Fire Research Note No 946.

SOME STATISTICS OF FIRES IN SHOPS AND THEIR APPLICATION TO TOWN CENTRE DEVELOPMENTS

by

M. A. NORTH and R. BALDWIN

September 1972

FIRE
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SUMMARY

The statistics of fires in shops are studied with a view to assessing fire hazards in shopping malls. It is estimated that, in a 200-shop mall, a fire would be expected most years on average and a large-loss fire every 30 years. The latter figure might be reduced to 5 years if shopping malls behave similarly to department stores.

One-quarter of the shop fires originated in cooking appliances, mainly deep-fat frying ranges, and shops using these appliances would merit special attention to fire prevention or protection. Good housekeeping and frequent refuse disposal would also reduce the number of fires.

It appears that sprinkler systems reduce the number of fires attended by the fire brigades by a factor of 2 or 3. The probability of failure of sprinkler systems in shops is estimated as 0.065 to 0.09.

KEY WORDS: Fire statistics, shops, shopping mall.

DEPARTMENT OF THE ENVIRONMENT AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

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INTRODUCTION

There have been a number of extensive town centre development schemes in recent years, in which shopping and recreational facilities are housed under one roof (ie as a shopping mall). These complexes present special fire safety problems, especially in regard to means of escape and spread of fire and smoke, and these aspects have been the subject of much recent research[1,2]. Central to any assessment of risk is the provision of an adequate statistical base, so that the problems may be viewed in their true perspective. However, because in this country this method of trading is a recent development, there are insufficient fires to make an adequate study. One approach is to examine the records of fires in other shops, on the assumption that, at least in the early stages, a fire in a shopping complex will be no different to one in a shop on an open street. This is supported by evidence from the United States[3], where 78 per cent of fires in shopping malls originated within an individual shop. This note presents a collection of statistical data for all shops and considers how these may be used to estimate the fire hazard of shopping malls.

DATA

The most recent year for which all records of fires reported by the United Kingdom fire brigades are available in a form suitable for computer analysis is 1967, and these data have been used to produce all the tabulations other than Tables 10 and 11, where the records for several years have been considered.

The data were classified according to the Scottish Building Regulations purpose groups which, in general, lead to a more detailed breakdown than the English ones. The group used for the tables in this note was the "commercial - shops" purpose group, which, in addition to shops, covers laboratories and television, radio and film studios. Table 2 was further sub-divided by use of the Standard Industrial Classification[7] to provide some information on the types of shop involved in fire.

EXPECTED NUMBER OF FIRES

The number of shops at risk is given[5] as approximately 505,000 while the number of fires in shops during 1967 was 5580 (Table 1). Thus the probability, p, of a fire occurring in any individual shop during a year is about 1.1×10^{-2}. This probability will vary from one type of shop to another, and with shops of different size, but there are not enough data to measure this variation. If we assume that shopping malls contain a representative selection of shops from the open street, and that the sources of ignition and materials are similar, then p may be used as an average probability of fire in the shops of the mall.

If there are n shops in the mall, then fires will be expected, on average, n times as often as in individual shops.

In the Appendix it is shown how to calculate the return period, that is the average time before a fire occurs, for a mall with n shops, assuming the average annual probability of p for each. The return period is denoted by T_n.

For one shop,

$$T_1 = 90 \text{ years}$$

For a 200-shop mall,

$$T_{200} = 0.45 \text{ years}$$

The figures of Table 1 enable us to break down this value by time of day to give:

Shopping hours	(0800 - 1759 hours),	$T_{200} = 0.9$ years
Evening hours	(1800 - 2359 hours),	$T_{200} = 1.3$ years
Night hours	(midnight - 0759 hours),	$T_{200} = 3.6$ years

