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FIRES CAUSING A LARGE MONETARY LOSS

An analysis of reports of fires in which the estimated direct damage was £10 000 or more, occurring in the United Kingdom between 1944 and 1952.

by

D.W. Millar and J.F. Fry

Summary

It is estimated that almost half the direct fire losses in the United Kingdom and Eire (about £25 million per year) result from the 200 to 300 fires in which the individual loss is £10 000 or more. Reports on these fires for the period 1944-52 have been examined and the data analysed. There is a general indication of an increasing yearly number of these large fires and an increasing loss in industrial premises, but it appears likely that both these increases may be largely due to the effect of rising prices. When indices are used to adjust prices to the 1949 level it appears that the annual incidence and cost of large fires in the period 1949-52 have remained roughly constant and that, in terms of 1949 prices, the average loss per large fire in both industrial and commercial premises was about £45 000. The average large fire losses per establishment and per 1 000 employed were greatest in leather and fur preparation and lowest in clothing manufacture, with the largest industrial group, metal and machinery manufacture, towards the low end of the scale.

Mathematical curves have been fitted to the distributions of estimated direct loss caused by large fires and it appears possible that the frequency distribution of large fire losses can be described by an equation of the form

$$f = Cx^{-\frac{1}{2}}(20 - x)^{\lambda}$$

in which $x = \dfrac{\text{£loss} - \text{£}\,10\,000}{\text{£}5\,000}$

There were many large fires in which no cause could be determined; the most frequent ascertainable causes were "mechanical heat and sparks" and "faults in electric wire and cable".

The most frequently occurring times of discovery of large fires were between midnight and 4 a.m. and at about 6 p.m. There was no evidence that the average losses in the fires depended on the time of discovery. There were no major differences either between days of the week or between months of the year in the numbers of large fires occurring.

More large fires occurred in single storey buildings than in buildings of other numbers of storeys but no information is available on the numbers of buildings at risk in these categories. It appears unlikely that the size of the building of origin materially affects the damage sustained except where it is the main factor controlling the quantity and value of material at risk.

The majority of fires that become large appear to be well developed when discovered and the period of time between the discovery and the arrival of the

Brigade, 10 minutes or less in three-quarters of the fires, appears to have had no marked influence on the losses. There was some indication that the loss per fire was greater where the water supply was initially inadequate but, as might be expected, there were few fires in which this inadequacy was encountered and variation among the losses was high.

It was noticeable that the period between the discovery of the fire and the call to the Brigade was longer in the case of fires tackled before the arrival of the Brigade which suggests that the occupants of the buildings tended to delay calling the Brigade while they carried out some fire-fighting operations themselves.

Among the materials ignited first in these fires textiles and timber were the two most frequently reported.

From the reports considered and from other reports of fires in which sprinklers were installed, it appears certain that sprinkler systems successfully prevented the development of many potentially large fires. The damage caused by some of the large fires could well have been reduced if the sprinkler systems had not been prevented from operating correctly.

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INTRODUCTION

It is estimated that fires in which the direct damage causes a monetary loss of £10 000 or more, in brief "large fires", together account for nearly half of the direct fire loss in the United Kingdom and Eire, a sum currently of the order of £25 000 000 a year. There are between 200 and 300 large fires a year although the total number of fires attended by Fire Brigades is about 80 000 a year. It is obvious that any reduction in either the frequency or the severity of large fires would be well worth while.

The information used in this analysis was compiled from two sources. The reports of major fires which are published monthly in the "Times" provided the lists of occurrences and the estimates of the financial loss caused by direct fire damage. These estimates appear shortly after the occurrence of the fires and are therefore likely to be only approximate. The National Fire Service and Fire Brigades attended nearly all the fires, and their reports provided all information other than the financial loss. Some information contained in earlier reports of work on the subject (1), (2), has been reproduced in this note.

ECONOMIC AND FIRE LOSS DATA

The "Times" estimates of the losses due to small fires (direct damage less than £1 000 each), medium fires (costing between £1 000 and £10 000) and large fires (costing more than £10 000 each) are summarised in Table 1 below. The source of the information given in the "Times" is not known to the Organization, but it appears that the figures have been derived from individual estimates of the losses caused by large and medium fires. The total annual losses due to small fires have been assumed to amount to 70 per cent (60 per cent prior to July 1947) of the sum of the individual estimates, allowance being made in 1949, 1951 and 1952 for the effect of three unusually large fires each costing more than £1 000 000.

Table 1

ESTIMATED DIRECT LOSSES DUE TO FIRE IN THE UNITED KINGDOM AND EIRE

Category of fire	Loss in units of £1 000										% age of total
	1944	1945	1946	1947	1948	1949	1950	1951	1952	Total	
Small	4 357	4 800	4 518	7 519	7 677	8 429	8 061	9 120	9 565	64 046	39.2
Medium	2 125	2 272	2 301	2 111	2 687	2 456	2 992	2 144	2 290	21 378	13.1
Large	5 136	5 728	5 228	9 230	8 279	11 586	8 523	11 884	12 375	77 969	47.7
Total	11 618	12 800	12 047	18 860	18 643	22 471	19 576	23 148	24 230	163 393	100.0

When the value of money is falling the number of fires causing direct damage to the extent of £10 000 or more, may be expected to increase considerably over a period of say five years. It can be seen from Table 2 that the annual total of fires classified as large by this criterion increased considerably during the period considered and Table 3 shows that the monetary loss caused increased two-fold between 1944 and 1952. As both these quantities depend on the value of money an attempt has been made to allow for changes in this value. Indices devised to measure the changes in the prices of industrial plant and equipment, in the prices of industrial raw materials and manufactures and in the cost of building, have been combined into weighted indices, and these have been used to measure the large fire losses in terms of the money values obtaining in 1949, the earliest year for which the indices for industrial plant and equipment are available to the Organization. The weights are believed to represent the proportions of loss in large fires due to damage to each of the three components of loss (i.e. structural damage, damage to machinery and equipment, and damage to stocks), but because of the limitations of the information available to the Organization they are very largely arbitrary. The numbers of large fires and the damage caused by them in 1950, 1951 and 1952, excluding fires causing damage to the extent of less than £10 000 in terms of 1949 money value, are shown in Tables 5 and 6 and in Figures 1 and 2. The average money loss per large fire at 1949 prices is shown in Table 7. Details of the weights used are given in the appendix.

The conclusions which can be drawn from the tables can be no more than tentative because of the arbitrary nature of the adjustments and the fact that the adjusted data are available for only a short period. The general indications of Tables 2 and 3 are of an increasing yearly number of large fires and an increasing loss in industrial premises. From the information in Tables 5 and 6 on the other hand, it appears quite possible that, since 1949, these increases may be due to the effect of rising prices inflating both the loss and, indirectly, the numbers of "large" fires. The "real" incidence of these fires and the "real" loss could well be constant for the period 1949-1952. It appears unlikely that there has been a decrease in these quantities. From Table 7 it appears that, in terms of 1949 prices, the average loss per large fire in both industrial and commercial premises is about £45 000 and in other buildings about £25 000.

An alternative method of examining the average loss per large fire is available for industrial premises, though again the basic data are somewhat scanty. The average loss per large fire, L_a, (at the prices current at the time of occurrence) is given by

$$L_a = \frac{\Sigma (T \times f)}{N \times \rho_0 \times \rho_1}$$

in which T is the amount at risk in each establishment,
f is the proportion damaged in each establishment,
N is the number of establishments,
ρ_0 is the average proportion of establishments in which there are outbreaks attended by a fire brigade,
and ρ_1 is the average proportion of outbreaks attended which become large fires.

In previous work(3) the frequency of Fire Brigade attendances was related to the number of establishments and to the number of persons employed. The conclusions were that the relative frequencies were consistently high for premises concerned with the manufacture of wood and cork and possibly for the chemical industry. Table 8 shows frequency of large fires in relation to Fire Brigade attendances. There is a possibility of sampling errors in the denominators of these proportions which may affect the year by year variation to some extent, but is unimportant compared with the fairly regular differences between industries. These differences may be considerably affected by differences in the composition of each industrial group, but the figures suggest that outbreaks of fire, in terms of attendances by Brigades, became large fires most frequently in premises used for leather and fur preparation, paper making and printing and, possibly, the manufacture of textiles and textile goods.

Economic and fire-loss data on the main industrial groups are given in Table 9. The economic data relate to establishments employing more than ten people. In general there are few large fires in establishments employing less than ten people although in the clothing industry in particular it is possible that there are some. The average large fire losses per establishment and per 1 000 employed were greatest in leather and fur preparation and least in clothing manufacture with the largest industrial group, metal and machinery manufacture, towards the low end of the scale.

There is considerable variation in the money values of stocks carried in different industries and this must influence the pattern of large fire losses throughout industry. From Table 9 it may be seen that in clothing manufacture, woodworking, and paper making and printing the average money values of stocks per establishment of finished goods, work in progress, materials and fuel were near the £10 000 level, which is the lower limit of direct damage defining a large fire. These figures do not, of course, take into account the value of capital equipment or buildings and they include the value of stocks of fuel which is not a major component of large fire loss. Damage to stocks is believed to be responsible for an important part of the loss in fires, so it is possible that many serious fires in these three industries are not classified as "large" simply because the value of the stocks is below £10 000. There are serious fires causing direct damage below £10 000 in other industries, but the average value of stocks at risk in all the other major industries is well above £10 000, and will therefore have less influence on the classification of the fires.

DISTRIBUTION OF LOSSES IN LARGE FIRES

Mathematical curves have been fitted to the distributions of the estimated direct losses caused by "large" fires and are shown in Figs. 3, 4 and 5. The distributions treated in this manner are:-

Fig. 3 - all large fires 1944-52; losses at prices current at time of occurrence.

Fig. 4 - fires in industrial premises 1949-52; losses measured in terms of 1949 prices.

Fig. 5 - fires in premises other than industrial 1949-52; losses measured in terms of 1949 prices.

The observed frequencies in Fig. 3 appear to be reasonably well represented by the curve except at the lower end of the loss scale, and in the loss range £50 000 - £55 000, which is probably due to rounding off the estimates of losses. The distribution is affected by the change in money values since 1944 and probably by the fact that fires in different occupancies are grouped together. The losses in some 1 500 large fires have been plotted and this large number of observations tends to smooth out the fluctuations apparent in Figs. 4 and 5. In both of these distributions there is some irregularity at the lower end of the loss scale, especially in the curve for industrial premises. The observed frequency in the loss group £15 000-£20 000 is higher than that of the curve by 70 per cent in the case of industrial premises and by 50 per cent in buildings other than industrial.

It appears possible that the frequency distribution of large fire losses can be adequately described by a curve of the form $f = Cx^{-\frac{1}{2}} (20 - x)^{\lambda}$ in which

$$x = \frac{\text{£loss} - \text{£10 000}}{\text{£5 000}}$$ and

there is only a single parameter λ

GENERAL FACTORS

The data obtained from the fire brigade reports are insufficient to permit simultaneous comparison of many factors by the statistical methods used in the design of experiments, although this would be desirable. Where it has been possible to allow for more than one factor this has been done.

CAUSE OF FIRE

The reported causes of the fires are shown in Table 10. In 56 per cent of the fires the cause could not be determined. Many fires were attributed to cigarette ends, smoking materials and matches but there may be some doubt in regard to these causes in large fires in which much evidence is destroyed. The largest individual item among the causes was "mechanical heat and sparks" and this was followed by "faults in electric wire and cable". The distribution of causes in individual occupancies is too scattered for any association to be observed.

In Table 11 the known causes of large fires have been summarized according to the fuel associated with the source of ignition, e.g. coal or oil in the case of boilers, electricity in the case of faults in electric wire and cable.

The distribution of the various fuels among large fires is similar to that obtained from an analysis of reports of all fires other than those in private houses and flats.

TIME OF DAY OF DISCOVERY OF OUTBREAK

There was no apparent connexion between the type of occupancy in which there was a large fire and the time of day when the occurrence was discovered (Table 12). The hourly frequency for all occupancies together has therefore been plotted for each year (Fig.6). The graphs show peaks between midnight and 4.00 a.m. and at about 6 p.m., and a trough at 9 a.m. Since the pattern of hourly frequencies did not differ significantly from one year to another an average hourly frequency taken over the five years 1948-52 has also been plotted in Fig. 6. It is important to remember that the time of discovery may be some time after the time of outbreak of the fire.

The time of day at which the fires were discovered was found to be associated with the location of the persons discovering them (Table 13 and Fig.7). There is some variation between years but this does not obscure the general pattern. About half of all the fires occurring in each year were discovered by people connected with the premises involved, the majority being inside the building. This proportion varied according to the period of the day. Between 6.30 a.m. and 6.30 p.m. 60 to 80 per cent of the fires were discovered by people connected with the premises, while between 6.30 p.m. and 6.30 a.m. the proportion varied from 35 to 50 per cent.

The variations in loss per fire in relation to the time of discovery of the fire are shown in Table 14. There is no evidence that the average loss in large fires depended on the period of the day in which the fire was discovered.

DAY OF WEEK OF OUTBREAK

There was no evidence of any association between the occupancy and the day of the week of outbreaks of fire. It might be expected that the fire incidence on Saturdays and Sundays would be considerably lower than that on other days of the week, but as may be seen from Table 15, there is some difference between years in this respect, and no more than a slight indication that there are fewer large fires on Sundays than on other days. The frequency of fires per day has been plotted in Fig. 8.

MONTH OF YEAR OF OUTBREAK

There was no evidence that large fires occur more frequently than usual in any particular month, or that the variations in frequency differed in various occupancies. The figures are shown in Table 16 and in Fig. 9. No corrections have been made for the differences in the number of days in the calendar months.

TYPE OF MATERIAL DAMAGE IN RELATION TO OCCUPANCY AND LOSS

An attempt has been made to find the relation between the loss and the type of material damage in the various occupancies. Unfortunately in many cases it was not possible to decide from the reported information which particular kind of damage produced the main loss. The information tabulated in Table 17 reflects this deficiency rather than the relation sought. It is possible, however, to draw some broad conclusions from the table, in conjunction with the original information. It is unlikely that structural damage is of major importance except in one or two rather specialised occupancies such as schools, hospitals, some private houses and some offices. There are few cases where the main loss is recorded in the table as due to damage to machinery, but it is not often in large fires that fires starting in machinery do not spread beyond the machinery and damage contents. It is difficult to assess the loss caused by damage to machinery because of the possibilities of salvage, and the restoration of a machine damaged by fire, which is not included in the estimate of loss, may be far more expensive than is apparent from the fire report. In industrial premises damage to machinery must be considered a substantial item, though probably a greater loss is caused by damage to materials used in manufacture, goods in process and stocks of completed goods.

FREQUENCY OF LARGE FIRES IN RELATION TO THE CHARACTERISTICS OF THE BUILDING INVOLVED

The loss caused by certain large fires is known to have been high because of the constructional characteristics of the buildings involved, and it is possible that both the frequency of large fires and the damage caused are related in some way to the type of building construction. Any general relationship of this sort might depend more upon internal than upon external construction, and would not then be apparent from the information contained in the reports examined. The available information is given in Table 18 and, in summary form, in Table 18a below. It can be seen that there was a tendency for large fires

Table 18a

THE FREQUENCY OF LARGE FIRES IN RELATION TO THE TYPE OF BUILDING CONSTRUCTION OF THE OCCUPANCY

Occupancy		Type of building construction			Total fires of known types of construction
		Load bearing walls without internal columns	Load bearing walls with internal columns	Other types of building construction	
Agriculture and industry	1948 1950 1952	23 (33.0) 28 (38.6) 56 (68.1)	51 (41.1) 43 (40.5) 46 (44.8)	22 (22.0) 47 (39.1) 45 (34.1)	96 118 147
Commerce and offices	1948 1950 1952	6 (6.5) 12 (8.5) 16 (17.6)	9 (8.1) 9 (8.9) 16 (11.6)	4 (4.3) 5 (8.6) 6 (8.8)	19 26 38
Public utilities, transport, public institutions, entertainment, private residences, hotels, clubs, other personal service, laundries	1948 1950 1952	28 (17.5) 19 (12.2) 36 (22.2)	11 (21.8) 10 (12.8) 9 (14.6)	12 (11.7) 8 (12.3) 3 (11.1)	51 37 48
All buildings	1948 1950 1952	57 59 108	71 62 71	38 60 54	166 181 233

N.B. The numbers in brackets are the expected frequencies of large fires in each cell of the table, on the assumption that type of building construction is independent of occupancy.

in industrial premises to take place in buildings with load bearing walls and internal columns and in buildings of "other types of construction" while the large fires in professional establishments, public utilities, transport, buildings concerned with entertainment, private residences, hotels, clubs, hostels and laundries tended to occur in buildings of load-bearing construction without internal columns. It is probable that these tendencies reflect a relationship between occupancy and type of building construction, rather than differences in the frequency with which large fires occur in various combinations of occupancy and types of building construction.

It was thought that there might be some connexion between the incidence of large fires in various occupancies and the numbers of storeys in the buildings involved, and an appropriate breakdown of the data is given in Table 19. There is no evidence of any consistent relation. There were more large fires in single storey buildings than in other groups of buildings classified by the number of storeys, and almost half of the fires were in single-storey or partly single-storey buildings. Unfortunately no information is available either on the numbers of buildings at risk in each group or on the number of storeys most common to each type of occupancy.

LOSS IN LARGE FIRES IN RELATION TO THE CHARACTERISTICS OF THE BUILDING INVOLVED

Earlier in this note it was shown that the average loss per large fire depended on the occupancy, and was some 80 per cent higher in industrial and commercial premises than in other buildings. This difference may have been due to the relative amounts at risk, or to the relative degrees of damage in various occupancies, or to a combination of the two factors. This being the case, damage and type of building construction have to be considered in relation to the occupancy of the building.

By comparing the average losses per fire within occupancy groups in Table 18 it is possible to eliminate the effect of occupancy on average loss and to examine the variation with the type of building. The figures suggest that loss per fire in industrial and in commercial premises of load bearing construction with internal columns is higher than that in similar premises without internal columns, but this difference does not hold for other categories of building. This is probably because buildings with internal columns are mainly of the large open-floor type in which the value of material at risk is likely to be high. It is also possible that expensive structural damage can occur easily in buildings of this type.

The loss in each fire has been related to what may be called the "equivalent volume" of the building; that is the base area multiplied by the number of storeys. The calculations were carried out for industrial premises only, and restricted to fires confined to building of origin, and buildings of uniform height. The losses were adjusted to 1949 levels. No consistent relationship was found, so that it seems unlikely that in fires costing £10 000 or more the size of the building of origin materially affects the ultimate direct loss except in the few instances of complete destruction of the whole of the contents.

The average loss per fire according to the number of storeys of the building is shown in Table 21. There is no evidence of any statistically significant differences between the average losses per fire for buildings with different numbers of storeys.

