprinkler Performance

For all fires included in this sprinkler performance assessment, the fire service arrived at the scene. The incidents where the sprinkler system operated, but the fire service was not notified, are not included in this assessment of sprinkler performance.

One of the data categories reported in the fire data record has been investigated to assess the performance of sprinklers. This category is: (i) sprinkler performance.

The fires where the equipment was present but the fire was considered too small to cause sprinkler operation have not been included in the assessment. In order to properly assess the sprinkler performance, and for those sprinklers that operated, data can be filtered as to determine the effectiveness of sprinkler extinguishing a fire or preventing fire spread.

In order to properly assess the sprinkler performance, only fires where the sprinklers were present and operated has been included in the assessment. The following sprinkler performance data categories have been included:

- Extinguished fire
- Prevented spread, but did not extinguish
- Did not prevent spread
- Equipment operated, performance not classified above

Taking into account the above considerations, of the 62,583 fires reported, only 1,023 met the criteria to be considered for this study. This small sample impacts on the reliability of the findings.

4.6.1 Results of Sprinkler Performance Assessment

- The assessment shows that sprinklers extinguished the fire or prevented it from spreading in 94 % of the incidents where sprinklers were present and operated.
- This number comprised of the following:
 - (a) the sprinklers extinguished the fire in 57% of the incidents where sprinklers were present and operated,

(b) the sprinklers prevented the fire from spreading in 37% of the incidents where sprinklers were present and operated (i.e. sprinklers controlled the fire)

- The remaining percentage was reported as did not prevent spread, or did operate but performance could not be classified

The above factors need to be taken into account when comparing the results of this study with other sprinkler performance studies, e.g. Marryat's works *A Century of Automatic Sprinkler Protection in Australia and New Zealand 1886-1986* (1988), which assessed the operational reliability of sprinklers in facilities where testing, inspection and maintenance procedures were well maintained and also well documented. Marryat's work included incidents which the fire service did and did not attend, and this differs from this assessment which is only based on incidents where the fire service attended the scene. Marryat's criteria of success were different to that used in this assessment as well. Therefore, when considering use of the fire statistics presented in this article, it is recommended the definition of successful sprinkler operation or sprinkler performance is carefully considered before a comparison between values are carried out.

5 Conclusion

The analysis contained in this report provides a first insight into the potential and utility that can be obtained from mining the statistical data captured in the AFAC national database.

Such analysis, combined with other statistical information, such as that contained in the annual Report on Government Services, provides a valuable insight into areas that could require attention by fire service agencies, fire safety engineers and those regulators who are concerned with fire safety outcomes.

AFAC is supportive of analysis of fire service data such as that undertaken by Arup in this study and is progressively moving towards the public release of more information.

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