SIZE OF FIRE

One measure of the size of fires is p_s, the probability of spread beyond the room of origin. This is presented in Table 2 for various types of shop and it can be seen that the probability of spread is lowest for betting shops ($p_s = 0.10$) and highest for shops selling household goods ($p_s=0.28$). Most of the values lie near the mean value of $p_s = 0.20$ and this could be used for most purposes. In Table 3 values of p_s are given for shops of different ages and it is seen that the probability of spread is less in newer buildings. This may be a result of improved building standards but other explanations are possible*. The main

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* p_s is calculated ignoring the small proportion of fires which spread beyond the building of origin and those confined to the item ignited first.

part of Table 3 gives more detail of the extent of spread of fire. Some 75 per cent of fires were confined to the room of origin and most of the remainder to the building of origin but the two per cent which spread beyond the building are of special concern when considering shopping malls. A difficulty with this measure of fire size is that the 'room of origin' may vary from the tiny 'corner shop' to the entire sales area of a department store. Thus, spread within some rooms may be more serious than spread beyond others. We are led, therefore, to look at other ways of ascertaining the fire size.

Another measure of fire size is the time taken by the fire brigade to bring the fire under control. The distribution of these control times for different periods of the day is shown in Table 4 and illustrated in Fig. 1. It can be seen that the mean control time is about 70 per cent higher at night than during shopping hours. This is probably the influence of delayed discovery of the fire, which gives rise to a larger fire when the Brigade arrives, and is an argument for automatic fire detection.

As a final indication of fire size, we look at large fires which, for present purposes, are defined as those fires in which the total estimated direct loss was £10,000 or more. There were 79 of these fires in the shops purpose group and these are broken down by time of day in Table 1. Also shown there, is the proportion, p_L, of fires which become large. The chance of a fire becoming large during the night is about three times as high as during shopping hours, which reinforces the evidence of increased control times during the night (Table 4) and suggests that automatic fire detection is desirable. The probability of a fire becoming large has also been calculated for the various types of shop accupancy and appears in Table 2. It will be noted that there is a high value of p_L for department stores and general stores, although the number of fires in the latter occupancy is insufficient to place much reliance on this figure. The average loss in these stores is also very high (about £187,500). One possible explanation is that these shops are bigger and have more at risk, another that they have large, undivided sales areas which may allow heat and smoke to damage a large quantity of stock.

From Table 1, we can calculate the annual probability that a large loss fire will occur in a shop. We obtain:

$$p = \frac{79}{505\ 000} = 1.6 \times 10^{-4} \text{ for large fires.}$$

Making the assumption that the chance of a large fire in a mall shop is the same as for a shop in isolation, a return period of 32 years is obtained for the 200¾shop development. However, the size of the mall may increase the fire-fighting difficulties, reduce the chance of early discovery, etc., and hence increase the chance of a large fire. Department stores probably represent the closest approach of individual shops to the mall principle and it is found (Table 2) that the probability of a large fire in these stores is about six times as great as the probability for all shops. If the value of p for large fires is multiplied by 6, the return period for a 200-shop complex becomes only 5.3 years.

The average estimated direct loss in the 79 large fires was £73,400 and in 39 cases it was possible to split the loss between damage to the building and damage to the contents. The mean building loss was £15,500 and the mean loss of contents £23,100. It must be remembered that these figures do not represent the average loss in all shop fires, since most fires have a total loss of less than £10,000.

The area in which the fire started was studied for large fires: 4 of the fires were in laboratories and 16 unknown. Of the other 59 fires, 24 (41 per cent) were in the sales area, 16 (27 per cent) in store or stock-rooms, 5 (8 per cent) in workshops and the remainder in a variety of other areas.

SOURCE OF FIRE

It is informative to study the source of the fire and to compare the source in shops with that of all fires. In Table 5 this is done and the ratio of the percentage of fires in shops to the percentage of fires in all buildings is shown. This shows that fires caused by lighting are relatively much more common in shops, while ashes, soot, chimneys and mechanical heat and sparks are much less common. Spontaneous combustion is twice as common in shops as generally and, while water heating equipment is also twice as common a source of ignition, space heating equipment is only half as common. The cooking appliances are largely deep-fat frying ranges and the remainder are chiefly cookers in kitchens adjoining the shop. Some of the more frequent sources of ignition are examined in Table 6 in relation to their power source.