LOSS IN RELATION TO WHERE THE FIRE STARTED

Since the cause of fire was often unknown, the point of origin of the large fires was often uncertain and was frequently reported, in terms of its position and with no regard to its function as part of a building. The available information is summarised in Table 22 for all high-loss fires, divided into occupancy groups with sub-groups according to the point of origin.

No information is available on the frequencies of fires in relation to the availability of "sources of ignition". It is worth pointing out, however, that one possible factor in the growth of large fires is that precautions tend to be massed where fires are expected to occur, and care is taken where the risk is high. Any "unexpectedness" in the cause of outbreaks in relation to the point of origin may tend to encourage the growth of the subsequent fire. For example while 1 per cent of all large fires were caused by oxyacetylene cutting and welding apparatus none of these fires occurred in welding shops or booths.

From Table 22 it is clear that the question of the existence of differences in the mean losses within occupancy groups is worth considering only for industrial premises. A statistical test of significance provides no evidence of any real differences, but it should be realised that the test is not "powerful" when used with highly variable data and widely differing numbers in the sub-groups. In other words, if the points of origin of large fires have an influence on the losses the influence is too small to become apparent from the data available.

LOSS IN RELATION TO TIME DELAY BETWEEN DISCOVERY OF FIRE AND THE ARRIVAL OF THE FIRE BRIGADE

The time delay between the discovery of the fire and the arrival of the Fire Brigade would not be expected to depend upon occupancy, and the relation between loss caused and time delay has therefore been considered for all occupancies together. Tables 23a-e give information on fires in which there was no reported fire-fighting before the arrival of the Fire Brigades, and in

Tables 23f-g there is similar information on those in which there was fire-fighting before the arrival of the Brigades. Inspection of these tables suggests that there is very little association between the loss and the time delay in large fires; large and small losses are associated with both large and small delays. It is of interest to see if the occurrence of fire-fighting before the arrival of the Fire Brigade affects either of the variables. Median time delays and median losses are shown in Table 24. The median, i.e. the observation above and below which there are equal numbers of fires, has been selected as the representative figure because it is less influenced by extreme values than the arithmetic mean. There was no significant difference between the median losses in the fires in which there was no fire-fighting before the arrival of the Brigade and those in the fires in which there was preliminary fire-fighting. The median time delay was significantly higher in fires belonging to the second category which suggests that the call to the Brigade was often delayed, while the fire was being tackled.

LOSS IN RELATION TO THE LOCATION OF THE PERSON DISCOVERING THE FIRE

About half of the large fires were discovered by people inside the premises and it is of interest to see if the loss is in any way connected with this fact.

The location of the person discovering the fire appears to be related to some extent to the occupancy in which the fire occurred. Only one-third of the fires in commercial premises were discovered by people inside the premises while the proportion was slightly over half in industrial premises as a whole and about one-half in other buildings. There may be differences within industrial premises; for example between two-thirds and three-quarters of the fires in chemical works and metal manufacturing premises were discovered by people inside the premises in each of the years 1948, 1950 and 1952. These were the only consistent differences from the general proportion of a half found among industrial premises.

The mean losses per fire have been tabulated in Table 25. There is a tendency for the mean loss in large fires to be higher when the person discovering the fire was inside the premises but the evidence is not very strong.

LOSS IN RELATION TO THE ADEQUACY OF THE INITIAL WATER SUPPLY AND A RURAL OR URBAN LOCATION

There were comparatively few fires where the initial water supply was reported to be inadequate or which occurred in rural districts. The two factors are related to the extent that in some 25 per cent of the fires in rural districts the initial water supply was inadequate while this was so in only about 5 per cent of the fires in other districts. The figures are shown in Table 26.

Comparisons between mean losses per fire in the various categories are rather difficult in that the numbers in some categories are small enough to cast doubt on the validity of any of the usable statistical tests. The types of occupancy in which large fires occurred in rural districts differed from those in other districts. There were, for example, no fires in commercial premises in rural districts and the proportion of fires in premises other than industrial or commercial was higher in rural than in non-rural districts. These differences tend to bias the mean loss per fire in rural districts to the low side. For this reason it was not possible to decide whether a rural location was generally associated with any differences in the levels of mean losses. The only strict comparison possible is that between large fires in which the initial water supply was inadequate and those in which it was adequate within non-rural districts. This provides some evidence that an inadequate initial water supply is associated with a greater loss per fire, but there is some uncertainty about this association because, as would be expected, there were few fires in which the water supply was inadequate and the variation among the losses was high. It appears that the majority of large fires are well developed when discovered and in these it is not likely that an inadequate initial water supply would greatly affect the loss.

MATERIAL FIRST IGNITED IN LARGE FIRES

The frequencies with which various materials were first ignited are shown in Table 27. There were many fires in which the material first ignited was not known; a consequence of the high proportion of large fires where the cause of fire was unknown. Among the known materials ignited first textiles and timber were the two most frequently reported.

THE EFFECT OF SPRINKLERS ON LARGE FIRES

There were 65 large fires in which sprinklers were installed in the premises or part of the premises, an average of 13 fires per year. The total number of fires in which sprinklers were installed and to which the Fire Brigades were called was approximately 360 a year. The effect of the sprinkler systems is shown in Table 28. The most important single reason for failure to control the fire was a rapid spread of fire or explosion, but in many of the fires where the sprinklers failed to operate or failed to control the fire, the reason was some fault of management in the installation or maintenance of the system, or in the control of it before or during the fire. Another common management fault was in bad storage of the materials the system was supposed to protect, for example storage arranged in such a manner that sprinkler heads were screened from the fire or were prevented from giving an adequate spread of water.

During the five year period there were 923 fires of all sizes attended by Fire Brigades which were controlled by sprinklers, and another 157 fires extinguished by sprinklers, while there were only 93 fires in which sprinklers operated but failed to control the fire. There were also 622 fires in which sprinklers were installed but did not operate, nearly all of which were small fires which did not generate enough heat to operate the sprinklers. The comparable figures for large fires were 25 fires in which sprinklers controlled the fire, 3 large fires which were extinguished by sprinklers and 26 fires on which sprinklers operated but did not control the fire. There were also 10 incidents in which sprinklers were installed but did not operate because in nearly all cases the systems were shut down or in a state of disrepair. There are therefore many fires which, but for the action of the sprinkler systems, might well have become large fires, and there are certainly some large fires the damage caused by which might well have been reduced had the sprinkler systems been allowed to operate freely.

CONCLUSIONS AND DISCUSSION

Economic and fire loss data

The information in Table 1 is an arbitrary estimate of the total direct damage caused by fire in the United Kingdom and Eire. The estimated component is some 40 per cent of the total in any year so the figures can give only a rough estimate of the magnitude of the total direct fire loss. Tables 2-9 deal with the frequencies of large fires in the United Kingdom only, and the loss caused. It has been shown that the adjusted figures of frequencies and losses in the period 1949-52, using 1949 prices as a reference level, are reasonably consistent with the suggestion that large fire frequency and total loss are remaining fairly constant. It is certain that some of the increase in both frequency and loss since 1944 has been due to the changing value of money, but it is not possible to assess the importance of this in the years prior to 1949 without further information on the earlier years, especially as there was something of a jump upwards in both total frequency and loss between 1946 and 1947, and the changes in the value of money have by no means followed anything like a smooth trend.

There appear to be, in terms of 1949 prices, two distinct levels of average loss per large fire; a level of about £45 000 in industrial and commercial buildings and one of about £25 000 in other buildings.

Differences in the composition of industries make comparisons between them difficult except in very broad terms, and while there is some evidence of differences in the rates of incidence of all fires attended by Fire Brigades, and in the relative proportions of large fires to all attendances, it is considered that only the most striking cases should be cited. The rate of outbreak of fire is high in the wood and cork industry and the data suggest that outbreaks of fire tend to become "large fires" most frequently in premises used for leather and fur preparation.

It is worth noting that the only useable criterion of a large fire, that is direct damage to the extent of £10 000 or more, almost certainly eliminates some serious fires from consideration in the clothing industry, and is quite likely to have the same effect in other industries such as woodworking and paper-making, since the average money value of stocks of finished goods, work in progress, materials and fuel per establishment in these industries is quite near the £10 000 mark. This factor affects comparisons of frequencies or losses occurring in these industries with those in other industries in nearly all of which the average value of stocks is higher.

General factors

The various factors which have been considered have surprisingly little effect on the monetary loss caused by large fires, possibly because the ignition and growth of fires of any size are very variable. It may be that the variation among large fires masks the effect of an individual factor, but that the cumulative effect of many factors determines the size of the fire. The data available in this investigation are insufficient to consider more than one or two factors simultaneously, but even if this were not so it is thought that the general attributes of a large fire considered in this note have little to do with the loss caused. It is possible that the internal construction of the building is of importance and it is intended to investigate this possibility by a study of the detailed research reports of a year's large fire experience.

There is a certain amount of somewhat indirect information dealing with the discovery of large fires which suggests that the majority of large fires are of considerable size when discovered and that measures aimed at earlier discovery might well be effective in reducing large fire losses. This information may be summarised as follows:-

1. The hourly frequency of discovery (see Fig. 2), which may differ considerably from the hourly frequency of ignition, fluctuated, being low during the working day but high at 6 p.m. and in the small hours of the morning. This suggests that there were two types of fire during the night, those which occurred soon after the premises were vacated and those which built up slowly. This variation in the hourly frequency of discovery is not reflected in the average losses per large fire which seemed to be independent of the time of day.

2. Half of all the large fires were discovered by people outside the premises, in other words occupants of neighbouring premises, passers-by and policemen. The proportion was between 30 per cent and 40 per cent during the hours 6.30 a.m. to 6.30 p.m. and considerably higher during the other half of the day. This factor was unrelated to average loss per large fire. The proportion of large fires discovered by people outside the premises was as high as two-thirds in commercial premises which compares with just over a half in industrial premises, and about a half in other buildings.

3. The time delay between the discovery of the fire and the start of fire-fighting (10 minutes or less in 70 to 80 per cent of the fires) was not related to the loss caused. There was no difference between the average losses in fires in which there was no fire-fighting before the arrival of the Brigade and fires in which fire-fighting took place before the Brigade arrived. There was a slightly longer interval between discovery of the fire and the arrival of the Brigade in the latter category of lerge fires than in the former, suggesting that the call to the Fire Brigade was a little delayed when fire-fighting was undertaken by the occupants of the premises.

Information on the numbers of buildings of different forms of construction in existence, and on the value of the contents at risk is lacking so the effect of the external construction of buildings on large fire loss could not be assessed. There was little information about internal construction in the Fire Brigade reports studied. It was found that there is probably a relation between the external construction of a building and the occupancy it contains, and that the average loss per large fire in industrial and commercial premises of load bearing construction with internal columns tends to be higher than that in similar premises without internal columns, but this difference was not apparent in other occupancies. The difference is presumably because buildings with internal columns are commonly those with large floor areas and may have contents of high total value.

There is some slight evidence that the loss is higher in large fires where the initial water supply was inadequate, but it is subject to the qualification that part of the comparison is based on a small number of fires. The initial water supply tends to be inadequate more often in rural districts than in urban, but there is not enough information to show whether there is any general tendency for the loss to be greater in large fires in rural districts.

Study of all attendances by Fire Brigades shows that about 200 fires a year are controlled or extinguished by sprinklers. The inference is that a proportion of these fires would have become large fires had there been no sprinklers. Where sprinklers are involved in large fires it is probable that some circumstances prevented the satisfactory operation of the sprinkler system, and it has been shown that better management of sprinkler systems in the widest sense is desirable.

Acknowledgments

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Table 2

THE FREQUENCY OF LARGE FIRES IN THE UNITED KINGDOM 1944-52
IN RELATION TO THE OCCUPANCY INVOLVED

Occupancy	Number of fires									Total
	1944	1945	1946	1947	1948	1949	1950	1951	1952	
Agricultural premises	-	-	1	1	1	-	3	1	4	11
Manufacturing industries										
Chemicals, dyes, explosives paints, oils, grease	5	5	7	12	8	12	13	20	15	97
Manufacture of metals, machines, implements, conveyances	19	21	14	19	22	23	29	27	35 (34)	209 (208)
Textiles and textile goods	25 (24)	23	22	12	17	22	24	27 (26)	20 (19)	192 (189)
Leather and fur preparation	2	-	1	3	4	4	3	3	5	25
Clothing manufacture	2	4	3	6	4	5	4	14	10	52
Food, drink, tobacco	7	10	13	11	12	12	15	11	11	102
Woodworking, furniture	10	10	9	3	11	13	16	9	24	105
Paper-making, printing	11	6	6	8	10	11	9	12	12	85
Rubber manufacture (including synthetic)	2	4	1	1	2	1	2	1	7	21
Other manufacturing industries	4	5	7	13	6	9	5	10	11 (10)	70 (69)
Total	87 (86)	88	83	88	96	112	120	134 (133)	150 (147)	958 (953)
Transport and communication	6	2	3	3	8	2	2	6 (5)	1	33 (32)
Commercial premises										
Retail shops, department stores	2	9	14	12	7	6	12	4	14	80
Warehouses	9	6	5 (4)	7	4	10 (9)	4	5	14	64 (62)
Wholesale dealers	8	14	6	8	11	14	10	12	11	94
Total	19	29	25 (24)	27	22	30 (29)	26	21	39	238 (236)
Professional establishments public institutions	1	10	7	9	12	14	7	7	15	81
Public entertainment	5	9	11	6	10	11	9	7	12	80
Houses and flats	8	2	5	11	12	14	4	3	9	68
Clubs, hotels, etc.	-	8	9	8	4	8	7	8	13	65
Laundries	-	3	1	3	3	3	4	3	-	20
Other buildings (including offices	4	8	7	7	3	3	7	4	2	46
Outdoor hazards	1	2	4	8	5	9 (8)	1	6	3	39 (38)
Total	131 (130)	161	156 (155)	171	176	206 (204)	190	200 (198)	248 (245)	1 639 (1 630)

Note. The figures in brackets show the numbers of fires when certain extremely large fires causing damage to the extent of £500 000 or more have been excluded.

Table 3

THE DIRECT MONETARY LOSS IN LARGE FIRES IN THE UNITED KINGDOM 1944-52
IN RELATION TO THE OCCUPANCY INVOLVED
AT THE PRICES CURRENT AT THE TIME OF THE OUTBREAK

Occupancy	Loss in units of £1 000								
	1944	1945	1946	1947	1948	1949	1950	1951	1952
Agricultural premises	-	-	10	10	100	-	32	10	70
Manufacturing industries									
Chemicals, dyes, explosives, paints oils, grease	164	251	150	440	411	451	286	1 161	428
Manufacture of metals, machines, implements, conveyances	858	662	478	794	1 116	981	1 430	1 805	2 397 (1 897)
Textiles and textile goods	1 711 (1 171)	706	697	970	804	1 135	1 771	1 978 (1 428)	1 788 (788)
Leather and fur preparation	52	-	15	165	160	216	210	160	219
Clothing manufacture	46	74	58	204	100	93	195	1 006	224
Food, drink, tobacco	198	433	443	491	750	1 017	497	549	450
Woodworking, furniture	146	234	156	58	292	369	327	447	895
Paper-making, printing	440	425	280	269	302	554	283	439	448
Rubber manufacture (including synthetic)	52	98	10	10	92	20	21	30	200
Other manufacturing industries	68	122	91	336	160	413	181	245	810 (310)
Total	3 735 (3 195)	3 005	2 378	3 737	4 187	5 249	5 201	7 820 (7 270)	7 859 (5 859)
Transport and communication	173	60	45	255	261	35	285	1 310 (310)	40
Commercial premises									
Retail shops, department stores	96	677	574	765	378	232	609	169	460
Warehouses	370	154	663 (163)	783	645	2 475 (475)	735	440	1 455
Wholesale dealers	213	631	116	427	438	541	251	449	214
Total	679	1 462	1 353 (853)	1 975	1 461	3 248 (1 248)	1 595	1 058	2 129
Professional establishments, public institutions	25	190	185	271	315	366	139	182	429
Public entertainment	99	336	319	148	376	295	275	178	425
Houses and flats	210	28	111	334	224	288	81	52	392
Clubs, hotels, etc.	-	236	166	179	98	201	283	259	335
Laundries	-	48	40	132	38	113	72	53	-
Other buildings (including offices)	115	321	271	315	78	93	340	109	30
Outdoor hazards	45	22	93	1 699	87	779	17	444	95
Total	5 081 (4 541)	5 708	4 971 (4 471)	9 055	7 225	10 667 (8 067)	8 320	11 475 (9 915)	11 804 (9 804)

Note. The figures in brackets show the total damage when certain extremely large fires, causing damage to the extent of £500 000 or more have been excluded.

Table 4

THE AVERAGE DIRECT MONETARY LOSS IN LARGE FIRES IN THE UNITED KINGDOM 1944-52 IN RELATION TO THE OCCUPANCY INVOLVED AT THE PRICES CURRENT AT THE TIME OF THE OUTBREAK

Occupancy	Average monetary loss per fire (£1 000s)								
	1944	1945	1946	1947	1948	1949	1950	1951	1952
Agricultural premises	-	-	10	10	100	-	11	10	18
Manufacturing industries									
Chemicals, dyes, explosives, paints, oils, grease	33	50	21	37	51	38	22	58	29
Manufacture of metals, machines, implements, conveyances	45	32	34	42	51	43	49	67	68 (56)
Textiles and textile goods	68 (49)	31	32	81	47	52	74	73 (55)	89 (41)
Leather and fur preparation	26	-	15	53	40	54	70	53	44
Clothing manufacture	23	19	19	34	25	19	49	72	22
Food, drink, tobacco	28	43	34	45	63	85	33	50	41
Woodworking, furniture	15	23	17	19	27	28	20	50	37
Paper-making, printing	40	71	47	34	30	50	31	38	37
Rubber manufacture (including synthetic)	26	25	10	10	46	20	11	30	29
Other manufacturing industries	17	24	13	26	27	46	36	25	74 (31)
Total	43 (37)	34	29	42	44	47	43	58 (55)	57 (40)
Transport and communications	29	30	15	85	33	18	143	218 (62)	40
Commercial premises									
Retail shops, department stores	48	75	41	64	54	39	51	42	33
Warehouses	41	26	133 (41)	112	161	248 (53)	184	88	104
Wholesale dealers	27	45	19	53	40	39	25	37	19
Total	36	50	54 (36)	73	66	108 (43)	61	50	55
Professional establishments, public institutions	25	19	26	30	26	26	20	26	29
Public entertainment	20	37	29	25	38	27	31	25	35
Houses and flats	26	14	22	30	19	21	20	17	44
Clubs, Hotels, etc.	-	30	18	22	24	25	40	32	26
Laundries	-	16	40	44	13	38	18	18	-
Other buildings (including offices)	29	40	39	45	26	31	49	27	15
Outdoor hazards	45	11	23	212	17	87	17	74	32
Total	39 (35)	35	32 (29)	53	41	52 (39)	44	57 (50)	47 (40)

Note. The figures in brackets show the average loss per fire when certain extremely large fires causing damage to the extent of £500 000 or more have been excluded.

