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FIRES IN PREMISES CONCERNED WITH TEXTILE DYEING, PRINTING, BLEACHING AND FINISHING 1946 - 50

by

D. W. Millar and J. F. Fry

Summary

An investigation has been made of 175 fires in textile dyeing, printing, bleaching and finishing premises. The greater part of the loss occurs in the few really large fires, and is mainly caused by damage to stocks of textiles. About 20 per cent of the fires are caused by mechanical heat and sparks, and in about 25 per cent of the fires textile fly or fluff and dust was the material first ignited. Better "housekeeping", the installation of more fire-breaks, avoiding the storage of large quantities of textiles, and the provision of sprinklers would reduce the fire incidence to a considerable extent.

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FIRES IN THE TEXTILE DYEING, PRINTING, BLEACHING AND FINISHING TRADES

A statistical analysis of reports of fires attended by Fire Brigades in the United Kingdom, 1946-50

by D.W. Millar and J.F. Fry

1. INTRODUCTION

The total losses due to fire in the United Kingdom are not known accurately, but sufficient information is available to show that about half the total losses are caused by large fires (arbitrarily defined as those individually costing at least £10,000). It would therefore appear important to devote attention not only to studies of fire prevention, but also to the recognition of factors which contribute to the development of large fires. There is more than one approach to a study of this kind, and in fact an investigation into large fires in general is now being carried out. A useful complementary approach is the study in more detail than is possible in a general investigation, of the fire incidence in a particular industry, with special reference to the large fires in the industry. The industry selected was the textile dyeing, printing, bleaching and finishing industry, more shortly described as the textile finishing industry. There were two main reasons for selecting this particular industry. Between 1944 and 1950 the total loss due to large fires in the industry was exceeded by that in only three other occupancies, warehouses containing mixed commodities, cotton manufacture and storage and the manufacture of electrical installations, cables, and apparatus. The average loss per large fire in textile finishing premises was exceeded only by the average loss per large fire in the warehouses mentioned above. For these reasons, after discussion with the Fire Offices' Committee Research Liaison Committee, the textile finishing industry was selected for a study of fire incidence.

2. THE PROCESSES CARRIED OUT IN THE INDUSTRY

The textile dyeing, printing, bleaching and finishing trades form the section of the textile industry which receives yarn or woven or knitted textile goods in an unfinished state and prepares them, either for other manufacturing industries using finished textiles as a primary material, or for the market.

Firms engaged in textile finishing may be occupied in any one or more of the dyeing, printing, bleaching or finishing trades. There are different processes peculiar to each of these trades and others which are used by nearly all firms. A very brief description of some of the main processes is given below.

There are various impurities to be removed from textile materials spun, woven or knitted from natural fibres. To do this cotton or linen materials are packed in large vessels through which boiling alkaline solution is circulated. Prior to this process it is necessary to singe cotton fabrics, either over red-hot metal plates bent in half hoops, or over horizontal rows of gas flames. Woollen fabrics are carbonised by soaking in a weak solution of sulphuric acid, drying in a centrifugal hydro-extractor and baking. This process destroys vegetable matter.

Bleaching of woollen and silk materials is carried out by exposure to sulphur dioxide fumes in a closed chamber. Cottons, linens, rayons and other artificial fibres, are usually bleached in a warm hydrogen peroxide or a chlorine solution. The technicalities of dyeing are very complex, but it is sufficient for the study of fire hazards to know that dyeing usually involves the use of boiling dye liquors in large vats. The machine printing of textiles involves the most complex machinery used in textile finishing. The fire risk is likely to be greater in the steaming process which follows printing than in the printing process itself.

Drying of textiles takes place during various stages of the processes, either over sets of heated drying cylinders, or over brattices in hot-air chambers. The final finishing processes usually involve stretching fabrics across their width on stentering machines. The fabrics are steamed before entering the stenter and dried, while in the machine, by hot air or gas flames. Lustre

is given to some fabrics by calendering or friction polishing over smooth or engraved steel cylinders.

3. THE SCOPE OF THE ANALYSIS

The Joint Fire Research Organization receives a report on every fire attended by a Fire Brigade in the United Kingdom. The information in all the reports received by the Organization for the years 1947 and 1948 was coded on punched cards for mechanical sorting; the cards appertaining to the textile finishing industry were used as an index to the original reports. It was possible to code in 1946 and 1949 only a random 1 in 4 sample, and in 1950 a random 1 in 2 sample of all the reports received. To locate the main bulk of the reports not included in the sample a search was made through the files of reports from the Yorkshire, Lancashire, North Midland and Belfast areas. In this industry about 80 per cent of the establishments employing more than ten people are in these areas (1).

4. THE OCCUPANCY IN WHICH THE FIRE TOOK PLACE

In Table 1 are shown the numbers of fires according to the trades carried on in the premises in which they occurred.

Table 1

The distribution of fires by trade within the textile finishing industry.

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

Trade	1946	1947	1948	1949	1950	Total 1946-50	Per cent
	No.	No.	No.	No.	No.	No.	
Bleaching	2	2	6	5	6	21	12
Dyeing	15	7	11	14	9	56	32
Finishing	2	3	3	7	1	16	9
Making-up and export .... packing	-	1	1	-	-	2	1
Printing	-	3	3	1	1	8	5
More than one of the above	9	12	11	22	18	72	41
Total	28	28	35	49	35	175	100

The Census of Production Report on the Textile Finishing Trade (1) indicates that in 1948 there were 596 establishments employing more than ten people and 104 establishments employing 10 people or less, in Great Britain. In this year there were 34 fires reported in Great Britain in textile finishing premises. This corresponds to a rate of 5.7 fires per year per 100 of the larger establishments, which is probably a good estimate of the incidence of fire in the textile finishing industry as a whole.