The material first ignited by the ignition source is of importance and is shown in Table 7 in a similar fashion to Table 5. Fires in shops are generally similar in this respect to all fires, the most notable exception being fires involving external fittings. Since, in a shopping mall these would probably be in the mall itself, this exception may be important.

RESCUES, ESCAPES AND CASUALTIES

The numbers of persons rescued, escaping or injured in shop fires are shown in Table 8 and the proportion of fires which involved hazard to life in Table 9, together with the mean number of persons involved in these fires. The figures given for rescues and escapes only show those known to the brigade and do not include those escaping by their own unaided efforts.

In a mall, these escape figures would refer only to escape from the shop into the mall and not to escape from the complex, where escape problems are more severe, because of the increased size of the building and the larger number of persons at risk. To overcome these problems a higher level of fire protection is demanded and the above data for life risk are not necessarily relevant. They are included here to provide a standard with which the hazard of shopping malls may be compared in future.

One measure of the safety of buildings is the fatal accident frequency rate, denoted by F. This is defined as the number of fatal accidents per occupier per 10^8 exposed hours and represents the number of deaths in a group of 1000 people during their working lifetime. The accident rate has been used in studying industrial accidents[8] and the safety of aircraft[9]. The value of F has been calculated for other occupancies:

Houses[10] : $F = 0.1$

Hotels[6] : $F = 1.0$

If the average shop is assumed to be open 2000 hours per year and to contain N persons on average, then for 10 deaths p.a. in 505,000 shops,

$$\therefore F = {}^{1}/N \text{ deaths per } 10^8 \text{ exposed hours.}$$

Then if $N = 10, \quad F = 0.1$

$N = 100, \quad F = 0.01$

and hence, on average, a person in a shop is as safe as or safer than a person in his home.

FIRES IN SPRINKLERED PREMISES

Because of the small number of fires reported from sprinklered shops, three years' data have been used to compile the statistics. In 1967 all fires were sampled but in 1968 only one-quarter were sampled and in 1969 one-half.

No multiplication of the fractionally-sampled years has been performed and the figures are, therefore, not comparable with the other tables in this report. Overall figures of sprinkler performance are given in Table 10 and the reasons for unsuccessful sprinkler action examined in more detail in Table 11.

Of the 79 large fires in 1967, 77 were in premises not stated as fitted with sprinkler systems (no clear distinction being made between buildings not fitted with sprinklers and those for which information on sprinklers is missing). Of the remaining two fires, one was controlled by the opening of 4 sprinkler heads with a loss of £30,000; while the other was extinguished with 1 head, the loss being £10,000. The first fire was in a shop selling clothing or footwear and the second in a store or stock-room of a department store.

An important probability associated with the reliability of sprinkler systems is the probability, p_f, of failure, given that the fire was not promptly extinguished by other means, ie that the sprinklers should have operated. From Table 10:

$$p_f = \frac{11}{70} = 0.16$$

This high failure rate may be associated with incomplete data on smaller fires.

Ramachandran[4], using data derived from fire brigade visits, has obtained values for the proportion of buildings in various occupancies fitted with sprinkler systems. Using the figure given above (505,000) for the number of shops in the United Kingdom means that, with 95 per cent confidence limits, the number of shops fitted with sprinkler systems is estimated as 13,900 $\pm$ 2400, ie the proportion of shops so fitted is 0.023 to 0.032. In Table 10 we have 10,500 fires in our sample and would expect to find from 240 to 340 fires in sprinklered premises. Since the actual number is 130, it would appear that shops fitted with sprinklers call the fire brigade much less frequently than the generality of shops.