Table 5

THE ESTIMATED FREQUENCY OF LARGE FIRES IN THE UNITED KINGDOM 1949-52
IN RELATION TO THE OCCUPANCY INVOLVED
EXCLUDING FIRES WHICH COST LESS THAN £10 000 AT 1949 PRICES

Occupancy	Number of fires			
	1949	1950	1951	1952
Manufacturing industries				
Chemicals, dyes, explosives, paints, oils, grease	12	9	18	10
Manufacture of metals, machines, implements, conveyances	23	26	24	25 (24)
Textiles and textile goods	22	24	24 (23)	17 (16)
Leather and fur preparation	4	3	3	5
Clothing manufacture	5	4	11	7
Food, drink, tobacco	12	14	9	10
Woodworking, furniture	13	14	7	19
Paper-making, printing	11	7	10	9
Rubber manufacture (including synthetic)	1	1	1	5
Other manufacturing industries	9	5	5	9 (8)
Total	112	107	112 (111)	116 (113)
Transport and communication	2	2	4 (3)	1
Commercial premises				
Retail shops, department stores	6	10	4	7
Warehouses	10 (9)	4	5	14
Wholesale dealers	14	10	10	8
Total	30 (29)	24	19	29
Professional establishments, public institutions	14	7	6	11
Public entertainment	11	9	7	9
Houses and flats	14	4	3	8
Clubs, hotels, etc.	8	7	8	11
Laundries	3	4	2	1
Other buildings (including offices)	3	7	4	1
Total (excluding agricultural premises and outdoor hazards)	197 (196)	171	165 (163)	186 (183)

Note. The figures in brackets show the frequencies when certain extremely large fires causing damage to the extent of £500 000 or more have been excluded.

Table 6

THE ESTIMATED DIRECT MONETARY LOSS IN LARGE FIRES IN THE UNITED KINGDOM 1949-52 AT 1949 PRICES, IN RELATION TO THE OCCUPANCY INVOLVED EXCLUDING FIRES WHICH COST LESS THAN £10 000 AT 1949 PRICES

Occupancy	Loss in units of £1 000			
	1949	1950	1951	1952
Manufacturing industries				
Chemicals, dyes, explosives, paints, oils, grease	451	226	878	277
Manufacture of metals, machines, implements, conveyances	981	1 287	1 366	1 685 (1 313)
Textiles and textile goods	1 135	1 628	1 500 (1 076)	1 305 (562)
Leather and fur preparation	216	193	123	163
Clothing manufacture	93	179	750	140
Food, drink, tobacco	1 017	448	406	326
Woodworking, furniture	369	282	327	626
Paper-making, printing	554	242	321	308
Rubber manufacture (including synthetic)	20	10	23	132
Other manufacturing industries	413	166	147	578 (206)
Total	5 249	4 661	5 841 (5 417)	5 540 (4 054)
Transport and communications	35	274	1 137 (273)	32
Commercial premises				
Retail shops, department stores	232	527	126	273
Warehouses	2 475 (475)	658	335	1 035
Wholesale dealers	541	225	318	126
Total	3 248 (1 248)	1 410	779	1 434
Professional establishments, public institutions	366	136	147	306
Public entertainment	295	269	152	304
Houses and flats	288	79	44	297
Clubs, hotels, etc.	201	276	219	242
Laundries	113	70	37	-
Other buildings (including offices)	93	332	92	15
Total (excluding agricultural premises and outdoor hazards)	9 888 (7 888)	7 507	8 448 (7 160)	8 170 (6 684)

Note. The figures in brackets show the total damage when certain extremely large fires causing damage to the extent of £500 000 or more (at current prices) have been excluded.

Table 7

THE AVERAGE DIRECT MONETARY LOSS PER LARGE FIRE IN THE UNITED KINGDOM 1949-52, AT 1949 PRICES, IN RELATION TO THE OCCUPANCY INVOLVED EXCLUDING FIRES WHICH COST LESS THAN £10 000 AT 1949 PRICES

Occupancy	Loss per fire in units of £1 000			
	1949	1950	1951	1952
Manufacturing industries				
Chemicals, dyes, explosives, paints, oils grease	38	25	48	28
Manufacture of metals, machines, implements, conveyances	43	50	57	67 (55)
Textiles and textile goods	52	68	62 (47)	77 (35)
Leather and fur preparation	54	64	41	33
Clothing manufacture	19	45	69	20
Food, drink, tobacco	85	32	45	33
Woodworking, furniture	28	20	47	33
Paper-making, printing	50	35	32	34
Rubber manufacture (including synthetic)	20	10	23	26
Other manufacturing industries	46	33	29	64 (26)
Total	47	43	52 (50)	48 (36)
Transport and communications	18	138	284 (91)	32
Commercial premises				
Retail shops, department stores	39	53	31	39
Warehouses	243 (53)	165	67	74
Wholesale dealers	39	22	32	16
Total	108 (43)	59	41	50
Professional establishments, public institutions	26	20	25	28
Public entertainment	27	30	14	34
Houses and flats	21	20	14	37
Clubs, hotels, etc.	25	39	27	22
Laundries	38	18	19	-
Other buildings (including offices)	31	48	23	15
Total (excluding agricultural premises and outdoor hazards)	52 (40)	43	51 (45)	44 (37)

Note. The figures in brackets show the average damage when certain extremely large fires causing damage to the extent of £500 000 or more (at current prices) have been excluded.

Table 8

PROPORTIONS OF LARGE FIRES TO ALL ATTENDANCES BY FIRE BRIGADES AT FIRES IN INDUSTRIAL PREMISES
(FIRES COSTING LESS THAN £10 000 AT 1949 PRICE LEVELS NOT COUNTED AS LARGE FIRES)

Occupancy	Year							
	1949		1950		1951		1952	
	No. of large fires	Percentage of all attendances	No. of large fires	Percentage of all attendances	No. of large fires	Percentage of all attendances	No. of large fires	Percentage of all attendances
Chemicals, dyes, explosives paints, oils, grease	12	3.2	9	2.4	18	4.3	10	2.4
Manufacture of metals, machines implements, conveyances	23	1.4	26	1.7	24	1.5	25	1.3
Textiles and textile goods	22	4.3	24	4.2	24	3.3	17	2.8
Leather and fur preparation	4	5.9	3	4.5	3	4.8	5	4.2
Clothing manufacture	5	1.5	4	1.3	11	3.7	7	2.2
Food, drink, tobacco	12	1.9	14	2.4	9	1.5	10	1.7
Woodworking, furniture	13	2.2	14	2.1	7	1.3	19	3.3
Paper-making, printing	11	4.4	7	3.0	10	4.2	9	3.5
Other manufacturing industries+	10	1.6	6	1.1	6	1.1	14	2.8

+ Excluding building and contracting in which there were no large fires.

Table 9

LARGE FIRE LOSSES AND ECONOMIC DATA RELATING TO CERTAIN INDUSTRIES IN THE UNITED KINGDOM+

Industry	Year	Average "large fire" loss per larger establishment	Average "large fire" loss per 1 000 employed in larger establishments	Average loss per large fire	Net output per person employed in larger establishments	Stocks of finished goods and work in progress per person employed in larger establishments	Stocks of materials and fuel per person employed in larger establishments	Total stocks per person employed in larger establishments	Total stocks per larger establishment
		(1) £	(2) £	(3) £000	(4) £	(5) £	(6) £	(7) £	(8) £000
Chemicals, dyes, explosives, paints, oils, grease	1948+	180	120	51	770	140	220	360	52
	1949	190	130	38	750	160	240	400	59
	1950x	140	90	22	860	170	220	390	61
Manufacture of metals, machines, implements, conveyances	1948+	60	30	51	530	160	110	270	47
	1949	50	30	43	550	190	120	310	54
	1950x	70	40	49	570	190	120	310	55
Textile and textile goods	1948+	120	100	47	520	100	160	260	33
	1949	160	120	52	520	130	170	300	39
	1950x	240	180	74	600	140	170	310	42
Leather and fur preparation	1948+	150	280	40	740	180	230	410	23
	1949	210	370	54	650	260	220	480	27
	1950x	200	350	70	740	260	230	490	29
Clothing manufacture	1948+	15	20	25	400	50	100	150	10
	1949	10	20	19	390	60	120	170	13
	1950x	30	40	49	400	60	140	200	16
Food, drink, tobacco	1948+	100	130	63	750	200	190	390	31
	1949	130	160	85	730	220	200	420	34
	1950x	120	120	35	820	250	260	510	52
Woodworking, furniture	1948+	70	130	27	510	60	130	190	10
	1949	90	160	28	490	70	140	200	11
	1950x	70	130	20	510	70	140	210	12
Paper-making, printing	1948+	70	70	30	630	60	100	160	15
	1949	130	130	50	610	70	110	180	17
	1950x	60	60	31	680	70	100	170	17

Source of economic data - Censuses of Production - Summary tables for 1948, 1949 and 1950

Note: The term "larger establishment" means an establishment employing more than ten people.

+ The figures for 1948 are for Great Britain only

x The census of Production data for 1950 is not comparable with the other years since certain manufacturers with major retailing or wholesaling activities have been excluded. The only industry in which this difference is important is the manufacture of food, drink, tobacco. The Census data is concerned with about 55 per cent of the establishments in the industry in 1950, while all large fires have been included in this year. The figures in columns (1) and (2) are therefore biassed upwards.

Table 10

SUPPOSED CAUSES OF LARGE FIRES

Supposed cause	1948	1949	1950	1951	1952	Total 1948-1952
Ashes, soot	1	2	2	-	1	6
Candle	1	1	-	-	1	3
Chimney on fire, not confined to chimney	1	-	1	-	-	2
Chimney, sparks from (outside building)	1	1	1	-	3	6
Doubtful+	-	4	1	2	2	9
Electric motor	1	4	2	2	-	9
refrigerator	-	1	-	1	1	3
iron	-	1	1	4	2	8
wire and cable, other than lead to apparatus	6	6	8	9	5	34
wire and cable, lead to apparatus	1	1	1	1	1	5
other apparatus	6	3	8	4	11	32
Explosives, fireworks	-	-	2	-	-	2
Fire in grate	1	-	4	2	3	10
Fish frying range (all fuels)	2	1	-	-	-	3
Flue	6	2	4	1	7	20
Furnace (coal or coke)	1	-	-	2	2	5
Gas (coal) burner, jet, ring	1	-	2	1	5	9
fire, heater, radiator	1	-	1	-	1	3
other	1	1	3	1	2	8
Incendiarism	-	4	-	-	1	5
Lightning	-	-	1	-	-	1
Locomotives, sparks from	1	2	-	1	-	4
Matches	1	-	2	-	1	4
Mechanical heat or sparks	5	12	7	15	6	45
Metal, hot	-	-	-	2	-	2
Oil, blowlamp	4	2	5	1	4	16
engine	2	-	1	1	-	4
lamp, stove	-	-	-	1	-	1
other apparatus	1	-	1	2	1	5
Oxyacetylene cutting and welding apparatus	2	1	1	3	5	12
Rubbish burning	-	1	3	1	-	5
Slow combustion stove	3	2	-	3	6	14
Smoking materials	9	8	13	11	25	66
Spontaneous combustion	3	1	4	4	3	15
Static electricity	1	1	-	1	-	3
Taper, lighted paper or sticks	1	1	2	-	1	5
Miscellaneous	12	16	12	7	14	61
Unknown	100	127	92	117	134	570
Total	176	206	185	200	248	1 015

+ Suspected arson or incendiarism but no person was charged.

Table 11

THE FUEL ASSOCIATED WITH THE SOURCE OF IGNITION IN LARGE FIRES OF KNOWN CAUSE COMPARED WITH OTHER FIRES ATTENDED BY FIRE BRIGADES

Fuel of apparatus causing ignition	1948		1949		1950		1951		1952		TOTAL
	Large fires	All fires except houses and flats	Large fires	All fires except houses and flats	Large fires	All fires except houses and flats	Large fires	All fires except houses and flats	Large fires	All fires except houses and flats	Large fires
Coal or coke	8 (10.8)	3 800 (20.8)	6 (7.9)	...	6 (6.5)	4 000 (20.1)	8 (9.6)	...	21 (18.4)	4 400 (21.4)	49 (11.2)
Electricity	16 (21.6)	3 100 (16.9)	17 (22.4)	...	21 (22.8)	3 600 (18.1)	21 (25.3)	...	20 (17.5)	3 800 (18.4)	97 (22.1)
Coal gas	3 (4.1)	900 (4.9)	1 (1.3)	...	6 (6.5)	1 100 (5.5)	2 (2.4)	...	8 (7.0)	1 100 (5.3)	19 (4.3)
Oil	7 (9.5)	1 100 (6.0)	2 (2.6)	...	7 (7.6)	1 200 (6.0)	5 (6.0)	...	5 (4.4)	1 200 (5.8)	26 (5.9)
Other fuels and undefined causes where no fuel is applicable	40 (50.4)	9 400 (51.4)	50 (65.8)	...	52 (56.6)	10 000 (50.3)	47 (56.6)	...	60 (52.6)	10 100 (49.0)	248 (56.5)
Total fires of known cause	74 (100.0)	18 300 (100.0)	76 (100.0)	...	92 (100.0)	19 900 (100.0)	83 (100.0)	...	114 (100.0)	20 600 (100.0)	439 (100.0)

Note. The figures in brackets are percentages of the total number of fires in each year.

Table 12

OCCUPANCY IN RELATION TO THE TIME OF DISCOVERY OF LARGE FIRES

Time	Average number per year						
	Agriculture and industry	Public utilities and transport	Commerce and offices	Professional establishments, public institutions, entertainment, private houses and flats	Clubs, hotels, laundries, other buildings	Outdoor hazards	Total fires in which time of discovery is known
12.30 a.m.-	7.0	0.8	1.2	2.4	1.2	-	12.6
1.30 a.m.-	6.8	-	1.4	3.2	1.6	0.2	13.2
2.30 a.m.-	5.6	0.2	1.0	2.4	1.2	-	10.4
3.30 a.m.-	7.2	0.4	2.2	2.4	0.8	-	13.0
4.30 a.m.-	3.8	-	0.6	0.8	0.4	-	5.6
5.30 a.m.-	5.2	0.2	1.8	1.8	0.4	-	9.4
6.30 a.m.-	3.6	-	1.2	0.8	0.8	-	6.4
7.30 a.m.-	3.6	-	0.6	-	0.4	-	4.6
8.30 a.m.-	1.0	-	-	0.2	0.4	-	1.6
9.30 a.m.-	4.6	0.2	0.6	0.4	-	0.2	6.0
10.30 a.m.-	2.6	0.2	1.0	0.4	0.4	-	4.6
11.30 a.m.-	4.0	0.2	0.8	0.8	0.2	0.6	6.6
12.30 p.m.-	4.8	-	0.8	2.2	-	0.6	8.4
1.30 p.m.-	5.0	0.2	0.6	1.2	0.2	0.6	7.8
2.30 p.m.-	4.0	0.2	1.2	1.2	0.4	0.2	7.2
3.30 p.m.-	3.0	-	0.8	1.2	-	0.2	5.2
4.30 p.m.-	6.2	-	1.6	0.8	1.0	0.6	10.2
5.30 p.m.-	8.6	0.4	2.8	1.4	-	0.2	13.4
6.30 p.m.-	7.0	0.2	1.0	0.4	0.2	-	8.8
7.30 p.m.-	7.0	0.4	1.8	0.4	0.6	0.2	10.4
8.30 p.m.-	5.6	0.4	1.4	0.4	0.4	0.2	8.4
9.30 p.m.-	6.4	0.2	0.6	0.6	0.6	0.2	8.6
10.30 p.m.-	5.0	0.4	1.6	1.8	0.8	-	9.6
11.30 p.m.-	4.4	0.2	1.4	1.8	0.6	0.6	9.0
Total	122.0	4.8	28.0	29.0	12.6	4.6	201.0

Table 13

TIME OF DAY OF DISCOVERY OF LARGE FIRES IN RELATION TO LOCATION OF PERSON MAKING THE DISCOVERY

Time of day	Year	Description of person discovering fire					Total
		People connected with premises either inside or outside building of origin (1)	Proportion of total in period	People in neighbouring premises or passers-by or policeman (2)	Proportion of total in period	Description not given or not known (3)	
		No.	%	No.	%	No.	No.
1. 12.30 a.m. - 6.29 a.m.	1948	22	43	29	57	-	51
	1950	27	43	36	57	-	63
	1952	28	36	49	64	-	77
2. 6.30 a.m. - 12.29 p.m.	1948	18	75	6	25	-	24
	1950	18	60	12	40	-	30
	1952	28	82	6	18	-	34
3. 12.30 p.m. - 6.29 p.m.	1948	33	59	23	41	-	56
	1950	28	70	12	30	-	40
	1952	41	63	24	37	-	65
4. 6.30 p.m. - 12.29 a.m.	1948	21	48	22	52	-	43
	1950	20	38	32	62	-	52
	1952	23	37	40	63	-	63
Time unknown	1948	-		-		2	2
	1950	-		-		5	5
	1952	-		-		9	9
Total	1948	94	53	80	45	2	176
	1950	93	49	92	48	5	190
	1952	120	48	119	48	9	248

Table 14

THE TIME OF DAY OF DISCOVERY OF LARGE FIRES IN RELATION TO THE LOSS CAUSED

Year	Time of day							
	12.30 a.m.- 3.29 a.m.	3.30 a.m.- 6.29 a.m.	6.30 a.m.- 9.29 a.m.	9.30 a.m.- 12.29 p.m.	12.30 p.m.- 3.29 p.m.	3.30 p.m.- 6.29 p.m.	6.30 p.m.- 9.29 p.m.	9.30 p.m.- 12.29 a.m.
	Average loss per fire (£ 000s)							
(a) Losses between £10 000 and £99 000								
1948	28.6 (31)	30.8 (20)	28.1 (9)	29.1 (12)	25.1 (21)	22.2 (27)	37.1 (22)	27.1 (15)
1949	29.0 (32)	27.6 (22)	19.7 (12)	23.3 (16)	24.4 (21)	30.4 (24)	29.1 (28)	30.6 (30)
1950	26.7 (31)	30.0 (24)	34.0 (14)	23.1 (13)	26.1 (10)	26.6 (25)	25.2 (23)	30.8 (23)
1951	27.3 (26)	28.6 (31)	30.8 (12)	27.1 (8)	23.8 (25)	35.2 (21)	33.1 (20)	31.5 (29)
1952	27.9 (42)	30.9 (27)	26.8 (11)	29.6 (22)	29.5 (27)	28.2 (35)	22.2 (30)	33.4 (28)
(b) Losses between £10 000 and £199 000								
1948	28.6 (31)	30.8 (20)	28.1 (9)	39.6 (14)	44.3 (26)	33.5 (30)	46.1 (24)	42.3 (18)
1949	32.6 (33)	35.1 (24)	40.4 (15)	43.1 (19)	35.1 (24)	39.2 (26)	29.1 (28)	30.6 (30)
1950	39.1 (35)	35.9 (26)	43.7 (15)	29.6 (14)	51.6 (12)	29.4 (26)	42.1 (28)	33.7 (24)
1951	33.4 (28)	38.4 (34)	38.1 (13)	48.8 (11)	23.8 (25)	35.2 (21)	50.5 (24)	36.7 (31)
1952	38.3 (47)	39.8 (30)	26.8 (11)	35.7 (23)	32.5 (28)	30.9 (36)	22.2 (30)	37.2 (29)
(c) All fires (losses greater than £10 000)								
1948	28.6 (31)	30.8 (20)	28.1 (9)	59.9 (15)	44.3 (26)	38.9 (31)	58.2 (25)	42.3 (18)
1949	48.2 (35)	35.1 (24)	40.4 (15)	140.9 (20)	35.1 (24)	39.2 (26)	62.8 (30)	30.6 (30)
1950	51.9 (37)	35.9 (26)	43.7 (15)	44.3 (15)	51.6 (12)	48.7 (28)	42.1 (28)	33.7 (24)
1951	61.8 (31)	76.5 (39)	38.1 (13)	71.8 (12)	36.4 (26)	45.0 (22)	88.4 (25)	36.7 (31)
1952	38.3 (47)	54.7 (31)	26.8 (11)	75.9 (24)	43.4 (29)	36.8 (37)	37.6 (31)	69.5 (32)

Note. The figures in brackets are the numbers of fires.