There is not likely to be any serious error in assuming that all the fires took place in the larger establishments, since these comprise 85 per cent of all textile finishing works, and the physical dimensions of the premises given in the fire reports agree with the assumption.

The corresponding rate in the primary textile manufacturing industries, excluding textile finishing, is approximately 9 fires per 100 larger establishments. This may be in error on the high side since it is known that there are many small firms in certain branches of the industry and the denominator of the rate may therefore be too small. Although the difference in the rates is statistically significant, it should be noted that the original data from which they are calculated may not be exactly comparable; also the size distribution of establishments throughout the textile industry is known to be very variable, and the two rates refer to one year's experience only. It would therefore be unwise to draw any conclusion more definite than that the fire incidence in the textile finishing trade <u>may</u> be lower than in the other sections of the textile industry.

5. THE CAUSES OF FIRES

The causes of fires in the textile finishing industry are given in Table 2 and a comparison between textile finishing premises and industrial premises as a whole is made for the more important causes in Table 3.

Table 2

The causes of fires in the textile finishing industry

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

Supposed source of ignition	Number	Per cent
Ashes	2	1.1
Boiler	6	3.4
Chemical reaction	1	0.6
Chimney, sparks from (outside building)	4	2.3
Electric fire, heater, radiator	3	1.7
iron	2	1.1
motor	8	4.6
wire and cable	17	9.7
other apparatus	5	2.9
Incomplete extinction of debris from previous fires in premises	3	1.7
Flue	4	2.3
Lightning	1	0.6
Locomotives, sparks from	1	0.6
Matches, children playing with	5	2.9
Mechanical heat and sparks		
(1) Overheating of drying machines, chambers, creels or their textile contents	10	5.7
(2) Heat from machinery, heat or sparks caused by friction in machinery ignited textiles, fluff and dust, waste	16 } 36	9.1 } 20.6
(3) Foreign matter in scutching, filling, breaking and drying machines caused friction which ignited textiles	10	5.7
Oil blowlamp	3	1.7
Oxyacetylene cutting and welding apparatus	6	3.4
Singeing machine	14	8.0
Steam pipes igniting fly and waste	3	1.7
Smoking materials	22	12.6
Spontaneous combustion	9	5.1
Static electricity	1	0.6
Miscellaneous and undefined	6	3.4
Unknown	13	7.4
Total	175	100.0

Table 3

Fires due to certain causes in textile finishing premises, in industrial premises and in buildings generally.

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50.)

Supposed cause of fire	Numbers 1946-50			Percentages		
	In textile finishing premises	In other industrial premises	In buildings other than industrial premises	In textile finishing premises	In other industrial premises	In buildings other than industrial premises
Electric motor.....	8	468	991	4.6	1.8	0.5
Electric wire and cable ..	17	1,304	10,668	9.7	5.0	5.7
Mechanical heat and sparks	36	1,650	357	20.6	6.3	0.2
Oxyacetylene cutting and welding	6	866	592	3.4	3.3	0.3
Smoking materials	22	3,319	17,200	12.6	12.7	9.2
Spontaneous combustion ...	9	445	955	5.1	1.7	0.5
Unknown cause	13	3,341	12,569	7.4	12.8	6.7
Other causes	64	14,669	143,603	36.6	56.3	76.9
Total, all causes	175	26,062	186,935	100.0	100.0	100.0

The six causes specified in Table 3 account for some 56 per cent of the fires in textile finishing premises, and fires caused by singeing machines account for another 8 per cent of the total number. It can be seen that fires due to welding apparatus and smoking materials are in the same proportion in textile finishing as in other industries, while those due to heat and sparks from electric motors, faults in electric wire and cable, mechanical heat and sparks and spontaneous combustion are relatively more frequent in the textile finishing industry. These differences between the textile finishing and other industries are statistically significant. It appears that the proportion of fires for which it was impossible to determine the cause is lower in the textile finishing trade than in other industrial premises.

6. THE MATERIALS FIRST IGNITED

The materials which were ignited first in the fires reported are shown in Table 4. In about a quarter of the fires, cadis, that is textile fly, fluff or dust was the material first ignited and in about another 30 per cent, textiles themselves in one form or another were first ignited. Any outbreak of fire requires a source of heat in the immediate neighbourhood of a flammable material and where there is likely to be an all-pervading flammable material such as fly, dust and fluff the prevention of outbreaks calls for attention to possible sources of heat and the possibility of eliminating the flammable material.

The source of ignition described as "mechanical heat and sparks" is divided in Table 2 into three categories. Fluff and dust were the materials first ignited in 12 fires in the second category ("heat and sparks caused by friction in machinery") and in 2 fires in the third category ("foreign matter in machinery causing friction").

Table 4

The materials ignited first in fires in textile finishing premises

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

Material first ignited	Number	Per cent
Cadis, i.e. fly, dust and fluff	41	23
Cotton - cloth (loose), cloth (baled), wool, yarn, waste, etc.	20	11
Wood - constructional materials	17	10
- contents	5	3
Wool - cloth (loose), cloth (baled or rolled), yarn, waste, etc.	11	6
Miscellaneous waste and rubbish	10	6
Fuel - oil and grease (liquid or vapour)	8	5
Hosiery, miscellaneous cloth	8	5
Linen, silk, rayon, velvet, felt	6	3
Insulation of wire and cable	5	3
Paper and cardboard	5	3
Rags	5	3
Jute sacks, webbing	4	2
Kapok, flock, shoddy	4	2
Fuel - coal	3	2
Other constructional materials	4	2
Miscellaneous and undefined	3	2
Unknown	16	9
Total number of fires	175	100

In 6 out of the 17 fires caused by electric wire and cable, and in 5 out of the 8 fires caused by heat or sparks from electric motors, fluff or dust was again the material first ignited. The high incidence of these fires is therefore closely connected with the presence of a readily flammable material.