On the basis of this argument, there are about 100–200 fires in sprinklered premises unreported to the brigade. Since these are likely to be small fires, we may assume that they are equally divided between the categories 'Small fires promptly extinguished' and 'Fires controlled or extingusihed by sprinklers', as are those reported to the brigade. On this basis we estimate p_f to be

$$\frac{11}{120} \text{ to } \frac{11}{170} \quad \text{ie} \quad 0.09 \text{ to } 0.065,$$

about $\frac{1}{2}$ to $\frac{1}{3}$ the figure estimated directly from the data. These figures are fairly close to the overall failure rate for all occupancies calculated from brigade reports.[11]

DISCUSSION AND CONCLUSIONS

In this note the fire hazard in shopping malls is deduced from the statistics of fires in all shops but it is necessary to study the limitations of this approach. It is probable that sources of ignition and materials first ignited will be the same whether the shop is on a street or a mall but the fire size and probability of injury as presented here may well be under-estimates. This follows from the increased complexity of the plan layout and the larger number of persons who would be within the complex, leading to more acute escape problems. The number of fires and the efficiency of sprinkler operation may be directly applicable but, if stricter control is exercised in the larger buildings, they may prove to be over-estimates.

From the data given in this note, we expect the return period for fires in a 200-shop mall to be about 0.5 years and for a large fire to occur, on average, every 32 years. If, however, fires in arcades behave like fires in department stores, this latter period would be cut to about 5 years.

Fires at night tend to take longer for the brigade to extinguish and the proportion of fires which give rise to a loss of £10,000 or greater is three times higher then. This is probably due to delayed discovery at a time when few people are about and is an argument in favour of automatic fire detection. For all shops, the proportion of fires which become large is 1–2 per cent but for department stores the figure rises to about 9 per cent.

The most common sources of ignition in shops are cooking appliances, smoking materials and lighting. Most of the cooking appliances are deep-fat frying ranges and careful consideration to fire protection should be given before allowing this type of installation in a shopping complex. Fires starting from lighting are relatively 5–6 times as common in shops as in all buildings and the detailed reasons for this may repay study. The materials first ignited by the ignition source are most frequently fat, electrical insulation and unspecified waste. The first merely reflects the most common source of ignition and the second are very minor fires, but the last indicates the need for good house-keeping and a frequent refuse disposal service.

It appears that shops fitted with sprinkler systems call the fire brigade less frequently than would be expected. This seems to indicate that the sprinklers either extinguished or controlled a large number of fires before they were able to grow to a significant size. This departure from expectation also affects p_f, the probability of failure of a sprinkler system to control or extinguish a fire. Taking the data of Table 10, we obtain $p_f = 0.16$, a much higher failure rate than that normally quoted. If, however, we make allowance for the estimated number of fires not reported to the brigades, a figure of 0.065 to 0.09 is obtained. This is more like the values of p_f in other occupancies, which can be calculated from the U.K. Fire Statistics[11].

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APPENDIX – Calculation of return period

Suppose that fires occur independently and at random in a shop and let the chance of a fire in the time interval $(t, t + dt)$ be $\lambda\, dt$.

If there are n shops in the mall, then fires will occur n times as often on average and then the chance of a fire in the mall in time $(t, t + dt)$ is $n \lambda\, dt$; choosing dt small enough so that the chance of more than one fire in the interval is neglible, ie $O((dt)^2)$.

Let p be the annual probability of at least one fire in a single shop, and let p_n be the annual probability of a fire in an n-shop mall.

Using a standard result for the Poisson process, the probability of a fire in the interval $(0, t)$

$$= 1 - e^{-\lambda t} \quad \text{for a single shop}$$

$$= 1 - e^{-n \lambda t} \quad \text{for an } n\text{-shop mall}$$

let the interval of one year be given by $t = Y$.

Then $\qquad p = 1 - e^{-\lambda Y}$

and $\qquad p_n = 1 - e^{-n \lambda Y}$

$$\therefore \quad Y = -\ln (1 - p)$$

$$\therefore \quad p_n = 1 - e^{-n \lambda Y} = 1 - (1 - p)^n$$

The return period is the average time between fires, and we denote the return period for an n-shop mall by T_n.