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Table 15

OCCUPANCY IN RELATION TO DAY OF WEEK OF OCCURRENCE OF LARGE FIRES

Occupancy	Year	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Total
Agriculture and industry	1948	6	17	13	14	15	12	19	96
	1949	7	16	22	15	13	24	14	111
	1950	10	23	13	24	17	19	14	120
	1951	12	14	17	17	34	18	22	134
	1952	16	20	26	25	26	19	17	149
Public utilities and transport	1948	3	4	-	2	-	-	-	9
	1949	-	1	1	-	-	1	-	3
	1950	-	-	1	-	-	-	2	3
	1951	1	-	-	-	1	5	1	8
	1952	-	-	-	-	-	-	1	1
Commercial premises including offices	1948	3	6	4	-	4	2	3	22
	1949	2	2	5	9	3	5	4	30
	1950	3	2	4	4	5	4	4	26
	1951	-	2	6	3	4	3	4	22
	1952	4	8	10	4	5	6	3	40
Professional establishments, public institutions, entertainment, private residences	1948	-	9	3	11	5	3	3	34
	1949	9	7	5	3	7	3	5	39
	1950	4	4	3	-	2	5	2	20
	1951	2	5	2	3	1	1	3	17
	1952	5	3	6	7	4	9	1	35
Clubs, hotels, laundries, other buildings	1948	-	2	-	2	3	-	2	9
	1949	2	1	1	2	5	1	1	13
	1950	2	4	3	-	2	3	1	15
	1951	1	1	2	1	4	2	1	12
	1952	3	1	2	3	3	-	2	14
Outdoor occupancies	1948	-	-	2	-	2	-	1	5
	1949	1	1	2	2	2	-	-	8
	1950	-	-	1	-	-	-	-	1
	1951	1	-	1	1	1	1	1	6
	1952	-	2	-	-	-	-	1	3
All occupancies for which day of outbreak is known	1948	12	38	22	29	29	17	28	175
	1949	21	28	36	31	30	34	24	204
	1950	19	33	25	28	26	31	23	185
	1951	17	22	28	25	45	30	32	199
	1952	28	34	44	39	38	34	25	242
Average yearly incidence in all occupancies		19.4	31.0	31.0	30.4	33.6	29.2	26.4	201.0

Table 16

OCCUPANCY IN RELATION TO MONTH OF OCCURRENCE OF LARGE FIRES

Month	Average number per year						
	Agriculture and industry	Public utilities and transport	Commerce and offices	Professional establishments, public instit-utions, enter-tainment, private houses and flats	Clubs, hotels, laundries, other buildings	Outdoor occupancies	Total
January	11.2	-	3.6	2.8	1.8	-	19.4
February	10.4	0.6	2.0	2.8	1.6	0.2	17.6
March	10.6	0.4	2.0	2.4	1.0	0.4	16.8
April	8.4	0.6	1.8	2.4	0.4	0.4	14.0
May	13.8	0.2	3.4	2.0	0.8	0.8	21.0
June	11.0	0.2	2.0	3.2	0.8	0.6	17.8
July	9.6	0.6	1.6	2.2	1.6	0.2	15.8
August	7.8	0.6	2.2	2.2	0.4	0.6	13.8
September	7.6	0.4	2.2	2.2	0.6	1.0	14.0
October	9.8	0.4	1.6	3.2	1.4	0.4	16.8
November	10.8	0.6	3.0	1.8	1.4	-	17.6
December	13.4	0.2	3.0	1.8	0.8	0.2	19.4
Total	124.4	4.8	28.4	29.0	12.6	4.8	204.0

Table 17

OCCUPANCY IN RELATION TO THE NATURE OF MATERIAL DAMAGE IN LARGE FIRES

Type of occupancy and damage	1948	1949	1950	1951	1952
Industrial premises (including agricultural)					
Main loss due to (a) structural damage	-	2	-	1	1
(b) damage to machinery	1	-	-	4	-
(c) materials used in manufacture	1	-	1	1	2
(d) materials in process of manufacture	2	2	1	1	3
(e) stocks of completed goods	2	3	-	1	5
(f) other contents, not machinery	1	4	-	-	1
(g) contents and machinery	4	3	5	9	5
(h) structure and machinery	2	1	1	5	1
(i) structure and contents	23	23	41	28	41
(j) structure, machinery and contents	60	71	70	81	90
(k) not stated	1	3	4	4	5
Total	97	112	123	135	154
Gas, water, electricity, sewage, transport and communication					
Main loss due to (a) structural damage	-	-	-	-	-
(b) damage to contents	3	1	-	-	-
(c) structure and contents	6	2	3	7	1
(d) not stated	-	-	-	1	-
Total	9	3	3	8	1
Commercial premises					
Main loss due to (a) structural damage	-	1	1	-	-
(b) damage to contents	-	4	1	-	2
(c) structure and contents	22	24	22	17	36
(d) not stated	-	1	2	4	1
Total	22	30	26	21	39
Professional establishments, public institutions, entertainment and residential houses and flats					
Main loss due to (a) structural damage	7	5	3	-	3
(b) damage to contents	-	1	-	-	1
(c) structure and contents	27	33	17	17	32
(d) not stated	-	-	-	-	-
Total	34	39	20	17	36
Clubs, hotels, personal service and other buildings					
Main loss due to (a) structural damage	-	3	1	-	-
(b) damage to contents	-	-	-	-	-
(c) structure and contents	9	10	16	13	15
(d) not stated	-	-	-	-	-
Total	9	13	17	13	15
Outdoor hazards					
Main loss due to (a) damage to structure and equipment of occupancy	-	8	-	1	-
(b) materials contained in occupancy	4	-	1	4	3
(c) structure, equipment and materials	1	-	-	1	-
(d) not stated	-	1	-	-	-
Total	5	9	1	6	3
Total fires	176	206	190	200	248

Table 18

THE FREQUENCY OF LARGE FIRES IN RELATION TO THE TYPE OF BUILDING CONSTRUCTION OF THE OCCUPANCY

Occupancy	Year	Type of building construction: Timber framed walls with or without internal columns – No. of fires	Timber framed walls – Average loss per fire £000	Load bearing walls without internal columns – No. of fires	Load bearing walls without internal columns – Average loss per fire £000	Load bearing walls with internal columns – No. of fires	Load bearing walls with internal columns – Average loss per fire £000	Framed unloaded walls with or without internal columns – No. of fires	Framed unloaded walls – Average loss per fire £000	Mixed construction – No. of fires	Mixed construction – Average loss per fire £000	Construction not reported – No. of fires	Total fires in buildings – No. of fires
(a) Fires in which the loss ranged between £10 000 and £199 000													
Agriculture and industry	1948	6	23.2	23	25.6	50	55.2	10	20.1	6	43.2	1	96
	1950	13	28.8	28	24.3	41	46.6	15	46.9	19	41.1	5	121
	1952	8	23.3	56	23.5	43	42.3	23	36.2	11	50.5	7	148
Public utilities, transport	1948	2	15.0	2	37.0	3	35.7	-	-	1	50.0	1	9
	1950	1	35.0	1	30.0	-	-	-	-	-	-	-	2
	1952	-	-	-	-	1	40.0	-	-	-	-	-	1
Commerce and offices	1948	1	158.0	6	42.8	8	41.9	1	15.0	2	58.0	2	20
	1950	-	-	12	18.9	7	40.1	4	108.3	1	180.0	2	26
	1952	2	43.5	16	22.3	15	53.7	4	46.3	-	-	2	39
Professional establishments, public institutions, entertainment, private residences	1948	2	34.0	22	24.5	5	20.4	5	40.0	-	-	-	34
	1950	1	12.0	10	21.0	5	25.8	2	35.0	1	14.0	1	20
	1952	1	18.0	24	36.2	8	27.5	1	75.0	1	50.0	1	36
Hotels, clubs, other personal services, laundries	1948	-	-	4	12.8	3	27.0	1	15.0	1	52.0	-	9
	1950	1	37.0	8	39.1	4	21.5	1	12.0	1	11.0	-	15
	1952	-	-	12	28.2	-	-	-	-	-	-	1	13
All buildings	1948	11		57		69		17		10		4	168
	1950	16		59		57		22		22		8	184
	1952	11		108		67		28		12		11	237
(b) All fires in which the loss exceeds £10 000													
Agriculture and industry	1948	6	23.2	23	25.6	51	60.0	10	20.1	6	43.2	1	97
	1950	13	28.8	28	24.9	43	58.4	15	46.9	19	41.1	5	123
	1952	9	76.2	56	23.5	46	79.7	24	53.4	12	67.1	7	154
Public utilities, transport	1948	2	15.0	2	37.0	3	35.7	-	-	1	50.0	1	9
	1950	1	35.0	1	30.0	1	250.0	-	-	-	-	-	3
	1952	-	-	-	-	1	40.0	-	-	-	-	-	1
Commerce and offices	1948	1	158.0	6	42.8	9	59.4	1	15.0	2	58.0	3	22
	1950	-	-	12	18.9	9	92.3	4	108.3	1	180.0	2	28
	1952	2	43.5	16	22.3	16	78.4	4	46.3	-	-	3	41
Professional establishments, public institutions, entertainment, private residences	1948	2	34.0	22	24.5	5	20.4	5	40.0	-	-	-	34
	1950	1	12.0	10	21.0	5	25.8	2	35.0	1	14.0	1	20
	1952	1	18.0	24	36.2	8	27.5	1	75.0	1	50.0	1	36
Hotels, clubs, other personal services laundries	1948	-	-	4	12.8	3	27.0	1	15.0	1	52.0	-	9
	1950	1	37.0	8	39.1	4	21.5	1	12.0	1	11.0	-	15
	1952	-	-	12	28.2	-	-	-	-	-	-	1	13
All buildings	1948	11		57		71		17		10		5	171
	1950	16		59		62		22		22		8	189
	1952	12		108		71		29		13		12	245

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Table 19

THE INCIDENCE OF LARGE FIRES IN RELATION TO THE NUMBER OF STOREYS OF THE BUILDING OF ORIGIN

Occupancy	Year	Number of storeys of building								Number of storeys not known	Total fires in buildings
		Single storey	Partly single and partly multi-storey	Two storeys	Three storeys	Four storeys	Five storeys	Six or more storeys	Multi-storeyed with a varying number of floors		
Agriculture and industry	1948	25	15	16	9	10	7	5	9	1	97
	1950	36	26	17	14	6	7	4	8	5	123
	1952	55	31	16	18	12	3	5	7	7	154
Public utilities, transport	1948	4	-	3	1	-	-	-	-	1	9
	1950	2	1	-	-	-	-	-	-	-	3
	1952	1	-	-	-	-	-	-	-	-	1
Commerce and offices	1948	5	4	-	5	3	3	1	-	1	22
	1950	4	2	3	6	7	4	-	-	2	28
	1952	3	6	9	3	9	3	4	3	1	41
Professional establishments, public institutions, entertainment, private residences	1948	10	4	6	5	-	-	-	7	2	34
	1950	8	3	3	5	-	-	-	1	-	20
	1952	6	12	5	6	1	-	-	5	1	36
Hotels, clubs, other personal service, laundries	1948	3	1	2	2	-	-	-	1	-	9
	1950	4	-	3	3	2	-	1	1	1	15
	1952	-	1	4	4	1	-	-	2	1	13
All buildings	1948	47	24	27	22	13	10	6	17	5	171
	1950	54	32	26	28	15	11	5	10	8	189
	1952	65	50	34	31	23	6	9	17	10	245

Table 20

THE FREQUENCY OF LARGE FIRES AND AVERAGE LOSS PER FIRE IN RELATION TO THE TYPE OF BUILDING CONSTRUCTION

Range of loss per fire		Type of building construction												Total fires in buildings
		Timber framed walls with or without internal columns		Load bearing walls without internal columns		Load bearing walls with internal columns		Framed unloaded walls with or without internal columns		Mixed construction		Construction not reported		
	Year	No. of fires	Average loss per fire	No. of fires	Average loss per fire	No. of fires	Average loss per fire	No. of fires	Average loss per fire	No. of fires	Average loss per fire	No. of fires		No. of fires
£10 000 -£99 000	1948	10	23.7	56	24.6	56	32.1	17	25.4	10	47.7	4		153
	1950	16	28.7	57	21.2	49	28.5	18	38.0	19	31.9	7		166
	1952	11	26.5	105	24.3	61	33.3	27	34.1	10	40.0	11		225
£10 000 -£199 000	1948	11	35.9	57	26.6	69	49.0	17	25.4	10	47.7	4		168
	1950	16	28.7	59	25.2	57	42.2	22	55.4	22	44.8	8		184
	1952	11	26.5	108	26.5	67	43.0	28	39.0	12	50.5	11		237
All fires £10 000 upwards	1948	11	35.9	57	26.6	71	54.7	17	25.4	10	47.7	5		171
	1950	16	28.7	59	25.2	62	61.4	22	55.4	22	44.8	8		189
	1952	12	65.9	108	26.5	71	73.0	29	53.2	13	65.8	12		245

Table 21

AVERAGE LOSS PER LARGE FIRE IN RELATION TO THE NUMBER OF STOREYS OF THE BUILDING CONCERNED

Range of loss		Number of storeys																			Total fires in buildings
		1 storey		Partly single, partly multi-storey		2 storeys		3 storeys		4 storeys		5 storeys		6 or more storeys		Multi-storey with a varying no. of floors		Not stated or not known			
		No. of fires	Average loss per fire	No. of fires	Average loss per fire	No. of fires	Average loss per fire	No. of fires	Average loss per fire	No. of fires	Average loss per fire	No. of fires	Average loss per fire	No. of fires	Average loss per fire	No. of fires	Average loss per fire	No. of fires			No. of fires
			£000		£000		£000		£000		£000		£000		£000		£000				
£10 000 -	1948	43	24.9	22	35.4	26	24.9	21	30.0	12	37.0	4	27.5	5	27.4	15	31.1	5			153
£99 000	1950	49	28.1	27	31.2	25	23.7	25	24.6	12	25.3	10	33.3	3	30.7	8	25.1	3			162
	1952	60	28.4	43	30.7	33	23.4	31	26.2	20	35.6	6	24.0	5	50.2	17	26.8	10			225
£10 000 -	1948	46	31.8	24	46.7	27	29.7	22	33.2	13	41.8	9	73.7	6	39.5	16	37.7	5			168
£199 000	1950	53	37.0	30	38.1	25	23.7	28	33.0	14	42.8	11	46.6	5	76.0	10	45.1	3			179
	1952	63	34.9	47	37.1	33	23.4	31	26.2	22	41.7	6	24.0	8	83.3	17	26.8	10			237
All fires	1948	47	38.6	24	46.7	27	29.7	22	33.2	13	41.8	10	86.3	6	39.5	17	53.1	5			171
(£10 000	1950	54	41.9	32	54.4	26	32.4	28	33.0	15	56.6	11	46.6	5	76.0	10	45.1	8			189
and over)	1952	65	46.9	50	53.9	34	37.4	31	26.2	23	59.4	6	24.0	9	185.1	17	26.8	10			245

Table 22

THE POINT OF ORIGIN OF LARGE FIRES IN RELATION TO THE AVERAGE LOSS PER FIRE

Where fire started	1948		1949		1950		1951		1952	
	No. of fires	Average loss	No. of fires	Average loss	No. of fires	Average loss	No. of fires	Average loss	No. of fires	Average loss
		£000		£000		£000		£000		£000
Industrial premises (including agricultural)										
Processing departments	21	33.0	21	51.7	29	40.4	36	70.6	36	61.9
Stores, warehouses	25	45.0	19	28.9	19	40.1	23	51.5	37	35.2
Canteens, kitchens, rest rooms, messengers lobbies, libraries, offices, laboratories	5	33.2	4	33.3	5	59.6	3	14.7	10	71.2
Boiler houses, engine rooms, generator houses, garages, stables, switchboard rooms	5	42.0	9	33.7	6	40.5	6	32.7	6	28.0
Roof space	-	-	3	14.0	-	-	2	25.0	3	23.7
Miscellaneous and unknown	41	51.1	57	55.5	64	43.3	65	59.8	62	55.8
Total	97	44.2	113	46.7	123	42.6	135	58.6	154	51.6
Commercial premises										
Stores, warehouses	8	85.0	8	47.5	7	104.7	4	35.3	16	54.9
Canteens, kitchens, rest rooms, messengers lobbies, libraries, offices, laboratories	-	-	1	10.0	-	-	-	-	4	37.3
Boiler rooms, generator houses, garages, stables, switchboard rooms	-	-	-	-	-	-	-	-	1	50.0
Roof space	-	-	-	-	-	-	-	-	-	-
Miscellaneous and unknown	14	55.8	21	136.1	19	45.4	17	37.2	18	58.4
Total	22	66.4	30	108.3	26	61.3	21	36.9	39	54.6
Entertainment and transport										
Offices	1	20.0	-	-	1	14.0	-	-	2	34.0
Garages	2	30.0	-	-	1	35.0	-	-	2	27.5
Roof	2	20.0	1	85.0	-	-	-	-	2	66.0
Miscellaneous and unknown	13	39.8	12	20.4	9	56.8	13	114.5	7	30.0
Total	18	35.4	13	25.4	11	50.9	13	114.5	13	35.8
Other buildings (including offices)										
Canteens, kitchens, rest rooms, messengers lobbies, libraries, offices, laboratories	2	71.0	2	32.5	3	14.7	3	18.3	3	15.0
Roof space	5	13.6	6	21.0	6	21.5	2	29.0	9	27.6
Miscellaneous and unknown	27	20.1	34	25.6	20	36.6	20	27.1	27	33.1
Total	34	22.1	42	25.3	29	31.2	25	26.2	39	30.4
Outdoor occupancies	5	605.6	8	95.6	1	17.0	6	74.0	3	31.7
Total	176	57.8	206	51.8	190	43.8	200	56.3	248	47.6