The fires caused by smoking materials are different in character: in 10 of the 22 fires, textiles in bales or rolls or in racks, were reported as the material first ignited, and in only 3 fires was it said that dust or fluff was first ignited. The fires attributed to spontaneous combustion nearly all occurred in textiles which had been treated with oil. This is a recognised source of fires in the textile industry, but fires may often be attributed by reporting officers either to this cause or to the careless disposal of smoking materials and matches, when there is actually no direct evidence although it is thought that all known possible alternatives have been eliminated. A degree of uncertainty must remain in many instances, and it is possible that the cause of some of these fires would more accurately be described as unknown.

7. POINT OF OUTBREAK OF FIRES

Table 5 shows the point of origin of fires in the textile finishing industry. The majority of the fires start in the drying department, in the stentering, finishing, singeing and miscellaneous processing departments or in the stores, boiler house or roof space.

Table 5

The point of origin of fires in the textile finishing industry

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

Where fire started	Number	Per cent
Bleaching department	2	1.1
Drying department	40	22.9
Dyeing Department	2	1.1
Filling and stentering department	7	4.0
Finishing department	10	5.7
Raising department	4	2.3
Singeing department	14	8.0
Other processing departments	16	9.1
Boiler house	8	4.6
Roof or roof space	9	5.1
Stores	20	11.4
Vehicles in garage or loading bay	3	1.7
Engine room	4	2.3
Workshop	2	1.1
Electrical apparatus, location not given	3	1.7
Miscellaneous	30	17.1
Unknown	1	0.6
Total	175	100.0

It is of interest to relate the point of origin to the cause of outbreak. This has been done in Tables 6 - 9.

In Table 6 the fires starting in drying departments are listed. Some 28 of the 40 fires were directly connected with the drying process. Ten of the remaining 12 fires could have occurred in places other than the drying department, but at least 6 of them were directly connected with textile processing, in that textiles or textile fluff and dust were the materials first ignited.

Table 6

The source of ignition of fires starting in the drying department

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

Reported source of ignition	Number
Drying machine - overheating of textiles	10
- electrical fault	2
- mechanical fault	3
Foreign material in drying machine caused friction and sparks	6
Spontaneous combustion in oiled wool or Shetland stocking	3
Electrical short circuit in wiring ignited fluff or dust	2
Boiler flue ignited jute sacks hung to dry	1
Cigarette end ignited bundled hosiery on floor and in drying racks	1
Conveyor of drying machine stopped; loose wool ignited	1
Heat and sparks from mechanical breakdown ignited wool fluff	1
Heat from steam pipes ignited fluff and yarn on pipes	1
Overheating of electrical tubular heaters left switched on ignited insulation of heater pipes	1
Self ignition of stack of hot damp partially dried cloth	1
Static electricity ignited fluff from cloth in drying machine	1
Unknown - known to be connected with drying machine	2
- not known to be connected with drying machine	4
Total	40

Table 7 refers to fires in processing departments other than drying departments. Singeing machines were the reported source of ignition in 14 fires, mechanical heat and sparks caused another 15 fires and smoking materials a further 8 fires. Thirtyone of the 55 fires were known to be connected with the processing machinery.

Table 7

The source of ignition of fires starting in the bleaching, dyeing, stentering, finishing, raising, singeing and other processing departments.

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

Reported source of ignition	Number
Heat or sparks in machinery ignited textiles, dust and fluff, oil	11
Singeing machine ignited fluff and dust	8
Smoking materials ignited sacks, kapok, fluff and dust, etc.	8
Cloth ignited in singeing machine; cloth left smouldering after passing through machine	6
Short circuits in electric wire and cable ignited structural timber, cotton fly, insulation of wiring	5
Sparks from foreign bodies in filling, scutching, rag breaking and cotton breaking machines ignited textiles or dust and fluff	4
Sparks from welding plant	3
Electric iron left switched on ignited ironing board	2
Miscellaneous causes	6
Unknown	2
Total	55

Fires which started in boiler houses, roofs or stores are given in Table 8. In only 3 of the fires, those started by spontaneous combustion, was the source of ignition particularly associated with the textile industry. The sources of ignition in 18 fires were chimneys, flues, boilers, or discarded smoking materials. In 5 of these fires structural timbers were ignited; in the other 13 mainly textile waste and textiles were set alight.

Table 8

The source of ignition of fires starting in boiler houses, roofs or roof spaces, and stores

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

Reported source of ignition	Number
Discarded smoking materials ignited textiles, roof timbers	7
Sparks or heat from flues and chimneys ignited coal, webbing, bags of waste dust, roof timbers, roofing felt	6
Sparks, heat or flames from boilers ignited waste placed on boiler, wooden gantry over boiler, roof timbers, coal and rubbish	5
Electrical faults ignited fluff and dust, timber duct, mains fuse box, oil residue in electric motor	4
Spontaneous combustion in baled wool, fine coal, carbonised wool waste	3
Workman's blowlamp ignited partition, paintwork on door	2
Children playing with matches set fire to waste paper and straw in storage sheds	2
Miscellaneous	5
Unknown	3
Total	37

The fires listed in Table 9 occurred in various places not covered by the lists in the preceding tables. Only 2 of the 43 fires, those in which the source of ignition was spontaneous combustion, are peculiar to the textile industries, but the materials first ignited in some of the fires, such as cotton yarn or waste, cotton fly, dust and fluff, are likely to occur only in textile processing.