Then $\qquad T_1 = {}^1/_\lambda$ units of time

This is a standard result for a Poisson distribution.

$$T_1 = {}^1/_{\lambda Y} \text{ years}$$

$$= - \frac{1}{\ln (1 - p)}$$

and $\qquad T_n = {}^{T_1}/_n$

$$= - \frac{1}{n.\ln (1 - p)}$$

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Table 1

Proportion p_L of large fires at different times of day

Time of day	All fires	Large fires	p_L
TOTAL	5580	79	-
UNKNOWN	5	-	-
TOTAL KNOWN	5575	79	0.014
Shopping hours	2927	33	0.011
Non-shopping hours	2648	46	0.017
Evening	1951	25	0.013
Night	697	21	0.030

Table 2

Fires in various types of shop

Standard Industrial Classification	Description of occupancy	No. of fires	p_s	p_L
8201	Grocery & provisions	278	0.22	0
8202	Other food	907	0.19	0.003
8203	Confectionery, tobacco & newspapers	241	0.20	0
8204	Clothing & footwear	519	0.19	0.040
8205	Household goods	609	0.28	0.033
8206	Other non-food	325	0.20	0.003
8207	General stores	16	0.22	0.125
8208	Department stores	200	0.22	0.090
8209	Supermarkets	164	0.25	0.030
8200	Unspecified	178	0.11	0.006
820	RETAIL DISTRIBUTION	3437	0.21	0.021
883	Betting	76	0.10	0
884	Catering	1114	0.19	0
885–886	Laundries & dry cleaning	306	0.14	0.003
889	Hairdressing	237	0.20	0
–	Other services	94	0.15	0.011
881–899	MISCELLANEOUS SERVICES	1827	0.18	0.001
8311–8313	Coal, builders, corn, seed & agricultural merchants (wholesale & retail)	17	0.27	0.059
–	OTHER	299	0.18	0.017
	TOTAL	5580	0.20	0.014

Table 3

Extent of fire by age of building
(percentages)

Extent of fire	Age of building			
	pre-1920	1920-1949	post-1949	All
Confined to exterior fittings	2.8	2.2	3.6	2.8
Confined to exterior components (wall,roof,etc)	5.5	6.4	10.9	6.7
Confined to common service spaces	1.1	1.4	2.4	1.4
Confined to room of origin				
Confined to appliance or item of origin	29.0	32.2	28.3	29.5
Spread beyond first item but no structure involved	20.7	21.9	24.6	21.7
Structure involved	25.0	21.7	17.4	23.0
Confined to building of origin, single compartment				
Confined to appliance or item of origin	< 0.1	0.4	0.1	0.1
Spread beyond first item but no structure involved	0.1	0.2	1.1	0.3
Structure involved	0.3	1.5	1.4	0.8
Confined to floor of origin, having spread from room of origin	3.6	2.7	3.0	3.3
Confined to building of origin, multi-compartment				
Single-storey	0.6	2.8	1.5	1.2
Multi-storey	8.7	4.1	2.5	6.6
Extended to:				
Adjoining building(s)	1.7	1.2	0.9	1.5
Separate building(s)	0.2	0.5	0.3	0.3
Other hazard(s)	0.1	0.1	0.6	0.2
Adjoining & separate building(s)	< 0.1	0	0	< 0.1
Adjoining building(s) and other hazards	< 0.1	0.1	0	< 0.1
Separate building(s) and other hazards	< 0.1	0	0.1	< 0.1
Explosions	0.4	0.6	1.3	0.6
TOTAL	100.0	100.0	100.0	100.0
Total No. of fires	3441	1125	1014	5580
p_s	0.22	0.18	0.14	0.20

Table 4

Control time by time of day
(percentage of known times)

Control time (min)	Shopping hours	Evening	Night	Total
1–	51.9	44.9	30.6	46.8
5–	27.1	30.0	26.5	28.0
10–	9.3	10.8	15.7	10.6
15–	4.4	5.4	8.9	5.3
20–	3.6	4.7	8.9	4.7
30–	1.5	2.1	3.7	2.0
40–	0.9	0.7	2.2	1.0
50–	0.6	0.7	1.0	0.7
>59	0.5	0.7	2.4	0.8
Total known	100.0	100.0	100.0	100.0
No. of fires with unknown control times	7	2	2	6
Total No. of fires	30	1953	697	5580
Mean control time* (min)	7.7	8.5	13.1	8.7

*Fires recorded as having a control time greater than 97 min have been considered to have control times of 100 min.