TABLE 23a

LOSS IN RELATION TO TIME DELAY BETWEEN DISCOVERY OF FIRE AND ARRIVAL OF FIRE BRIGADE 1948
(No fire-fighting before arrival of Brigade)

Numbers of fires

Loss	Time delay (mins.)							TOTAL
	1-5	6-10	11-15	16-20	21-30	30 and over	Unknown	
£10 000-	10	12	2	1	2	1	-	28
£15 000-	4	5	2	1	1	-	1	14
£20 000-	3	6	2	1	-	2	1	15
£30 000-	10	8	2	2	-	1	-	23
£50 000-	3	12	1	2	2	-	-	20
£100 000-........	2	5	1	2	-	-	-	10
£200 000 and over	1	1	-	-	-	-	-	2
TOTAL	33	49	10	9	5	4	2	112

TABLE 23b

LOSS IN RELATION TO TIME DELAY BETWEEN DISCOVERY OF FIRE AND ARRIVAL OF FIRE BRIGADE 1949
(No fire-fighting before arrival of Brigade)

Numbers of fires

Loss	Time delay (mins.)							TOTAL
	1-5	6-10	11-15	16-20	21-30	30 and over	Unknown	
£10 000-	6	16	3	2	-	2	-	29
£15 000-	14	10	1	1	-	2	-	28
£20 000-	13	12	2	3	1	-	-	31
£30 000-	3	10	1	3	1	2	-	20
£50 000-	10	9	3	1	1	-	-	24
£100 000-........	2	-	-	1	2	-	-	5
£200 000 and over	1	-	-	-	1	-	-	2
TOTAL	49	57	10	11	6	6	-	139

TABLE 23c

LOSS IN RELATION TO TIME DELAY BETWEEN DISCOVERY OF FIRE AND ARRIVAL OF FIRE BRIGADE 1950
(No fire-fighting before arrival of Brigade)

Numbers of fires

Loss	Time delay (mins.)							TOTAL
	1-5	6-10	11-15	16-20	21-30	30 and over	Unknown	
£10 000-	13	16	3	1	1	2	-	36
£15 000-	11	7	1	-	1	1	-	21
£20 000-	8	10	2	2	-	1	-	23
£30 000-	4	10	3	-	1	1	-	19
£50 000-	2	10	2	1	-	1	-	16
£100 000-........	7	1	-	1	1	-	-	10
£200 000 and over	2	1	-	-	1	-	-	4
TOTAL	47	55	11	5	5	6	-	129

TABLE 23d

LOSS IN RELATION TO TIME DELAY BETWEEN DISCOVERY OF FIRE AND ARRIVAL OF FIRE BRIGADE 1951
(No fire-fighting before arrival of Brigade)

Numbers of fires

Loss	Time delay (mins.)							TOTAL
	1-5	6-10	11-15	16-20	21-30	30 and over	Unknown	
£10 000-	10	14	4	1	1	-	-	30
£15 000-	6	12	3	-	-	-	-	21
£20 000-	8	12	3	3	1	1	-	28
£30 000-	6	14	3	-	-	-	-	23
£50 000-	6	12	3	-	-	2	-	23
£100 000-	2	5	-	1	-	-	-	8
£200 000 and over	1	5	-	-	1	-	-	7
TOTAL	39	74	16	5	3	3	-	140

TABLE 23e

LOSS IN RELATION TO TIME DELAY BETWEEN DISCOVERY OF FIRE AND ARRIVAL OF FIRE BRIGADE 1952
(No fire-fighting before arrival of Brigade)

Numbers of fires

Loss	Time delay (mins.)							TOTAL
	1-5	6-10	11-15	16-20	21-30	30 and over	Unknown	
£10 000-	14	17	4	2	1	-	1	39
£15 000-	4	11	1	-	1	2	2	21
£20 000-	7	20	2	-	4	3	-	36
£30 000-	6	10	3	3	3	2	-	27
£50 000-	10	9	4	1	-	-	2	26
£100 000-	2	2	1	2	-	-	1	8
£200 000 and over	2	1	-	-	-	-	-	3
TOTAL	45	70	15	8	9	7	7	160

TABLE 23f

LOSS IN RELATION TO TIME DELAY BETWEEN DISCOVERY OF FIRE AND ARRIVAL OF FIRE BRIGADE 1948
(Fire-fighting occurred before the arrival of the Fire Brigade)

Numbers of fires

Loss	Time delay (mins.)							TOTAL
	1-5	6-10	11-15	16-20	21-30	30 and over	Unknown	
£10 000-	3	7	1	4	1	1	-	17
£15 000-	3	3	2	1	1	2	-	12
£20 000-	1	5	1	2	1	-	-	10
£30 000-	1	4	1	-	1	-	-	7
£50 000-	1	4	1	1	2	1	1	11
£100 000-	1	2	1	-	1	-	-	5
£200 000 and over	-	-	1	-	-	-	-	1
TOTAL	10	25	8	8	7	4	1	63

TABLE 23g

LOSS IN RELATION TO TIME DELAY BETWEEN DISCOVERY OF FIRE AND ARRIVAL OF FIRE BRIGADE 1949
(Fire-fighting occurred before the arrival of the Fire Brigade)

Numbers of fires

Loss	Time delay (mins.)							TOTAL
	1-5	6-10	11-15	16-20	21-30	30 and over	Unknown	
£10 000-	1	4	1	3	2	2	-	13
£15 000-	-	2	5	1	-	1	-	9
£20 000-	3	7	3	2	-	1	-	16
£30 000-	2	1	-	1	2	1	-	7
£50 000-	-	2	2	1	1	2	-	8
£100 000-	-	1	-	4	2	2	-	9
£200 000 and over	1	-	1	-	-	1	-	3
TOTAL	7	17	12	12	7	10	-	65

TABLE 23h

LOSS IN RELATION TO TIME DELAY BETWEEN DISCOVERY OF FIRE AND ARRIVAL OF FIRE BRIGADE 1950
(Fire-fighting occurred before the arrival of the Fire Brigade)

Numbers of fires

Loss	Time delay (mins.)							TOTAL
	1-5	6-10	11-15	16-20	21-30	30 and over	Unknown	
£10 000-	1	3	1	1	1	-	-	7
£15 000-	1	2	5	-	2	1	-	11
£20 000-	1	3	1	2	-	1	-	8
£30 000-	2	4	2	-	-	-	-	8
£50 000-	1	6	-	3	2	2	-	14
£100 000-	1	1	1	1	1	2	-	7
£200 000 and over	1	-	-	-	-	-	-	1
TOTAL	8	19	10	7	6	6	-	56

TABLE 23i

LOSS IN RELATION TO TIME DELAY BETWEEN DISCOVERY OF FIRE AND ARRIVAL OF FIRE BRIGADE 1951
(Fire-fighting occurred before the arrival of the Fire Brigade)

Numbers of fires

Loss	Time delay (mins.)							TOTAL
	1-5	6-10	11-15	16-20	21-30	30 and over	Unknown	
£10 000-	1	2	3	1	3	-	-	10
£15 000-	1	5	1	-	1	2	-	10
£20 000-	-	4	1	2	1	1	-	9
£30 000-	2	4	-	1	1	1	-	9
£50 000-	2	4	1	1	2	-	-	10
£100 000-	1	4	1	1	-	-	-	7
£200 000 and over	1	2	-	1	-	-	-	3
TOTAL	8	25	7	7	8	4	-	59

TABLE 23j

LOSS IN RELATION TO TIME DELAY BETWEEN DISCOVERY OF FIRE AND ARRIVAL OF FIRE BRIGADE 1952
(Fire-fighting occurred before the arrival of the Fire Brigade)

Numbers of fires

Loss	Time delay (mins.)							TOTAL
	1-5	6-10	11-15	16-20	21-30	30 and over	Unknown	
£10 000-	5	13	1	2	2	1	1	25
£15 000-	2	4	2	1	-	-	-	9
£20 000-	2	7	2	2	2	1	-	16
£30 000-	4	4	1	-	-	-	-	9
£50 000-	1	4	1	2	3	2	1	14
£100 000-	2	1	-	-	1	-	-	4
£200 000 and over	-	1	-	2	2	-	-	5
TOTAL	16	34	7	9	10	4	2	82

TABLE 24

THE LOSS CAUSED BY LARGE FIRES IN RELATION TO THE TIME DELAY BETWEEN THE DISCOVERY OF THE FIRE AND THE ARRIVAL OF THE FIRE BRIGADE

	No firefighting before arrival of Fire Brigade		Fire-fighting before arrival of Fire Brigade	
	Median delay (minutes)	Median loss £	Median delay (minutes)	Median loss £
1948	6.8	27 500	9.2	20 000
1949	6.5	20 400	14.0	24 800
1950	6.6	20 300	10.4	33 000
1951	7.0	24 900	9.8	29 500
1952	7.2	23 500	9.6	24 000

TABLE 25

THE LOSS CAUSED BY LARGE FIRES IN RELATION TO THE LOCATION OF THE PERSON DISCOVERING THE FIRE

Range of loss	Year	Location of person discovering the fire: Inside the premises - inside or outside the building of origin: Number of fires	Inside the premises - inside or outside the building of origin: Average loss per fire	Neighbouring premises or passers-by or policemen: Number of fires	Neighbouring premises or passers-by or policemen: Average loss per fire
			£'000		£'000
£10 000 - £99 000	1948	83	27.0	73	29.2
	1950	80	28.4	83	26.1
	1952	107	29.2	112	27.8
£10 000 - £199 000	1948	92	37.0	79	36.2
	1950	90	40.5	90	34.5
	1952	113	33.9	118	33.4
All fires (10 000 and upwards)	1948	94	43.1	80	38.2
	1950	93	47.8	92	40.3
	1952	120	59.4	119	36.9

Table 26

THE LOSS CAUSED BY LARGE FIRES IN RELATION TO THE ADEQUACY OF THE INITIAL WATER SUPPLY AND RURAL OR URBAN LOCATION OF THE FIRE

Fires in buildings with individual losses between £10 000 and £199 000

Location of fire and adequacy of water supply	Year									
	1948		1949		1950		1951		1952	
	No. of fires	Mean loss per fire	No. of fires	Mean loss per fire	No. of fires	Mean loss per fire	No. of fires	Mean loss per fire	No. of fires	Mean loss per fire
		£ 000		£ 000		£ 000		£ 000		£ 000
Initial water supply adequate										
Fires in rural districts										
Industrial premises	5	21.6	11	37.1	12	27.6	10	49.9	12	44.3
Commercial premises	-	-	-	-	-	-	-	-	-	-
Other buildings	10	29.0	10	18.2	8	42.1	8	20.3	5	36.8
	15	26.5	21	28.1	20	33.4	18	36.8	17	42.1
Fires in other districts										
Industrial premises	84	41.1	93	36.5	100	36.8	110	39.8	127	31.2
Commercial premises	19	35.7	28	41.4	21	46.0	21	36.9	35	38.3
Other buildings	30	28.7	34	26.1	25	27.8	21	25.6	37	27.1
	133	37.5	155	35.1	146	36.6	152	37.4	199	31.7
All fires with adequate initial water supply	148	36.4	176	34.3	166	36.2	170	37.3	216	32.5
Initial water supply inadequate										
Fires in rural districts (all occupancies)	5	48.6	9	26.8	6	44.3	4	42.0	8	43.5
Fires in other districts (all occupancies)	15	44.0	8	68.0	12	50.5	10	39.0	7	58.9
All fires with inadequate initial water supply	20	45.2	17	46.2	18	48.4	14	39.9	15	50.7
Total all fires	168	37.4	193	35.3	184	37.4	184	37.5	231	33.7

TABLE 27

MATERIAL FIRST IGNITED IN LARGE FIRES

Materials first ignited	Year				
	1948	1949	1950	1951	1952
Hay and straw	-	1	1	2	1
Chemicals - vegetable and mineral oils ...	8	7	4	4	4
other chemicals	3	3	15	9	12
	11	10	19	13	16
Solid fuels	-	2	3	-	1
Wood - timber stacks, other wooden objects	4	2	1	3	3
- chippings, flour, sawdust, shavings	-	2	2	3	3
	4	4	3	6	6
Paper - oiled paper, cardboard, waste	4	8	3	4	9
Textiles	15	8	15	15	20
Furniture, furnishings, household goods ..	2	5	4	6	9
Building materials other than wood	3	-	2	1	2
Woodwork structural, occupancies other than buildings	1	-	-	1	1
exterior of buildings	-	-	3	-	1
interior of buildings					
roof	3	4	4	-	5
other	14	7	11	4	15
	18	11	18	5	22
Food, drink, tobacco	3	3	4	-	3
Insulation of electric wiring	3	5	6	8	4
Miscellaneous	6	12	10	16	7
Not stated or unknown	107	137	102	125	147
TOTAL	176	206	190	201	248

TABLE 28

THE ACTION AND EFFECT OF SPRINKLER SYSTEMS INVOLVED IN LARGE FIRES 1948-52

Action of sprinklers	Number of fires	Direct damage in each fire £.
1. Sprinklers extinguished the fire	3	10 000; 11 000; 30 000
2. Sprinklers controlled		
(a) fire completely	17	10 000; 10 000; 10 000; 10 000; 11 000; 12 000; 13 000; 13 000; 16 000; 21 000; 26 000; 35 000; 35 000; 40 000; 56 000; 75 000; 80 000.
(b) part of fire where installed or prevented fire from spreading	8	10 000; 17 000; 20 000; 32 000; 37 000; 60 000; 75 000; 90 000.
	25	
3. Operated but did not control fire because of		
(a) lack of water pressure	3	70 000; 75 000; 105 000.
(b) incompleteness of system	1	65 000
(c) water supply turned off during fire; system mishandled by employees	3	11 000; 25 000; 60 000.
(d) fire inaccessible to sprinklers; storage of material did not allow water to spread	4	13 000; 24 000; 70 000; 85 000.
(e) collapse of structure and sprinkler system	1	25 000
(f) rapid fire spread or explosion (in some cases combined with causes a-e)	9	15 000; 15 000; 25 000; 30 000; 35 000; 55 000; 115 000; 143 000; 185 000.
(g) because radiated or conducted heat operated sprinklers in a building where there was no fire	2	35 000; 350 000
(h) reason not stated	3	15 000; 45 000; 100 000
	26	
4. Sprinklers were installed but did not operate because		
(a) sprinkler system was shut down	7	15 000; 25 000; 50 000; 55 000; 80 000; 136 000; 1 000 000.
(b) sprinkler system was in a state of disrepair or obsolete	2	23 000; 250 000.
(c) heat generated was insufficient to actuate heads situated in high roof-space	1	10 000.
	10	
5. The action of the sprinkler system is not known; the building was totally destroyed by the fire	1	150 000.
Total large fires in which sprinklers were involved	65	

APPENDIX

Details of the statistical methods used and results

Part Ia.

The data on fire losses were taken from the lists of major fires published monthly in "The Times". Figures of attendances by Fire Brigades at fires of any size have been used; these are compiled regularly from the detailed reports of attendances which are received from every Fire Brigade. The economic data used in Table 9 were taken from the Board of Trade reports on the Census of Production(4).

1. Three sets of indices have been used to allow for the changes in money values between 1949 and 1952. The measure of building costs used was "The Builder" index compiled by Mr. H.J. Venning. The Ministry of Supply made available to the Organization confidential price indices for a series of items of industrial plant and equipment. Prices of industrial materials and goods were measured by the part of the Board of Trade Wholesale Price Index (old series) dealing with industrial materials and manufactures.

The weights used in combining these indices, after they have been converted to a common base year, into indices designed to measure the variations in fire loss caused by changing money values are tabulated below for the various occupancies concerned.

Occupancy	Building costs	Plant and equipment prices	Wholesale prices	Interim index of retail prices: Household durable goods	Interim index of retail prices: Clothing
Industrial premises	20	30+	50*	-	-
Transport	20	80+	-	-	-
Commercial premises	20	-	80≠	-	-
Professional establishments; public entertainment	80	-	-	20	-
Houses, flats, hotels	70	-	-	30	-
Laundries	10	20+	-	-	50
Other buildings	70	-	-	30	-

\+ The series appropriate to the occupancy group were used.
* Industrial materials and manufacturers. ≠ All articles.

The resulting indices were used to eliminate fires which came into the "large fire" category solely because the fall in the value of money had altered the magnitude of the defining criterion, and to deflate the resulting figures of loss after the elimination had taken place.

2. Table 8 shows the proportion of "Large" fires (after the first part of the adjustment above had been made), to all attendances by Fire Brigades.

(a) Test of equality of proportions in each industry, between years 1949-52.

Industry	χ^2	d.f.
Chemicals, etc.	3.316	3
Metals, etc.	1.769	3
Textiles and textile goods	2.483	3
Leather and fur	Not calculated	-
Clothing	4.868	3
Food etc.	1.333	3
Woodworking, furniture	3.836	3
Paper-making	0.779	3
Other manufacturing	4.336	3
	22.720	24

(b) Test of equality of proportions between industries, all years together
$\chi^2 = 73{\cdot}93^{xxx}$ for 8 d.f.

Part Ib.