Table 9

The source of ignition of fires starting in places other than processing departments, boiler houses, roofs or roof spaces and stores.

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

Reported source of ignition	Number
Electric motor sparking, overheating or short circuiting, ignited grease, dust and fluff, cotton fly, petrol vapour; broken electric inspection lamps ignited petrol or spirit vapour	8
Electrical faults in wire and cable ignited insulation, silk rolls, cotton fly, oil vapour	7
Discarded smoking materials ignited waste paper, rubbish, cotton yarn, cotton waste, wood wool and hay	6
Oxyacetylene cutter, blowlamp, ignited residue oil and grease, flammable material, timber support, sawdust packing	4
Children playing with matches ignited waste paper, rubbish and petrol	3
Incomplete extinction of previous fire	3
Spontaneous combustion in greasy waste and oily loose woollen materials	2
Miscellaneous	8
Unknown	2
Total	43

8. TIME OF OUTBREAK OF FIRES

The numbers of fires occurring in each month are shown in Table 10. There were generally about 14 or 15 fires per month with departures from this average in some months which may reflect the influence of peak periods of output and of holidays.

Table 10

The numbers of fires in textile finishing premises according to the month in which the outbreaks occurred

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

Month	Number of fires		
January	15	0	0
February	10	5	25
March	14	1	1
April	10	5	25
May	24	9	81
June	17	2	4
July	13	2	4
August	9	6	36
September	12	3	9
October	15	0	0
November	14	1	1
December	22	7	49
	12 | 175	6	235
	14½		16
	15		

There does not appear to be any relation between the month of occurrence and the cause of fire. It is a truism that the number of fires in textile finishing premises, as in other industrial premises, is largely dependent upon the level of activity in the premises at any time. It can be seen from Table 11 that there were about half as many fires on Saturdays and Sundays as there were on the other days of the week.

This distribution would be expected in an industry working either a five and a half, or a five day full working week with maintenance work and perhaps certain continuous processes being carried out for part of, or the whole of, Saturday and all Sunday. The causes of fires occurring on Saturdays and Sundays agree with this suggestion.

$\chi^2 = 16$

11 df

Table 11

The day of the week in which fires occurred in textile finishing premises

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

Day of week	Number of fires
Sunday	14
Monday	28
Tuesday	26
Wednesday	28
Thursday	31
Friday	31
Saturday	17

Two of the 14 fires which occurred on Sundays were due to hot ashes, and there was 1 fire due to each of the causes "electric wire and cable", "flue", "boiler", "children playing with matches" and "mechanical heat and sparks". Three fires were attributed to smoking materials, 2 to spontaneous combustion, and 1 to rags in a drying creel overheating; the cause of 1 fire was unknown. The fire due to mechanical heat and sparks was caused by a bearing in a sueding machine overheating. This fire, and the fire due to rags overheating are the only two which appear likely to have resulted from normal working being carried out on a Sunday. The fires occurring on Saturdays were due to very much the same causes as those occurring on Sundays and there were few that appear to have resulted from normal working activities.

The times of discovery of the fires are given in Table 12. From 4.30 p.m. the numbers rise to a peak of 23 between 7.30 and 8.30 p.m. and then decrease.

The distribution of the causes of fire, according to the time of discovery, which may differ considerably from the time of outbreak, is shown for the more important causes in Table 13. The variation in incidence at different periods of the day is to some extent explained, if some works are in either complete or partial operation day and night. There were, for example, fires caused by mechanical heat and sparks, smoking materials and singeing machines, between 9.30 p.m. and 7.30 a.m.

Table 12

The times of discovery of fires in textile finishing premises

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50).

Time of discovery	Number
11.30 p.m. - 12.29 a.m.	6
12.30 a.m. - 1.29 a.m.	2
1.30 a.m. - 2.29 a.m.	2
2.30 a.m. - 3.29 a.m.	5
3.30 a.m. - 4.29 a.m.	3
4.30 a.m. - 5.29 a.m.	7
5.30 a.m. - 6.29 a.m.	2
6.30 a.m. - 7.29 a.m.	5
7.30 a.m. - 8.29 a.m.	3
8.30 a.m. - 9.29 a.m.	8
9.30 a.m. - 10.29 a.m.	8
10.30 a.m. - 11.29 a.m.	7
11.30 a.m. - 12.29 p.m.	7
12.30 p.m. - 1.29 p.m.	9
1.30 p.m. - 2.29 p.m.	4
2.30 p.m. - 3.29 p.m.	10
3.30 p.m. - 4.29 p.m.	6
4.30 p.m. - 5.29 p.m.	11
5.30 p.m. - 6.29 p.m.	15
6.30 p.m. - 7.29 p.m.	14
7.30 p.m. - 8.29 p.m.	23
8.30 p.m. - 9.29 p.m.	10
9.30 p.m. - 10.29 p.m.	1
10.30 p.m. - 11.29 p.m.	7

The day can be divided into three periods, (1) 7.30 a.m. - 4.30 p.m. with an average of about 7 fires per hour, (2) 4.30 p.m. - 9.30 p.m. with an average of about 15 fires per hour, and (3) 9.30 p.m. - 7.30 a.m. with an average of 4 fires per hour. For each of these periods the differences between the average number and the actual number in any hourly interval are small enough for the fire incidence to be regarded as constant for that period. The incidence certainly differs between the three periods.