Table 5

Source of ignition

Source of ignition	Fires in shops (%)	Fires in all buildings (%)	Ratio
Lighting	8.9	1.6	5.6
Cooking appliances	23.7	16.8	1.4
Water heating equipment	3.0	1.5	2.0
Space heating equipment	6.4	12.8	0.5
Central heating equipment	1.0	1.3	0.8
Appliances (domestic)	7.2	5.2	1.4
" (industrial)	2.2	4.9	0.5
Special electrical equipment	1.5	0.8	1.9
Miscellaneous appliances	0.6	1.0	0.6
Wire, cable and leads	8.1	6.3	1.3
Ashes and soot	0.3	1.8	0.2
Chimneys	1.4	5.0	0.3
Explosives	0.5	0.4	1.5
Arson	1.7	1.5	1.1
Naked flames (including matches)	2.5	2.6	1.0
Children with fire	5.5	8.8	0.6
Mechanical heat and sparks	0.2	1.2	0.1
Natural causes	0.3	0.5	0.7
Rubbish burning	1.2	1.8	0.6
Smoking materials	10.3	9.9	1.0
Spontaneous combustion	1.1	0.6	2.0
Re-ignition	<0.1	0.1	0.3
Other	0.1	0.1	0.6
Unknown	12.3	13.7	0.9
TOTAL	100.0	100.0	1.0
NUMBER OF FIRES	5580	75057	

Table 6

Basic fuel of ignition source

Source of ignition	Basic fuel							Total
	Elec-tricity	Town gas	Solid fuel	Oil	LPG	Other	Unknown	
Lighting	492	0	–	1	0	0	0	493
Cooking appliances	217	707	11	8	5	0	364	1312
Water heating equipment	116	39	1	7	0	0	1	164
Space " "	102	20	98	129	3	0	5	357
Central " "	7	9	12	20	0	0	7	55
Appliances (domestic)	349	42	0	0	0	0	8	399
" (industrial)	25	11	1	38	23	13	12	123
Wire, cable and leads	434	13	–	–	0	0	3	450
TOTAL	1742	841	123	203	31	13	400	3353

Table 7

Material first ignited

Material first ignited	Fires in shops (%)	Fires in all buildings (%)	Ratio
TOTAL	100.0	100.0	1.0
GASES	2.0	2.6	0.8
Town gas	1.6	1.9	0.9
LPG	0.3	0.5	0.7
Acetylene	$<$0.1	0.2	0.1
Others and unspecified	0.1	0.1	0.5
LIQUIDS	3.5	7.1	0.5
Petrol, lighter fuel	0.3	1.3	0.2
Paraffin, kerosene	1.9	2.9	0.6
Diesel oil, fuel oil	0.2	0.6	0.3
Paint, varnish, printing ink, etc.	0.1	0.3	0.2
Other oils	0.4	1.3	0.3
Other and unspecified	0.8	0.7	1.2
CARBONACEOUS MATERIALS	0.4	0.6	0.7
Coal, coke, peat, etc.	0.1	0.2	0.7
Bitumen, pitch, asphalt	0.2	0.3	0.5
Soot	0.1	0.1	1.3
Other and unspecified	0	$<$0.1	0
TEXTILES	4.0	6.4	0.6
Raw fibres	0.4	0.9	0.4
Rags	0.2	0.6	0.4
Fluff	0.3	0.2	2.3
Clothing on person	0.1	0.5	0.1
Clothing not on person	1.8	3.0	0.6
Other, laundry	1.2	1.2	1.0
FURNISHINGS AND FURNITURE	4.2	14.1	0.3
Bedding	1.1	5.9	0.2
Upholstery, cushions, etc.	0.7	3.2	0.2
Curtains and blinds	0.5	1.2	0.4
Floor covering	1.0	1.4	0.7
Other and unspecified	1.0	2.4	0.4