Frequency distributions of losses in large fires

The frequency curves fitted to the distributions of losses caused by large fires (figs 3, 4, 5) are the Type I distributions in the form

$$f(x) = \frac{N}{(a_1+a_2)^{m_1+m_2+1}} \frac{\Gamma(m_1+m_2+2)}{\Gamma(m_1+1)\,\Gamma(m_2+1)} x^{m_1}(a_1+a_2-x)^{m_2} \qquad 0 < x < a_1 > a_2$$

where $x = \dfrac{\text{£ loss} - \text{£}10\,000}{\text{£}5\,000}$. This scale is used throughout.
The data relating to the distributions all of which have been truncated at above a loss of £100 000 are:-

(a) All large fires 1944-52

$\mu' = 4.4838 = \text{£}29\,900$ $\qquad \sqrt{b_1} = 1.473$
$\mu_2 = 16.8030$ $\qquad \hat{s} = \text{£}20\,500$ $\qquad b_2 = 4.595$
$\mu_3 = 101.4831$ $\qquad k = -0.794$
$\mu_4 = 1297.4304$ $\qquad N = 1511$

The estimated equation is

$$f(x) = C_1\, x^{-0.569}\,(20.756-x)^{1.142} \qquad 0 < x < 20.756$$

and the differential equation it satisfies is

$$\frac{df}{dx} = -\frac{(0.573\,x + 11.810)f}{x\,(20.756 - x)}$$

(b) Industrial premises 1949-52 (at 1949 prices)

$\mu' = 4.7475 = \text{£}31\,200$ $\qquad \sqrt{b_1} = 1.357$
$\mu_2 = 17.7287$ $\qquad b_2 = 4.080$
$\mu_3 = 101.2881$ $\qquad \hat{s} = \text{£}21\,050$ $\qquad k = -0.635$
$\mu_4 = 1282.3175$ $\qquad N = 400$

The estimated equation is

$$f(x) = C_2\, x^{-0.583}\,(19.292-x)^{0.793} \qquad 0 < x < 19.292$$

and the corresponding differential equation is

$$\frac{df}{dx} = -\frac{(0.210\,x + 11.247)f}{x\,(19.292 - x)}$$

(c) Premises other than industrial 1949-52 (at 1949 prices)

$\mu' = 4.1169 = \text{£}28\,100$ $\qquad \sqrt{b_1} = 1.509$
$\mu_2 = 14.0065$ $\qquad b_2 = 4.839$
$\mu_3 = 79.0324$ $\qquad \hat{s} = \text{£}18\,700$ $\qquad k = -0.887$
$\mu_4 = 949.5011$

The estimated equation is

$f(x) = C_3\, x^{-0.529}\,(20.550-x)^{1.524}$ and its differential equation is

$$\frac{df}{dx} = -\frac{(0.995x + 10.871)\,f}{x\,(20.550 - x)} \qquad 0 < x < 20.550$$

No goodness of fit tests have been carried out since the representation of data of this kind is at best very approximate.

Part II.
1. Table 11 compares the fuel concerned with the source of ignition in large fires with all attendances by Fire Brigades in which the cause was determined excluding those in houses and flats.

(a) Test of equality of proportions for all fuels within years between large fires and other attendances by Fire Brigades.

Year	$\overset{o}{\chi}{}^2$	d.f.
1948	5.08	3
1950	10.87 x	4
1952	1.24	4
	17.19	11

2. The frequency of large fires in relation to the occupancy in which they occurred and the time of day of the outbreak is shown in Table 12.

(a) Tests of association between occupancy (in four groups) and time of day (divided into three 6 hourly periods)

Year	$\overset{o}{\chi}{}^2$	d.f.
1948	7.38	6
1949	11.67	6
1950	3.37	6
1951	4.02	6
1952	5.94	6
	32.38	30

(b) Test of association between time of day of outbreak (hourly periods) and year (all occupancies). (Some adding together of frequencies is necessary)

$\overset{o}{\chi}{}^2 = 98.963$ for 88 d.f. $\qquad P\,(\chi^2_{88} \geqslant \overset{o}{\chi}{}^2) > 0.05$

(c) Test of hypothesis of constant hourly frequency considering each year separately

Year	$\overset{o}{\chi}{}^2$	d.f.
1948	40.197 x	23
1949	42.118 xx	23
1950	39.053 x	23
1951	55.119 xxx	23
1952	50.106 xxx	23

3. The time of day of discovery of the fire in relation to the location of the person making the discovery is shown in Table 13.

(a) Test of hypothesis that the attributea are independent

1948	$\overset{o}{\chi}{}^2 =$ 7.73	for	3 d.f.
1950	$\overset{o}{\chi}{}^2 =$ 11.64 x	for	3 d.f.
1952	$\overset{o}{\chi}{}^2 =$ 28.99 xxx	for	3 d.f.
	48.36 xxx		9

(b) Test of equality of proportions within periods between years

Periods (1) and (4) 6.30 p.m. - 6.30 a.m. $\overset{o}{\chi}{}^2 = 2.60$ for 5 d.f.

Periods (2) and (3) 6.30 a.m. - 6.30 p.m. $\overset{o}{\chi}{}^2 = 7.16$ for 5 d.f.

(c) The difference between the proportions for periods (1) and (4) compared with periods (2) and (3) is highly significant $\overset{o}{\chi}{}^2 = 40.25$ for 1 d.f.

4. The average loss per fire in relation to the time of the day of discovery is shown in Table 24. The significance of the differences between the means has bee judged by ranking them in order and testing the concordance of the ranks. The assumption implicit in this procedure is that each mean is of equal weight. Except for one or two cells with very small or very large numbers of items the standard deviations of the means which are inversely proportional to the square roots of the numbers of items are of much the same order.

Loss range £10 000 - £199 000

Coefficient of concordance of ranks of means
$= 0.0767$ for 5 rankings of 8 items.
$\overset{o}{\chi}{}^2 = 35\,W = 2.68$ for 7 d.f.

5. The frequency of large fires in relation to the occupancy in which the fire occurred and the day of the week is shown in Table 15.

(a) Test of association between occupancy and day of week of outbreak (all years together in five occupancy groups)

$$\overset{o}{\chi}^2 = 15.92 \text{ for } 18 \text{ d.f.}$$

(b) Test of the hypothesis of constant weekly incidence, each year considered separately. The χ^2 test is combined with a test of the significance of the pattern of the signs of the differences between the observed and expected values. The approximate significance levels of χ^2 and of the combined criterion are shown

Year	$\overset{o}{\chi}^2$	$P(\chi^2 \geqslant \overset{o}{\chi}^2)$	d.f.	Combined criterion
1948	18.08^{xx}	0.006	6	$0.01 < P < 0.05$
1949	5.79	0.435	6	$0.05 < P$
1950	5.13	0.519	6	$0.05 < P$
1951	16.66^{x}	0.011	6	$P < 0.01$
1952	8.40	0.216	6	$0.05 < P$
	54.06^{xx}		30	

(c) Test of association between day of week and year

$$\overset{o}{\chi}^2 = 29.11 \text{ for } 24 \text{ d.f.}$$

6. Table 16 shows the frequency of fires in relation to the month of the year.

(a) Test of association between occupancy and month of year of outbreak (all years together in four occupancy groups)

$$\overset{o}{\chi}^2 = 22.39 \text{ for } 33 \text{ d.f.}$$

(b) Test of hypothesis of constant monthly incidence, each year considered separately. The χ^2 test is combined with a test of the significance of the pattern of signs of the differences between the observed and expected values. The approximate significance levels of χ^2 and of the combined criterion are shown.

Year	$\overset{o}{\chi}^2$	$P(\chi^2 \geqslant \overset{o}{\chi}^2)$	d.f.	Combined criterion
1948	10.54	0.502	11	$0.05 < P$
1949	13.72	0.256	11	$0.05 < P$
1950	6.55	0.833	11	$0.05 < P$
1951	12.64	0.316	11	$0.05 < P$
1952	16.58	0.126	11	$0.05 < P$
	60.03		55	

7. The relations between occupancy and the type of construction and the number of storeys of the building in which the fire occurred are shown in Tables 18, 18a, 19 and the average losses per fire are shown in Tables 18, 19, 20, 21.

(a) Test of association between type of building construction and occupancy (Some adding of frequencies is necessary)

Year	$\overset{o}{\chi}^2$	d.f.
1948	17.22^{xx}	4
1950	15.86^{xx}	4
1952	27.50^{xxx}	4
	60.58^{xxx}	12

(b) Test of association between number of storeys of building and occupancy (Some adding of frequencies is necessary)

Year	$\overset{o}{\chi}^2$	d.f.
1948	5.89	6
1950	11.81	6
1952	22.17^{xx}	6
	39.87^{xx}	18

A breakdown into component χ^2's of the calculation for 1952 gives a χ^2 of 15.52 corresponding to 1 d.f.

(c) Correlation coefficients between equivalent volume of buildings and loss. The calculations were carried out on a reciprocal transformation of the loss, and a building of 900 000 cubic feet equivalent volume was excluded. The estimated correlation coefficient was -0.165 for 217 d.f. The standard error of r for 217 d.f. is 0.0679 so the overall correlation coefficient is significantly large. The calculations were done in four sections corresponding approximately to the years 1949, 1950, 1951 and 1952. The correlations in each section are shown below. The conclusion is that there is no consistent relation since only in the last section is there a correlation significantly different from zero.

Section	Correlation coefficient	d.f.
1	- 0.086	53
2	- 0.087+	58
3	- 0.012	59
4 a)	- 0.418	41
b)	- 0.357x	40

\+ Excluding a building of 900 000 cubic feet equivalent volume
x Excluding two fires whose adjusted losses were £372 000 and £743 000.

8. Loss in relation to where the fire started

The hypothesis of the equality of the mean losses per fire for the various categories of points of origin within the group "industrial premises" shown in Table 22 have been tested by means of an analysis of variance carried out on the reciprocals of the losses. The calculations were made for the years 1949 and 1951.

Analysis of Variance - 1949

	S.S.	d.f.	M.S.	F
Between sub-groups within industrial premises	515 678	5	103 136	1.60
Within sub-groups within industrial Premises	6 876 136	107	64 263	
	7 391 814	112		

1951

	S.S.	d.f.	M.S.	F
Between sub-groups within industrial premises	416 809	5	83 362	0.90
Within sub-groups within industrial premises	11 925 007	129	92 442	
	12 341 816	134		

The F ratio of the residual mean square for 1951 to that for 1949 is 1.44 just significant at the 5 per cent level. If the transformation was not altogether successful in equalising the within sub-group variances, and these were still dependent on the mean, then the residual mean square in 1951 would be expected to be lower than that in 1949.

9. (a) The bivariate distributions of loss in relation to the time delay between the discovery of the fire and the arrival of the Fire Brigade are shown in Tables 23a-e (a) no fire fighting reported before the arrival of the Brigade and Tables 23 f-j (b) the fire was tackled before the arrival of the Brigade. The marginal distributions are skew so that the immediate application of normal regression theory is not appropriate. The line of regression can be defined for a perfectly general bivariate population as the expectation of the dependent variable for given values of the independent variable. If one assumes that the curve is linear in this case which is reasonable for a limited range of the loss (l) between say £10 000 and £99 000 then

$E(l|t) = \alpha + \beta t$ where α, β are constants and t is the time delay

$$\therefore \int_0^\infty l \frac{f(l,t)}{g(t)} dl = \alpha + \beta t$$

$$\therefore \int_0^\infty \int_0^\infty l f(l,t) \, dl dt = \int_0^\infty \alpha g(t) \, dt + \int_0^\infty \beta t \, g(t) \, dt$$

$$\therefore \mu'_{01} = \alpha + \beta \mu'_{10}$$

$$\text{and} \quad t \, E(l|t) = \alpha t + \beta t^2$$

$$\therefore \int_0^\infty \int_0^\infty l \, t \, f(l,t) \, dl dt + \int_0^\infty \alpha t g(t) \, dt + \int_0^\infty \beta t^2 g(t) \, dt$$

$$\therefore \mu'_{11} = \alpha \mu'_{10} + \beta \mu'_{20}$$

$$\text{and} \quad \mu'_{01} \mu'_{10} = \alpha \mu'_{10} + \beta \mu'^2_{10}$$

$$\therefore \beta = \frac{\mu_{11}}{\mu_{20}}$$ in agreement with normal regression theory.

If there is an association between l and t and the relation is even approximately linear then b, the usual estimate of , which measures the change in l for a unit change in t, should be a non-zero quantity. A priori considerations suggest that β cannot be negative.

Fires causing damage between £10 000 - £99 000	No fire-fighting before arrival of the Fire Brigade b (£/mi)	Correlation coefficient	No. of items	Fire-fighting before arrival of the Fire Brigade b (£/mi)	Correlation coefficient	No. of items
1948	- £25	- 0.014	98	- £207	- 0.092	56
1949	- £35	- 0.021	132	+ £125	+ 0.174	53
1950	+ £215	+ 0.101	114	+ £320	+ 0.137	48
1951	+ £130	+ 0.085	125	- £288*	- 0.114*	47*
1952	+ £59	+ 0.031	144	+ £889	+ 0.348	70

* Excluding one fire with an exceptionally long delay

An exact test of significance of the regression coefficients (or equivalently the correlation coefficients) is not available, but it is obvious that when considering the values and signs of b in relation to the total loss that only in 1952 is there the possibility of any relation between loss and the time delay, and this occurs in fires where there is fire-fighting before the arrival of the Fire Brigade.

(b) The median delays and losses for the two categories of fires are shown in Table 24. The hypothesis of the equality of the median delay or loss in the first category where there was no fire-fighting before the arrival of the Fire Brigade, and in the second category where there was fire-fighting before the arrival of the Brigade is tested by the following procedure. The two categories are merged for each year and the median of the combined series is computed. The number of items in each category greater than the combined median is found. It can be shown that the joint distribution of these two quantities on the hypothesis of equality is the hypergeometric distribution, and the equality of the medians can be tested by testing the equality of the proportions that these two quantities bear to the total numbers in the respective categories, that is by means of a χ^2 test.

	Test of equality of median losses χ^2	d.f.	Test of equality of median delays χ^2	d.f.
1948	2.00	1	10.90xxx	1
1949	0.30	1	39.15xxx	1
1950	2.72	1	20.79xxx	1
1951	1.20	1	7.07xx	1
1952	0.002	1	4.62x	1
	6.22	5	82.53xxx	5

10. Loss in relation to the location of the person discovering the fire.

(a) Tests of the association between occupancy and the location of the person discovering the fire have been carried out using a broad classification of occupancy into industrial, commercial and other buildings. No table showing this data is included in the text.

$\overset{o}{\chi}{}^2$	d.f.
4.205	2
6.306	2
4.843	2
15.354[x]	6

(b) The significance of the differences between the mean losses per fire tabulated in Table 25 has been tested using a two-sided (approximate) test. Fires in which the loss was £200 000 or more have been excluded.

Year	$\bar{x}_1$	$\bar{x}_2$	n_1	n_2	$\hat{s}$	Standard normal deviate	Significance level (two-tailed test) P	-2 $\log_e$P	d.f.
1948	37.0	36.2	92	79	34.05	+ 0.149	.882	0.252	2
1950	40.5	34.5	90	90	36.41	+ 1.105	.271	2.611	2
1952	33.9	33.4	113	118	30.31	+ 0.125	.901	0.210	2
							$\overset{o}{\chi}{}^2$ =	3.073	6

For the three years considered $\bar{x}_1$ is always larger than $\bar{x}_2$. It is difficult to assess the significance of this in conjunction with the t. test but it is unlikely to make the significance level even approach 0.05.

11. The average loss per fire in relation to the adequacy of the initial water supply and the geographical location of the fire is shown in Table 26.

The following approximate test has been used to test the hypothesis of equality of the mean losses. Each mean is regarded as normally distributed, though the parent distribution is non-normal because of the Central Limit Theorem. The fires in which the initial water supply is adequate are by far the most numerous so these are used to estimate the standard deviation in each year. The details of the test are summarized below

Year	$\bar{x}_1$ £000	$\bar{x}_2$ £000	n_1	n_2	$\hat{s}$	$\hat{S}_{\bar{x}_1-\bar{x}_2}$	Standard normal deviate	Significance level P (one tailed test)	- 2 $\log_e$P
1948	37.5	44.0	15	133	32.50	8.85	0.734	.232	2.926
1949	35.1	68.0	8	155	35.27	12.79	2.572	.005	10.557[xx]
1950	36.6	50.5	12	146	29.58	8.88	1.565	.065	5.479
1951	37.4	39.0	10	152	32.27	10.54	0.152	.440	1.642
1952	31.7	58.9	7	199	32.89	12.65	2.150	.016	8.321[x]
									28.925[xx]

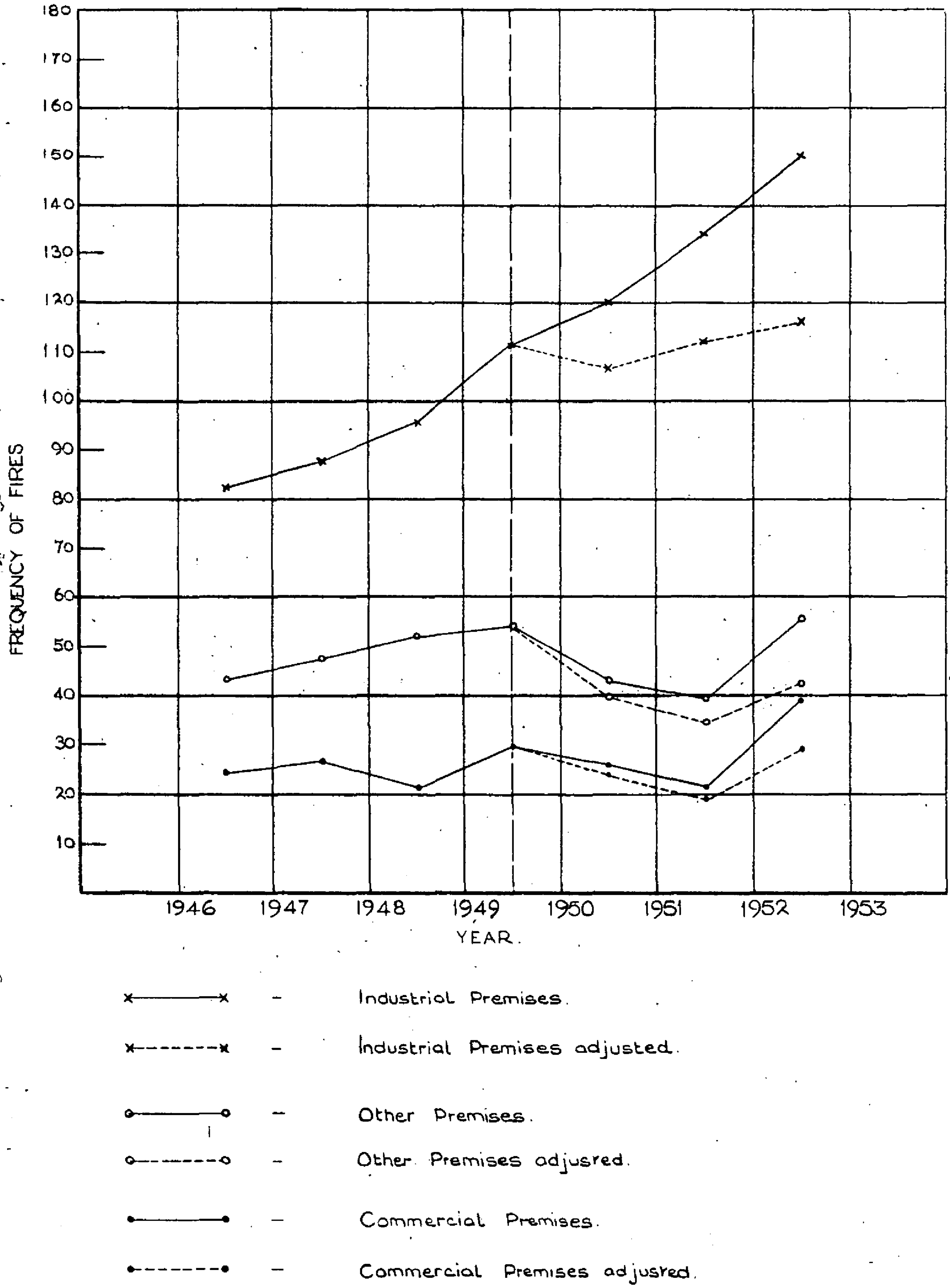

FIG.1. THE FREQUENCY OF LARGE FIRES* 1946 - 1952, SHOWING THE FIGURES ADJUSTED TO EXCLUDE THOSE FIRES COSTING LESS THAN £10,000 AT 1949 PRICES.