The number of fires per hour is higher for every cause in Period II (the peak period) than in Period I, which covers a normal working day until the beginning of the peak period, but because of the small numbers of fires, and the large element of chance which enters into the outbreak of almost any fire, the difference can be regarded as significant only for fires due to mechanical heat and sparks, smoking materials, and the other causes specified separately in Table 2 and added into one item in Table 8. Scrutiny of the reports of individual fires does not show any reason for this outburst of fires in Period II.

Table 13

The causes of fires in relation to the times of discovery

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

(The figures in brackets are numbers of fires per hour)

Cause of fire	Period I 7.30 a.m.-4.30 p.m.		Period II 4.30 p.m.-9.30 p.m.		Period III 9.30 p.m.-7.30 a.m.	
Electric motor	3	(0.3)	2	(0.4)	3	(0.3)
wire and cable	6	(0.7)	7	(1.4)	4	(0.4)
Mechanical heat and sparks	14	(1.6)	16	(3.2)	6	(0.6)
Singeing machine	5	(0.6)	4	(0.8)	5	(0.5)
Smoking materials	7	(0.8)	10	(2.0)	5	(0.5)
Spontaneous combustion	2	(0.2)	2	(0.4)	5	(0.5)
Other causes specified in Table 2	18	(2.0)	24	(4.8)	8	(0.8)
Miscellaneous causes	2	(0.2)	4	(0.8)		-
Unknown cause	5	(0.6)	4	(0.8)	4	(0.4)
Total ...	62	(6.9)	73	(14.6)	40	(4.0)

Another interesting feature of fires in textile finishing premises is the mode of discovery of the fire. Table 14 shows the person who discovered the fire according to the period of the day. The fact that between 4.30 p.m. and 7.30 a.m. about 20 per cent to 25 per cent of the fires were reported to have been discovered by passers-by, suggests that the procedure devised for discovering fires is somewhat inadequate for the level of activity which, it is believed, exists in textile finishing premises during these hours.

Table 14

The person discovering the fire in relation to the time of discovery

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

(The figures in brackets are percentages)

Person discovering the fire	Period I 7.30 a.m.-4.30 p.m.		Period II 4.30 p.m.-9.30 p.m.		Period III 9.30 p.m.-7.30 a.m.	
Employees, owners or other occupiers of the premises	55	(89)	46	(63)	19	(48)
Passers-by	3	(5)	18	(25)	8	(20)
Policemen on beat)	1	(1)	1	(1)	2	(5)
Watchmen, caretakers	2	(3)	7	(10)	9	(22)
Other people	1	(1)	1	(1)	2	(5)
	62	(100)	73	(100)	40	(100)

9. LARGE FIRES

There were 19 large fires in textile finishing premises in the period 1944-1950. Large fires which occurred in 1944 and 1945 have been included to extend the information available. None of these fires was caused by enemy action. The average loss per fire in each year is given in Table 15 and the distribution of the fires according to the amount of the loss in Table 16.

The numbers of large fires differs from the number given in references (2) and (3), since further enquiry revealed that three large fires which actually occurred in textile finishing had previously been included with reports of fires in other branches of the textile industry.

Table 15

The average direct loss per year from large fires in textile finishing premises.

(Compiled from monthly reports in "The Times")

Year	Total loss	Number of fires	Average loss per fire
	£000's	No.	£000's
1944	595	3	198
1945	107	4	27
1946	40	2	20
1947	293	4	73
1948	191	1	191
1949	386	4	97
1950	36	1	36
	1,648	19	87

The loss due to large fires probably accounts for a proportion of the order of 90 per cent, if not more, of the total loss due to fire in the textile finishing industry. Table 16 shows that the loss caused by only 5 fires amounted to 70 per cent of the total loss due to large fires; the loss due to one fire alone was 30 per cent of the total. There were four other really large fires.

Table 16

The distribution of large fires according to the direct loss

(Compiled from monthly reports in "The Times")

Direct loss	Number of fires	Total loss due to fires of given size	Per cent of total loss
		£000's	
£10,000 and under £25,000	7	115	7
£25,000 and under £50,000	5	166	10
£50,000 and under £100,000	2	161	10
£100,000 and under £200,000	4	666	40
£200,000 or over	1	540	33
Total	19	1,648	100

Special reports, in more detail than the routine reports from the Fire Brigades are available for five large fires. The only information available on one fire is that the trade carried on was dyeing and calico printing and the direct loss was £25,000. There is information in greater or lesser detail on 18 large fires.

The causes of 7 fires were reported with no expression of uncertainty. The causes of two fires were reported as dropped cigarette ends or lighted matches, causes which are difficult to establish and should be regarded with reserve.

One fire was reported as probably due to sparks from a boiler fire travelling through ventilators and igniting linen yarn in drying racks, and another as due to a probable electrical fault. Prior to the outbreak of this latter fire there had been an electrical fault which cut off the supply to the works, presumably at the main fuse-box. It was reported that the electric wiring was exposed to heat and was not in conduits.

The remaining nine fires were reported as due to unknown causes. In one fire waste rags were ignited by an unknown source of ignition.