Material first ignited	Fires in shops (%)	Fires in all buildings (%)	Ratio
STRUCTURE	4.7	8.3	0.6
Floor, skirting board	1.0	1.5	0.7
Stairs	< 0.1	< 0.1	0.8
Wall, wall lining,etc.	0.8	1.1	0.7
Ceiling, ceiling lining	0.8	0.4	2.0
Roof, roof members	0.9	2.1	0.4
Timber in chimney	0.1	0.5	0.1
Timber under hearth	0.6	1.1	0.6
Other and unspecified	0.4	1.5	0.3
FITTINGS AND FIXTURES	5.1	3.2	1.6
Door	0.4	0.3	1.3
Window	0.4	0.6	0.6
Shelves, other internal fittings	2.3	1.9	1.2
External fittings	2.0	0.4	5.5
Other fixtures	0	0	1.0
MISCELLANEOUS	62.5	41.5	1.5
Dust, powder, flour	0.8	0.7	1.1
Food, fat	21.3	12.9	1.7
Food, other	1.1	1.3	0.8
Lagging, insulation	0.5	0.7	0.7
Cleaning materials	0.3	0.4	0.7
Rubber tyres	0.1	0.2	0.6
Packing, wrapping	3.4	1.4	2.4
Paper, cardboard, etc.	2.6	2.0	1.3
Confined to electrical insulation	15.8	6.2	2.5
Wood, dust, shavings	0.5	0.9	0.5
Wood, boards, articles	0.2	0.6	0.3
Fireworks, explosives	0.1	0.1	1.7
Decorations (e.g. Xmas)	0.1	0.1	0.6
Adhesive	0.1	0.2	0.3
Toys and games	< 0.1	0.1	0.4
Lubricant, non-liquid	< 0.1	< 0.1	0.8
Other	3.5	2.5	1.4
Unspecified waste	12.1	11.1	1.1
UNKNOWN	13.5	16.1	0.8
NUMBER OF FIRES	5580	75057	

Table 8

Rescues, escapes and casualties

	Number of persons										Total
	None	1	2	3	4	5	6	7	8	>8	
Rescues and escapes	5523	25	11	5	8	6	1	0	0	1	5580
Non-fatal casualties	5451	102	14	6	3	3	0	0	1	0	5580
Fatal casualties	5572	7	0	1	0	0	0	0	0	0	5580

Table 9

Fires causing life hazard

Fires leading to:-	Percentage of shop fires	Mean number of persons
Rescues and escapes	1.02	2.5
Non-fatal casualties	2.31	1.4
Fatal casualties	0.14	1.3