* A LARGE FIRE IS DEFINED AS ONE COSTING £10,000 OR MORE.

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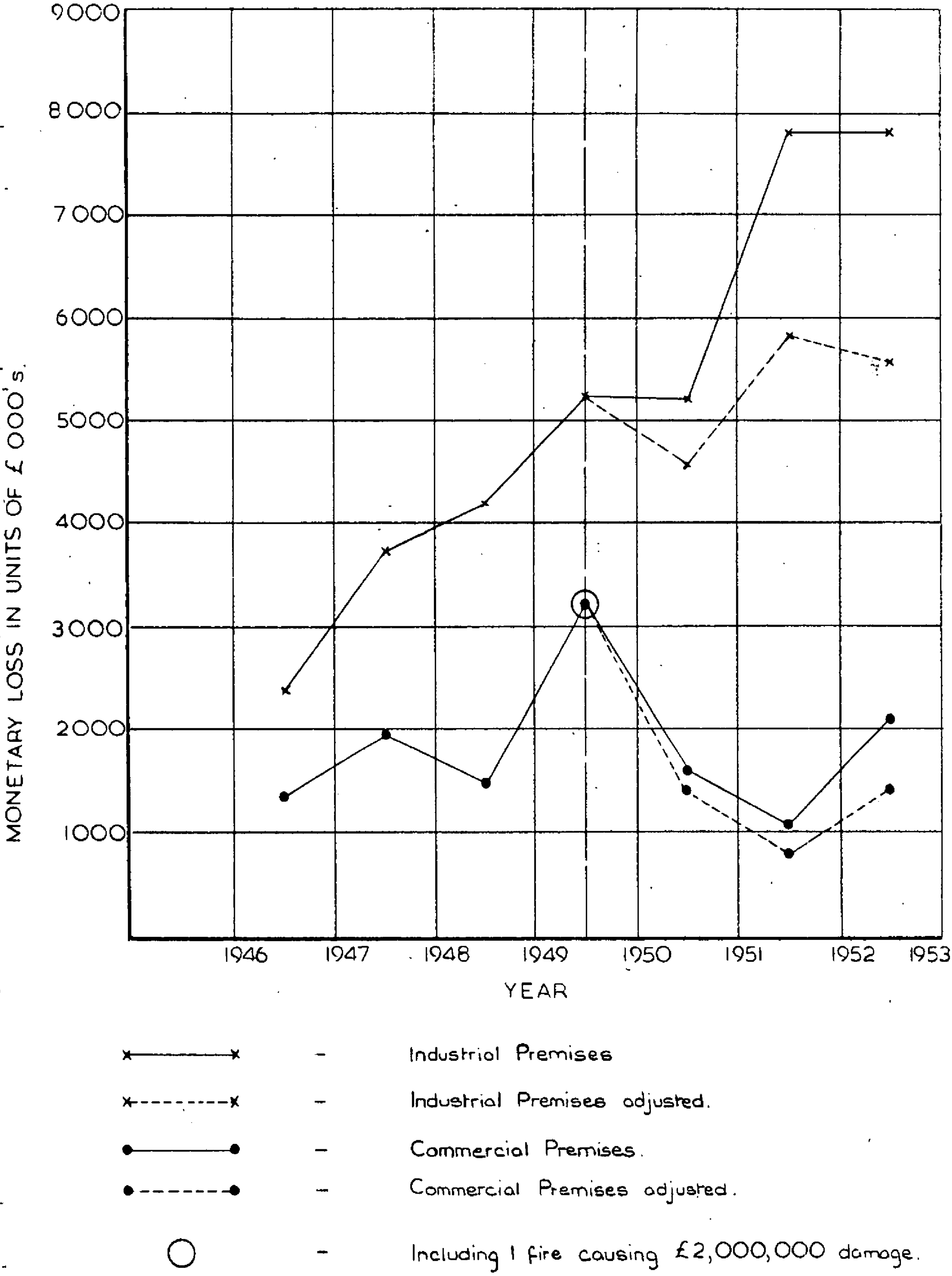

Indices measuring building costs, prices of industrial plant and raw materials have been combined to adjust the fire losses to the 1949 price level.

FIG. 2. LARGE FIRES* 1946 - 1952.
DIRECT MONETARY LOSS, SHOWING THE FIGURES ADJUSTED TO EXCLUDE THOSE FIRES COSTING LESS THAN £10,000 AT 1949 PRICES.

* A LARGE FIRE IS DEFINED AS ONE COSTING £10,000 OR MORE.

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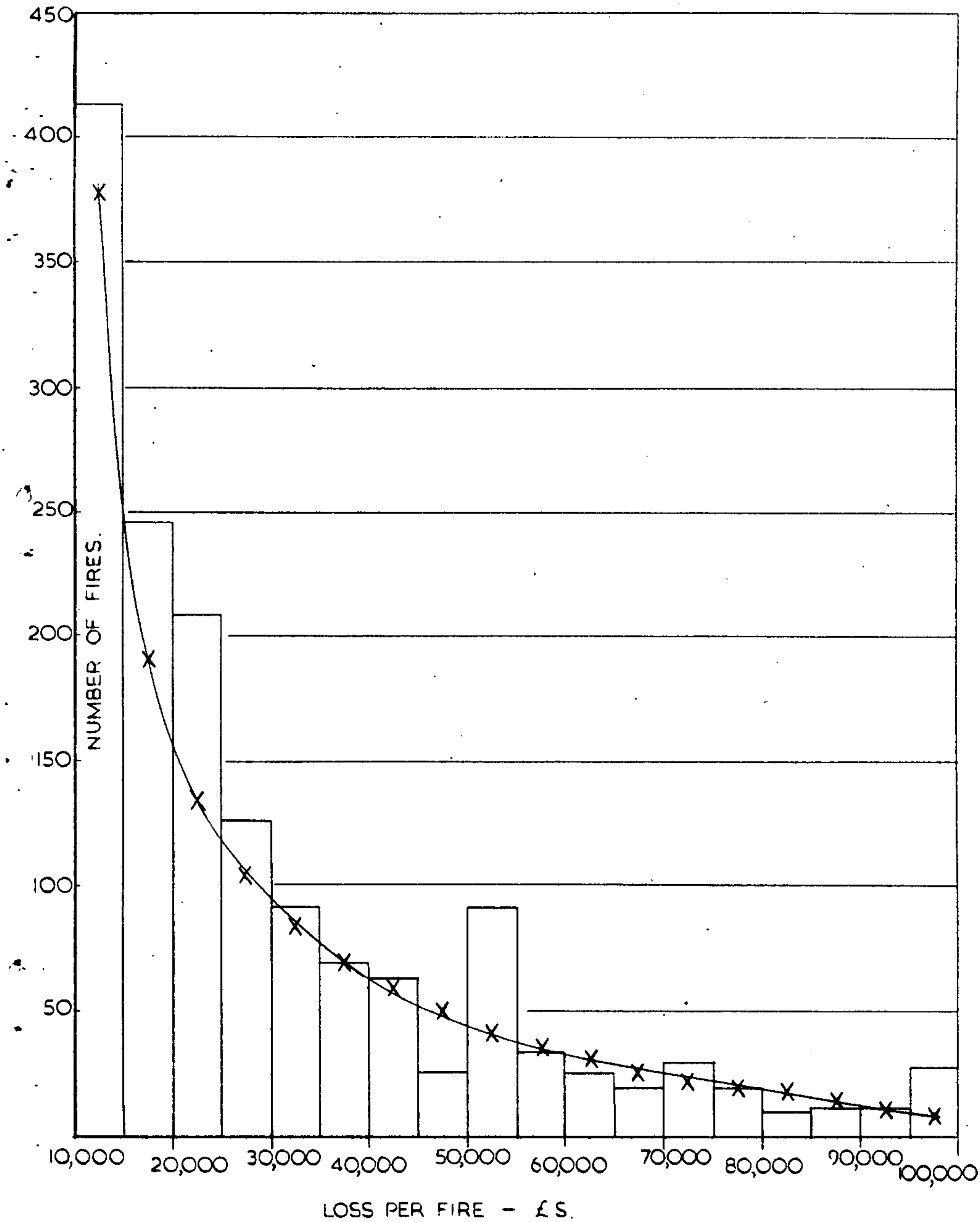
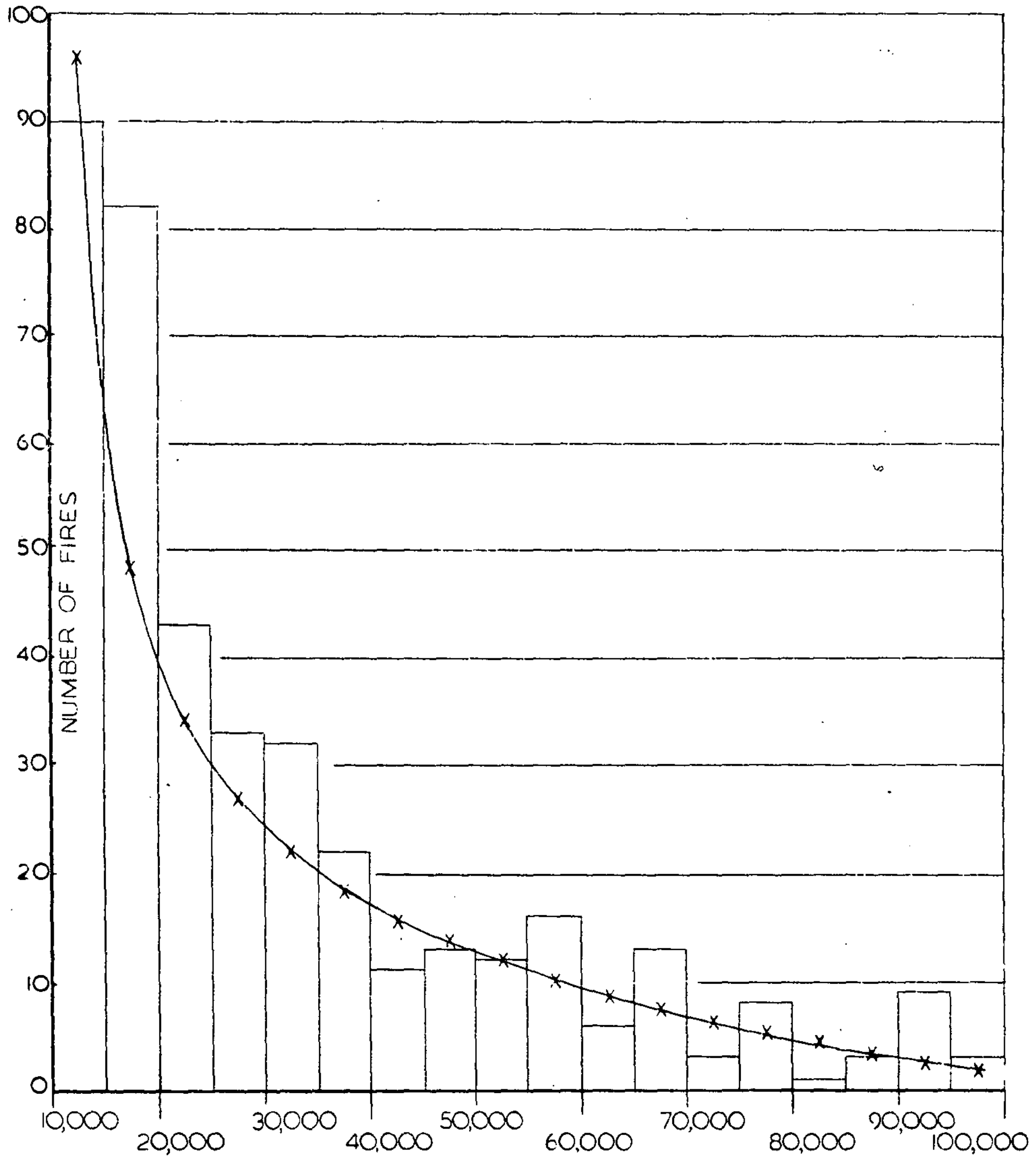


FIG. 3. LOSSES IN LARGE FIRES 1944 - 1952



INDUSTRIAL PREMISES

FIG.4. LOSSES IN LARGE FIRES 1949 - 1952

(LOSSES IN TERMS OF 1949 MONEY VALUES, EXCLUDING FIRES WHICH WOULD HAVE COST LESS THAN £10,000 AT 1949 PRICES).

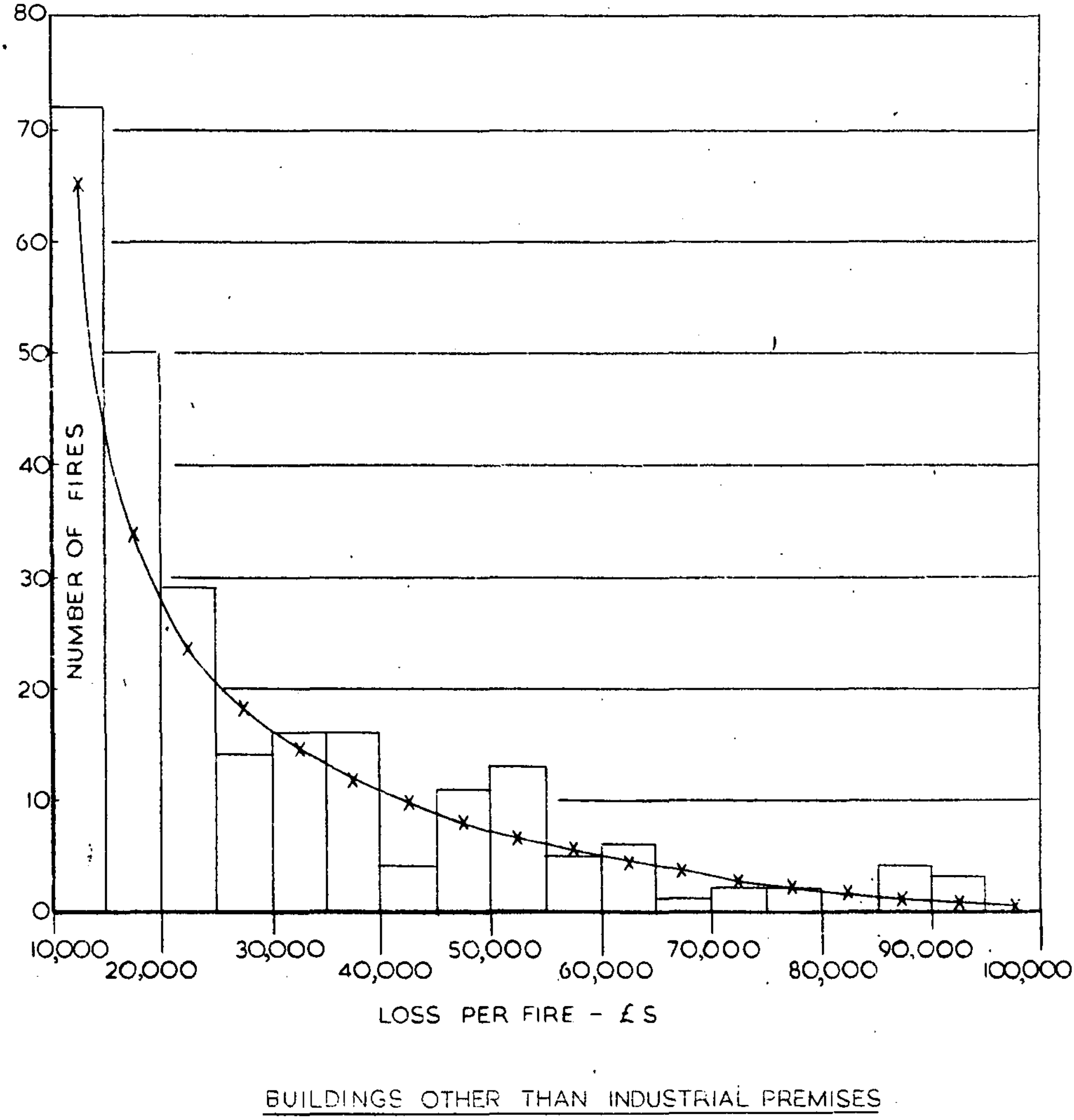


FIG. 5. LOSSES IN LARGE FIRES 1949 - 1952

(LOSSES IN TERMS OF 1949 MONEY VALUES, EXCLUDING FIRES WHICH WOULD HAVE COST LESS THAN £10,000 AT 1949 PRICES).