It was reported that the possible causes of fire had been carefully examined in two large fires. The possible causes in one fire were either an electrical fault or a dropped light. Spontaneous combustion was considered to be unlikely. The possible causes of the other fire were considered to be as follows: (1) Heat from steam pipes started a chemical reaction in hessian wrappers which led to spontaneous combustion. This would only be likely if the hessian had become impregnated with oil. (2) The electric wiring had been renewed within the two years previous to the outbreak, but not enclosed in conduits. There was a $\frac{1}{2}$ inch layer of cotton fly present on the beams and machinery of the drying rooms. It was possible that an electric motor overheated and ignited this cotton fly. (3) There was a strict "No smoking" rule in force, but there were only six men working at the time of the outbreak. The possibility of illicit smoking could not be ruled out.

The detailed report on the fire which caused the most severe loss, mentioned several factors which aided the spread of fire. There was a quantity of cotton and kapok fluff on the floors and beams which helped the spread of fire around the source of ignition. There were no sprinklers in the building; there were open communications from floor to floor; fire breaks were lacking; the works appliances were defective or could not be operated; the contents of the buildings were highly flammable, and finally there was a high wind blowing. This combination of adverse circumstances was exceptional, but one or other of these circumstances occurred in every large fire and in many of the smaller fires. No sprinklers were fitted in any of the 18 premises in which large fires occurred, and for which information is available. Only 4 of the 18 fires took place in normal working hours; 2 fires were discovered early on Saturday afternoons, one at 1.00 p.m. and the other at 1.50 p.m. The remaining fires were all later than 6 p.m., 6 of them were discovered between 6.00 p.m. and 10.30 p.m. It is shown later in the report that there is some evidence of an association between the delay between the discovery of the fire and the arrival of the Fire Brigade and the damage caused by the fire. The presence of a layer of cotton fly, fluff or dust was mentioned in several reports either as a readily flammable material or as a circumstance which contributed to the rapid spread of fire. The presence of fire resisting doors which helped to contain the fire were reported in three large fires and one of the smaller fires. The presence or absence of fire-stops, other than fire-resisting doors, and of openings from floor to floor were not often explicitly mentioned, but it can be inferred that fire stops and fire-resisting doors would have prevented considerable damage in some of the large fires.

10. THE DAMAGE CAUSED BY FIRES

There are several ways of measuring fire damage. One of the best scales, though by no means ideal, is in terms of the financial loss due to material damage. The information necessary to do this is unfortunately available only for the "large" fires, those causing damage to the extent of £10,000 or more. Another scale is in terms of the physical extent of the damage, that is "fires confined to the room of origin", "fires confined to the floor of origin", "fires spread beyond the building of origin" and so on. This scale, though useful for fires in dwellings, has been found to be misleading in the case of fires in industrial premises in which there is large machinery in use, and consequently in which there are likely to be long, high rooms, extending, on occasion, over two or more floors.

The scale that has been used for indicating damage in this report is a combination of physical extent and the type of material damaged and the results of examining the fire reports on this basis are given in Table 17.

Table 17

The damage caused by fires in textile finishing premises

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

Type of damage	Fires causing very slight damage	Other fires
(1) Damage to structure of premises only	16	11
(2) Damage to contents of premises only ..		
(a) textiles only, finished, or in process (excluding waste textiles)	4	-
(i) including fires where the damage was not adequately described	-	15
(b) textile processing machinery only .... (including electric cables)	13	4
(c) other contents (including machinery other thn textile processing machinery and waste textiles)		
(i) textile waste	4 } 16	1 } 5
(ii) other contents	12	4
(3) Damage to structure and contents only ..... (excluding textile processing machinery)	6	-
(i) fires in which the damage was not adequately described	-	7 } 35
(ii) other fires	-	28
(4) Damage to structure and processing machinery only		
(i) fires in which the damage was not adequately described	-	3 } 9
(ii) other fires	-	6
(5) Damage to contents (including textiles) and processing machinery only	3	10
(6) Damage to structure, processing machinery and contents	1	15
(7) Large fires (damage to the extent of £10,000 or more)	-	12
Total	59	116

Out of 175 fires some 59 caused trivial damage; these were mainly the fires which involved damage to the structure of the premises only or to processing machinery only or to contents other than processing machinery and textiles but including textile waste. In the 27 fires in which structure only was damaged, it was reported that mechanical heat and sparks, sparks from short circuits in electric wire and cable, discarded cigarette ends or other smoking materials, sparks from chimneys, heat from blowlamps or oxy-acetylene torches and two or three miscellaneous causes ignited fluff and dust and then structural materials in 10 fires, and structural timber directly in the other fires. The total financial loss due to the 11 fires in which the damage was not trivial is believed to be only a very small proportion of the total financial loss due to fire in the whole industry. There was only one fire reported in which there appeared to have been a serious loss due to damage to textiles only. In this fire 2,000 curtains and bedspreads were destroyed out of a stock of 7,000. In none of the fires involving textile processing machinery only was there severe damage. The same appears to be true of the fires in which the damage was to miscellaneous contents, including textile waste and machinery other than textile processing machinery. In general the damage referred to in this report is direct fire damage, but it is possible that indirect damage to machines due to heat, smoke and water, is often of major importance.

There were 41 fires in all, in which both structure and contents, excluding processing machinery, were damaged. The damage in 6 of these fires was trivial; in 7 more fires the damage was not adequately reported but in no case was the loss likely to have been really heavy. It is difficult to classify the

remaining 28 fires according to any objective criterion in the absence of information on financial loss, but there appear to have been only 3 fires in which the damage was severe. In one of these about 12,000 yards of cotton piece goods were severely damaged together with damage to about 50 sq. yards of glass and asbestos roofing and slight damage to wood scrays and piece carts. In the building there were 300 cotton pieces 80 yards long and about half of these were severely damaged by fire. The second fire took place in a store containing approximately a million yards of cotton cloth and velvet. The suspected source of ignition was a cigarette end. The fire damaged approximately 40,000 yards of the material. The third fire was due to an explosion in a chemical laboratory which destroyed all the contents of the laboratory.