Table 10

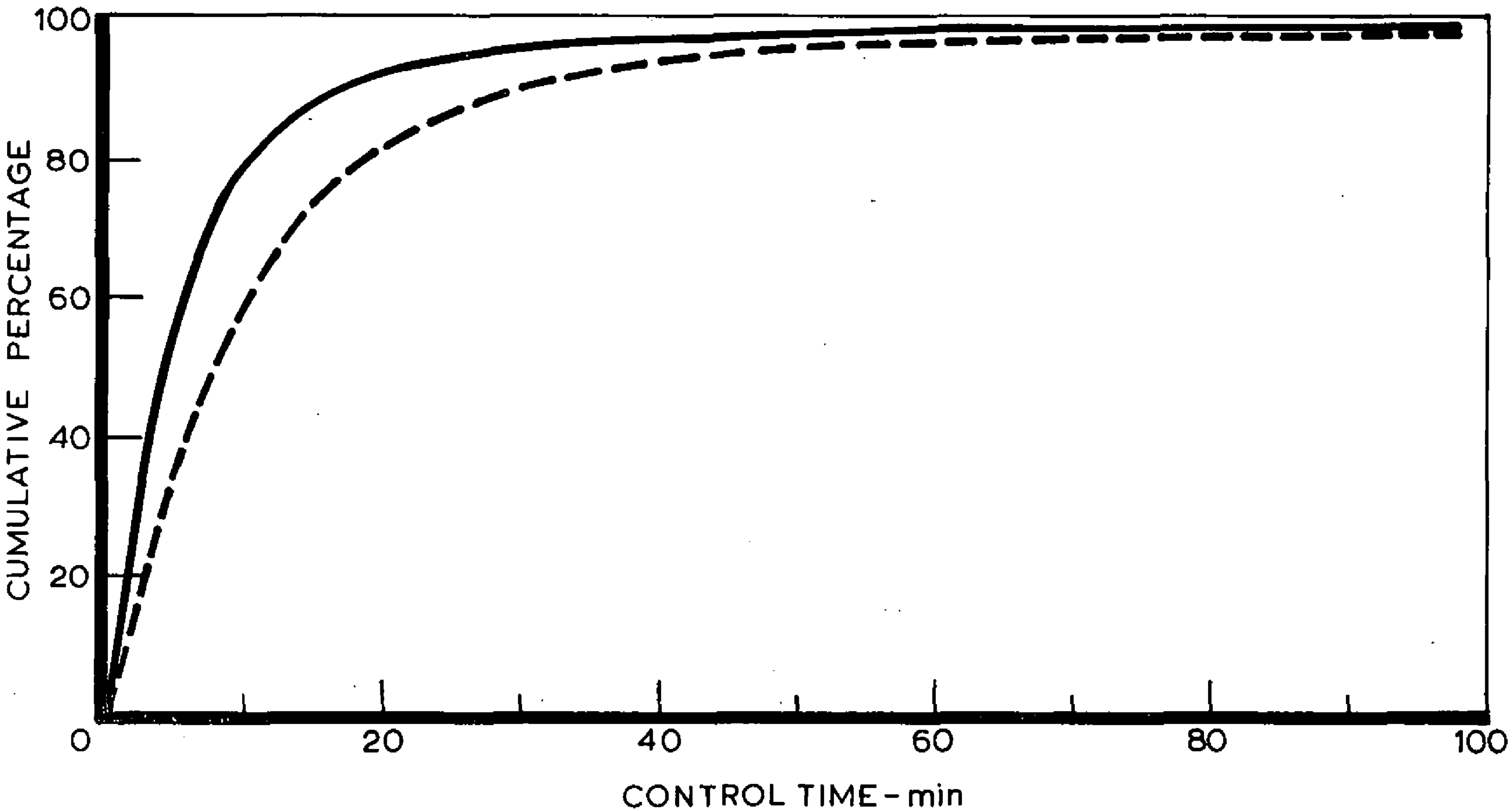
Sprinkler performance, 1967-69

Performance	Fires in sample
TOTAL FIRES	10 500
Sprinklers not fitted	10 370
Sprinklers fitted	130
Small fires, promptly extinguished	60
Fires in which sprinklers should have operated	70
Controlled or extinguished by sprinklers	59
Not controlled or extinguished by sprinklers	11
Sprinklers operated but did not control fire	3
Sprinklers did not operate	8

Table 11

Reason for sprinkler malfunction

Reason	No. of fires in sample	
TOTAL		11
UNKNOWN		1
SPRINKLER SYSTEM DESIGN FAULT		6
Fire in non-sprinklered area	4	
Fire contained within trunking	1	
Fire above sprinkler heads	1	
SPRINKLER USAGE FAULT		4
System shut off	3	
Goods stacked round heads	1	



Fires during shopping hours (0800–1759)

Fires during the night (midnight–0759)

FIG.1 FIRE CONTROL TIME FOR DIFFERENT TIMES OF DAY