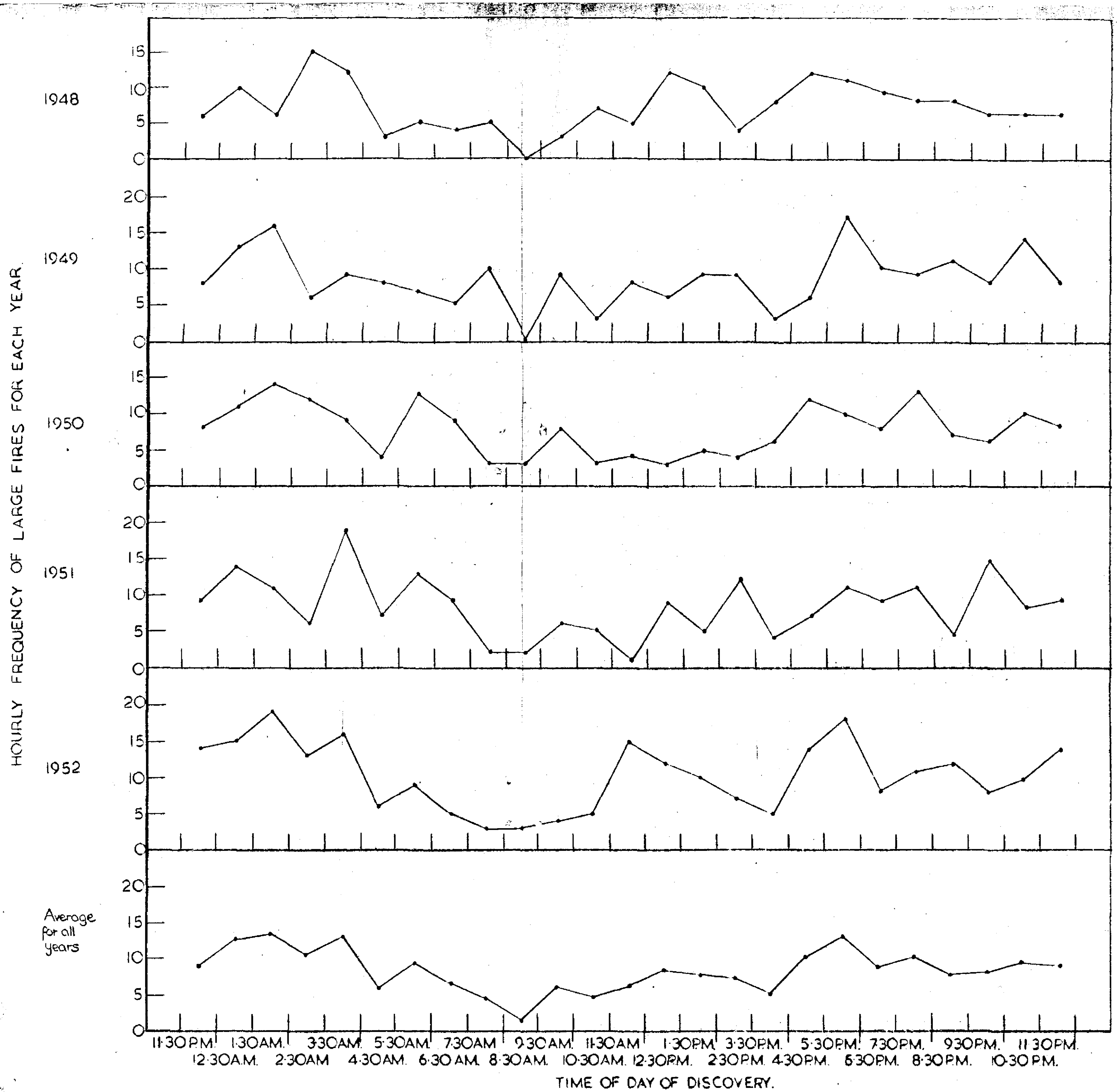
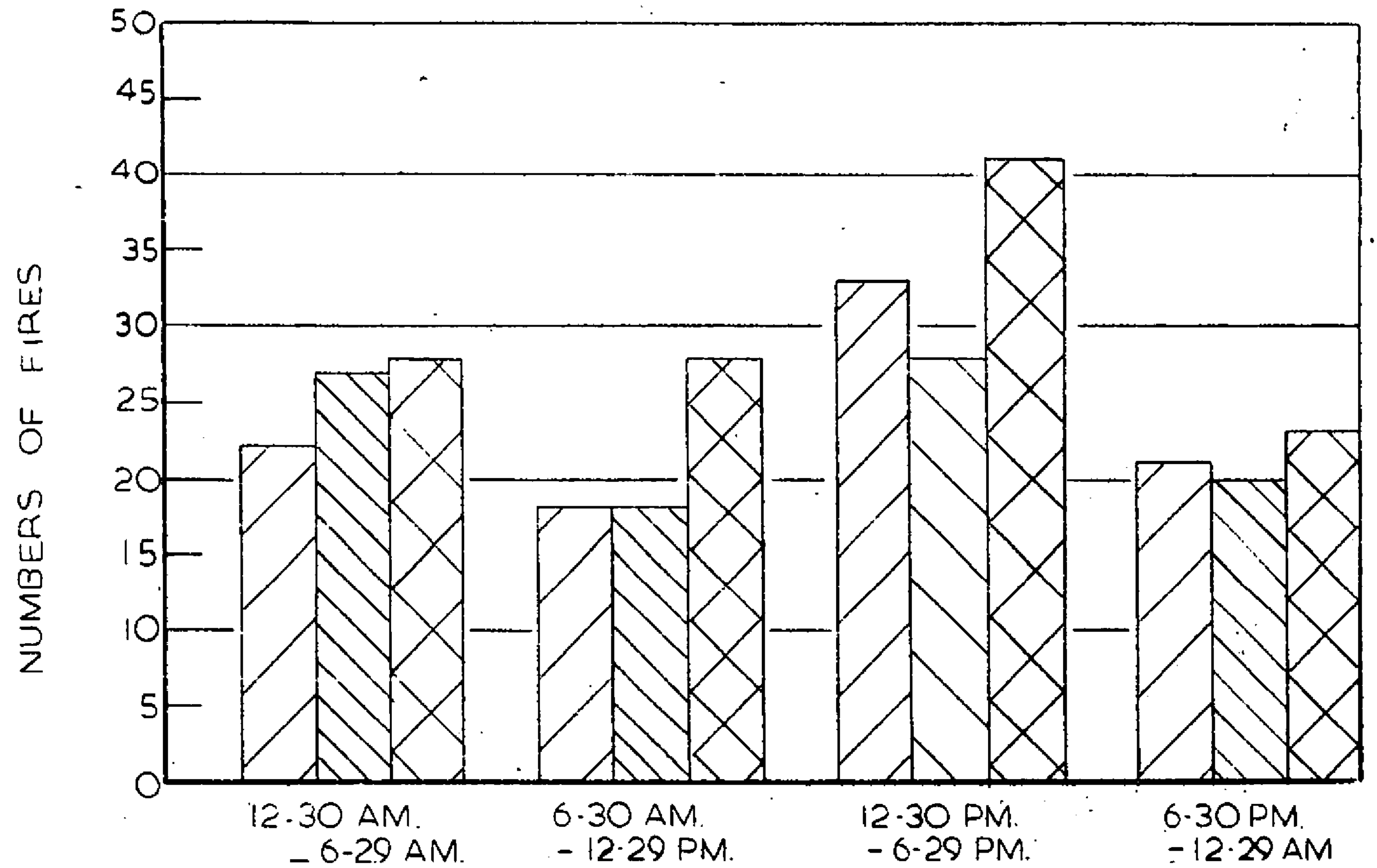
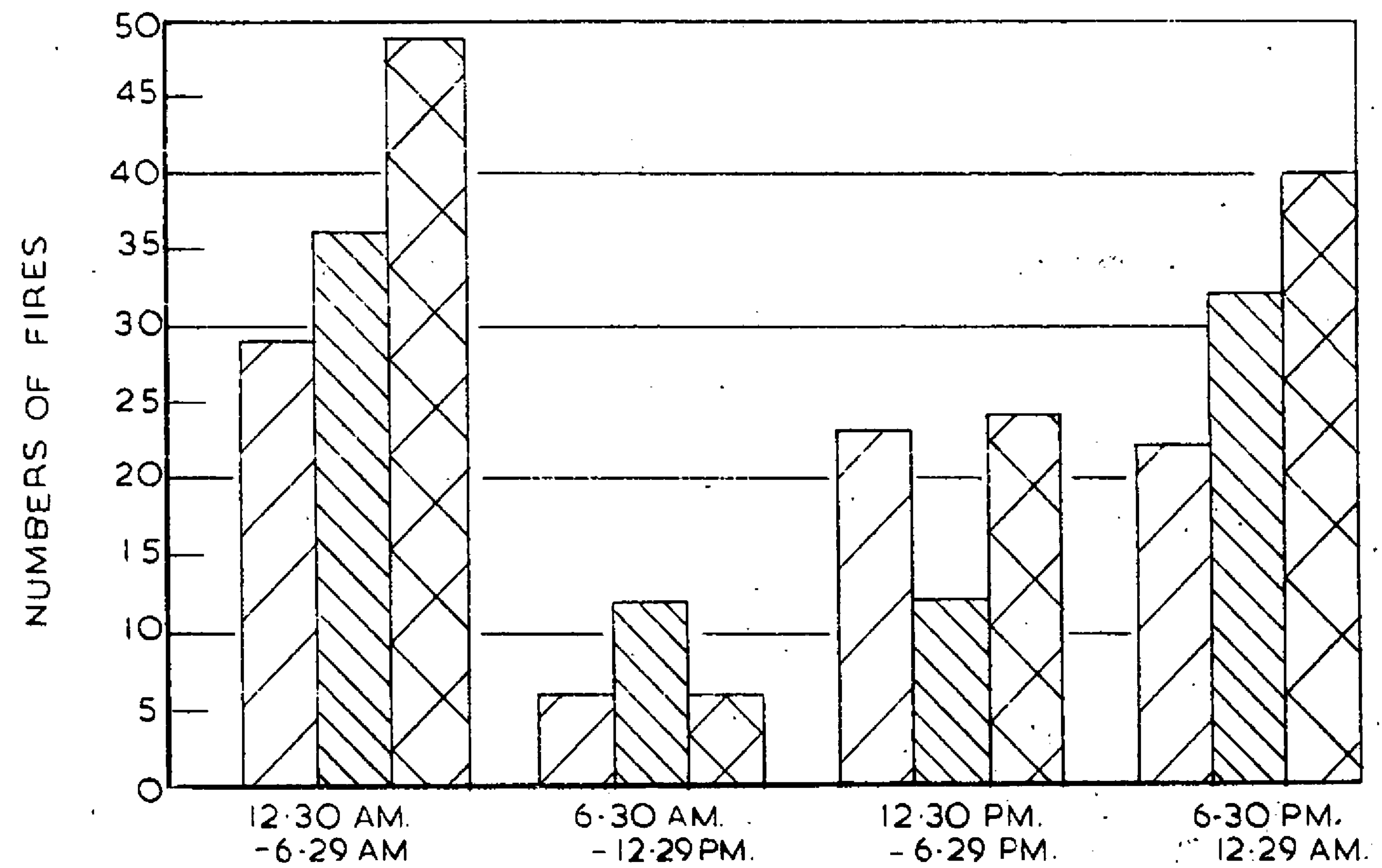


FIG. 6. THE TIME OF DISCOVERY OF LARGE FIRES.



1. FREQUENCIES OF LARGE FIRES DISCOVERED BY PEOPLE CONNECTED WITH THE PREMISES OF ORIGIN.



2. FREQUENCIES OF LARGE FIRES DISCOVERED BY PEOPLE IN NEIGHBOURING PREMISES, OR PASSERS - BY.

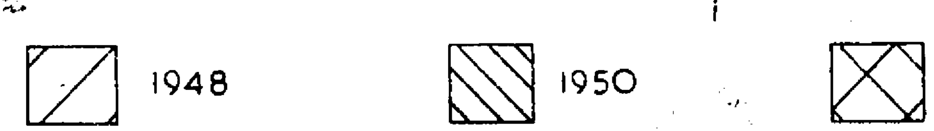


FIG. 7. THE LOCATION OF THE PERSON DISCOVERING THE FIRE

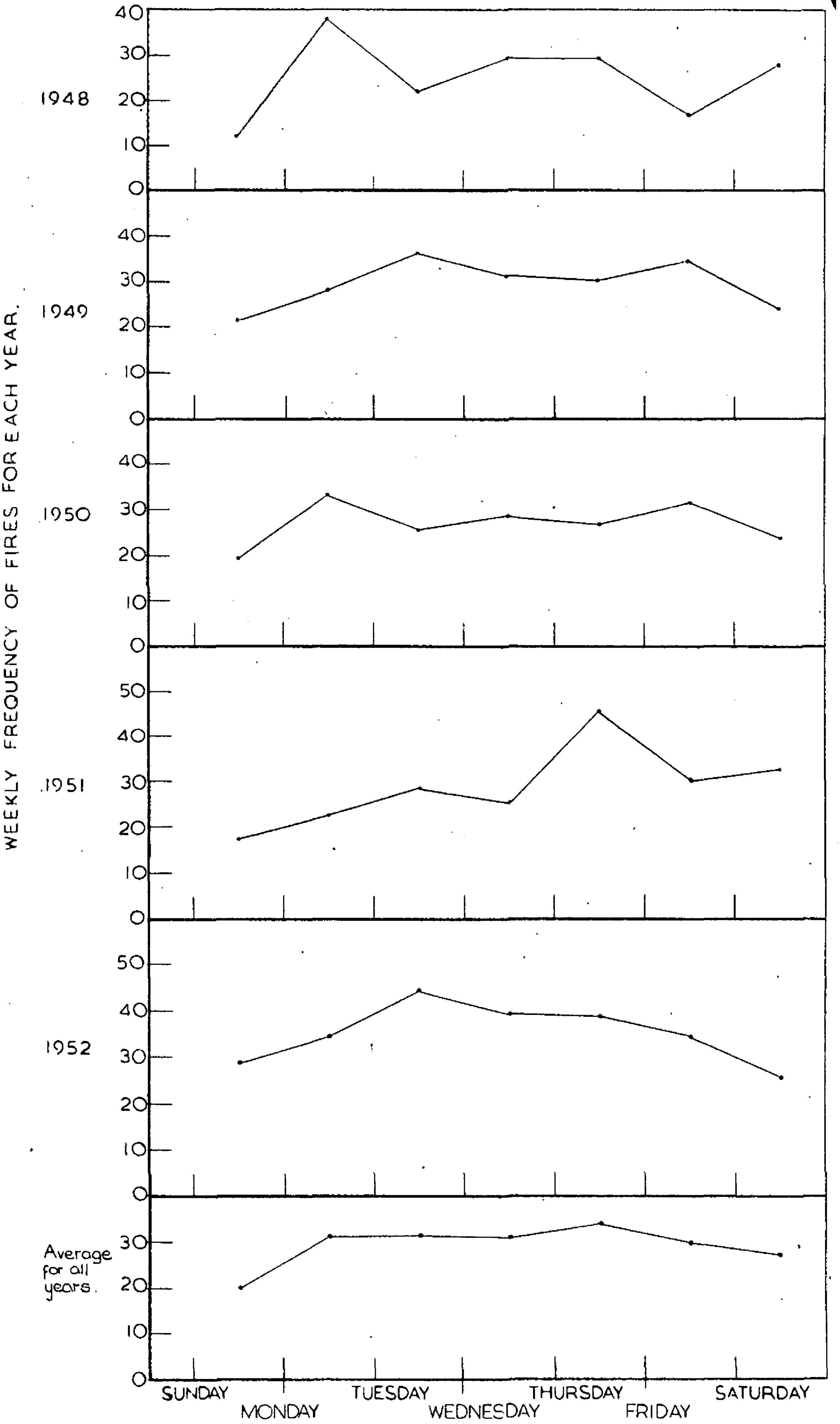


FIG. 8. DAY OF WEEK OF OUTBREAK OF LARGE FIRES

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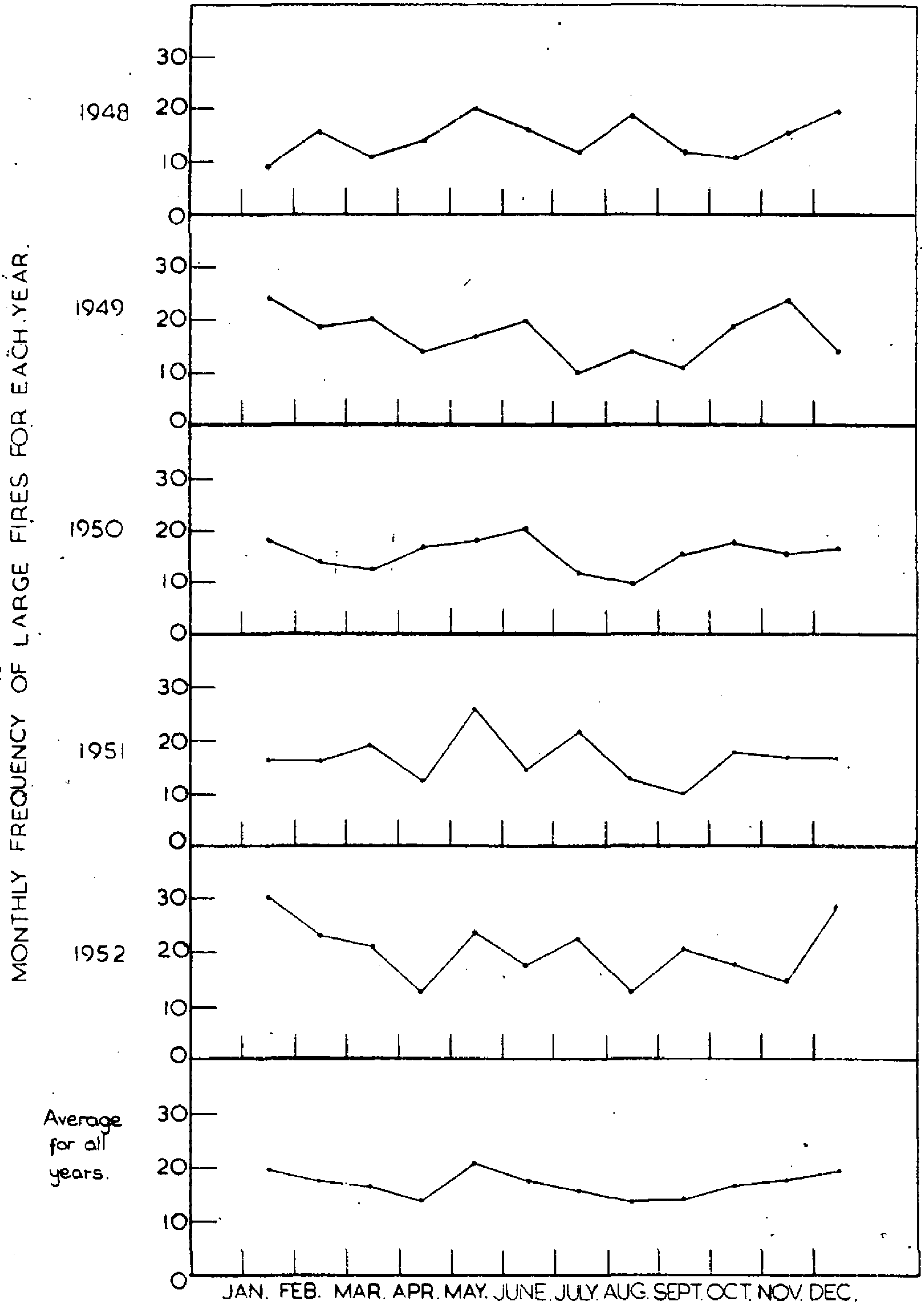

FIG. 9. THE MONTH OF OCCURRENCE OF LARGE FIRES.