In the next category, that in which there was damage to processing machinery and structure but not contents, there were no fires causing severe damage.

There were two fires causing severe damage to contents and textile processing machinery only. In one about 5,500 yards of grey cloth were damaged and two gas singeing machines and two electric motors were slightly damaged. The main damage in the other fire was to machinery, 7 raising machines and a rope race being severely damaged together with an unspecified quantity of flannelette.

In the 16 fires in which there was damage to structure, contents and processing machinery, there were seven which apparently caused appreciable damage. The damage in some of these seven fires was probably severe. For example, one fire took place in a part single storey and part two storey building containing large stocks of cloth, carbonizing machinery and brushing machines, and it was reported that there was severe damage to structure and machinery, and destruction of about 50 per cent of the cloth. The damage caused in these fires may be summed up as follows. During the period 1946-1950 there were at least 59 fires which caused only trivial damage; 104 which caused non-trivial damage, in at least 6 of which the damage was severe (bur presumably below £10,000 for each fire), and 12 large fires in each of which the loss amounted to £10,000 or more. The damage due to the large fires between 1946 and 1950 amounted to £946,000, an average of £79,000 per fire. Seven per cent of the fires in textile finishing premises were large fires and this may be compared with just under 2 per cent of the fires in all other industrial premises. A breakdown has been obtained of the monetary losses in two large fires. In one fire about 50 per cent of the loss was due to damage to machinery, about 25 per cent to damage to structure and about 25 per cent to damage to textiles. In the other the main damage was in the destruction of textiles which accounted for about 75 per cent of the loss; the destruction to machinery amounted to about 15 per cent and the structural damage to about 10 per cent of the total loss. In general, the major part of the loss in the textile finishing industry appears to have been through damage to textiles in various stages of manufacture; the loss caused by damage to processing machinery and to building structures being, so far as it can be determined from the reported information, subsidiary to the loss caused by damage to textiles.

Damage to processing materials such as dyestuffs and detergents was reported in some fires; the proportion of the total loss due to damage to these materials appears to have been small. The final report of the Census of Production for 1948, for the Textile Finishing Trade gives figures, in money terms, of the amount of work in progress and stocks of processing materials for the larger firms in the industry, that is those firms employing more than ten persons. The figures are reproduced in Table 13; only a quarter of the total value is represented by work in progress, but about 40 per cent of the value is in dyestuffs. The fact that most of the loss has been caused by damage to textiles may be due to their flammable nature, and to the fact that they are probably much more handled during processing and in storage than dyestuffs.

Table 18

Work in progress and stocks of material and fuel-1948

Establishments in the textile finishing trade employing more than ten persons

(Reproduced from "Final report of Census of Production for 1948: Trade P Textile Finishing")

	At beginning of year		At end of year	
	Value £000	Per cent	Value £000	Per cent
Work in progress	1,686	26	2,040	26
Materials and fuel				
Dyestuffs	2,597	40	3,292	42
Soap, detergents, other materials	1,743	27	2,020	26
Coal	472	7	493	6
Total	6,498	100	7,845	100

Tables 19 and 20 show the relation between the category of damage and the cause of fire and point of origin of the fire respectively. A point to be noted from Table 19 is that in no less than 6 of the 12 large fires the cause was unknown. It can be seen from Table 20 that fires starting in drying departments tend to cause more than their share of non-trivial damage.

Table 19

The causes of fires according to the category of damage sustained

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

Cause of fire	Fires causing only trivial damage		Fires causing damage to an extent of less than £10,000		Fires causing damage to an extent of £10,000 or more	
	No.	Per cent	No.	Per cent	No.	Per cent
Ashes, soot	1	1.7	1	1.0		
Boiler	3	5.1	2	1.9	1	8.3
Chimney, sparks from (outside building)	3	5.1	1	1.0		
Electric fire, heater, radiator	1	1.7	1	1.0	1	8.3
iron	1	1.7	1	1.0		
motor	2	3.4	6	5.7		
wire and cable	7	11.9	10	9.6		
other apparatus	3	5.1	2	1.9		
Incomplete extinction of debris from previous fires	2	3.4	1	1.0		
Flue	3	5.1	1	1.0		
Matches, children playing with	3	5.1	2	1.9		
Mechanical heat and sparks	7	11.9	27	26.0	2	16.7
Oil blowlamp	2	3.4	1	1.0		
Oxyacetylene cutting and welding apparatus	1	1.7	5	4.8		
Singeing machine	5	8.5	9	8.7		
Steam pipes igniting fly and waste	1	1.7	2	1.9		
Smoking materials	5	8.5	15	14.4	2	16.7
Spontaneous combustion in materials other than rubbish	2	3.4	7	6.7		
Miscellaneous and undefined ...	6	10.2	4	3.8		
Unknown	1	1.7	6	5.7	6	50.0
Total	59	100.0	104	100.0	12	100.0

Table 20

Where fires started according to the damage sustained

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

Where fire started	Fires causing only trivial damage		Fires causing damage to an extent of less than £10,000		Fires causing damage to an extent of £10,000 or more	
	No.	Per cent	No.	Per cent	No.	Per cent
Bleaching department	1	1.7	1	1.0	-	-
Drying department	5	8.5	31	29.8	4	33.3
Dyeing department	2	3.4	-	-	-	-
Filling and/or stentering departments	2	3.4	4	3.8	1	8.3
Finishing department	3	5.1	5	4.8	2	16.7
Raising department	-	-	4	3.8	-	-
Singeing department	5	8.4	9	8.7	-	-
Other processing departments ..	3	5.1	12	11.5	1	8.3
Boiler house	5	8.4	3	2.9	-	-
Roof or roof space	7	11.9	2	1.9	-	-
Stores	5	8.4	14	13.5	1	8.3
Vehicles in garage or loading bay	1	1.7	1	1.0	1	8.3
Engine room	-	-	4	3.8	-	-
Workshop	1	1.7	1	1.0	-	-
Electrical apparatus (location not given)	3	5.1	-	-	-	-
Miscellaneous	16	27.1	12	11.5	2	16.7
Unknown	-	-	1	1.0	-	-
Total	59	100.0	104	100.0	12	100.0

In Table 21 the amount of damage caused by fires is shown in relation to the trade being carried on.

Table 21

The category of damage in relation to the trade carried on in textile finishing premises

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

Trade carried on	Fires causing only trivial damage		Fires causing damage to an extent of less than £10,000		Fires causing damage to an extent of £10,000 or more	
	No.	Per cent	No.	Per cent	No.	Per cent
Bleaching	6	10.2	14	13.5	1	8.3
Dyeing	16	27.1	37	35.6	3	25.0
Finishing	5	8.5	10	9.6	1	8.3
Making-up and export packing	2	3.4	-	-	-	-
Printing	4	6.8	4	3.8	-	-
More than one of the above .	26	44.1	39	37.5	7	58.3
Total	59	100.0	104	100.0	12	100.0

A point of interest in fires in textile finishing premises is whether there tends to be a rapid spread of fire. This cannot be measured directly from the reported information but an idea can be gained from the figures in Table 22 in which the size of the fire is related to the time between its discovery and the arrival of the Brigade.

Table 22

The time delay between the discovery of the fire and the arrival of the Fire Brigade, according to the damage sustained.

(Reports of fires attended by the Fire Services in the United Kingdom 1946-50)

	Fires causing only trivial damage		Fires causing damage to an extent of less than £10,000		Fires causing damage to an extent of £10000 or more	
	Mean delay	Median delay	Mean delay	Median delay	Mean delay	Median delay
	Mins.	Mins.	Mins.	Mins.	Mins.	Mins.
Fires in which there was no fire-fighting before the arrival of the Fire Brigade	8.8	7.0	8.5	7.0	15.9	14.5
	based on 20 fires		based on 34 fires		based on 8 fires	
Fires in which there was fire-fighting before the arrival of the Fire Brigade	9.9	8.0	9.8	8.0	19.0	17.5
	based on 39 fires		based on 70 fires		based on 4 fires	

In Table 22 two representative figures for the time delay between the discovery of the fire and the arrival of the Fire Brigade are given, for the various categories of damage sustained. The reported delays for individual fires vary considerably and since a few long delay times affect the arithmetic mean unduly, the median, that is the middle observation when the data are ranked in size order, has also been calculated. The conclusions are the same whichever representative figure is used. Because of the variation in the delay times a larger number of fires are needed, for differences in the means to be considered statistically significant, but there is a suggestive pattern in the figures. The three categories of damage are not equally spaced on any scale of measurement, and it has been shown that the majority of fires in the category "fires causing non-trivial damage less than £10,000 do not cause damage that could be regarded as severe. It is not surprising that there is no appreciable difference between the mean or median figures for the first two categories of damage, whereas the means or medians for the third category, the "large fires", are twice the corresponding figures for the first two categories, but they are based on small numbers of fires. The other points of interest are the proportion of fires in which there was firefighting before the arrival of the Fire Brigade, and whether this factor is associated with any increase in the delay between discovery of the fire and arrival of the Fire Brigade. There was firefighting before the arrival of the Fire Brigade in two-thirds of the fires in the first two categories of damage but in only one-third of the "large" fires. This difference again is not statistically significant but it suggests that lack of firefighting before the arrival of the Fire Brigade is associated with the spread of fire throughout the premises. Where there is firefighting before the arrival of the Fire Brigade there may be a slightly longer delay between discovery of the fire and arrival of the Fire Brigade, but there is not enough evidence to draw a firm conclusion.

11. THE PROVISION OF FIRE-FIGHTING FACILITIES

(a) Sprinklers

There were 18 fires reported in different premises in which sprinklers were installed. In 4 fires the sprinklers failed to operate, either because insufficient heat was generated by the fire or because the fire was shielded in some way from the sprinkler system. There were 3 fires where the sprinkler system operated but did not control the fire. In 2 fires the reason for this was reported to be the spread of fire due to dust and fluff; the remaining fire was between floor boards and ceiling. In 10 fires the reported information was that the sprinklers controlled but did not extinguish the fire, and 1 fire was reported to be extinguished by water from the sprinkler system.

In 11 out of the 14 fires in which sprinklers operated, between 1 and 5 heads were actuated, and in the other 3 fires between 6 and 10 heads were actuated.

In only two of the 11 fires in which the fire was controlled or extinguished by the sprinkler system was there sizeable damage. In one of these fires one-third of the structural woodwork of the roof of a 150 ft. by 100 ft. building was severely damaged by fire, and in the other there was damage to 150 pieces of cotton cloth. The damage appears to have been more severe in two of the three fires where the sprinklers operated and did not control the fire because of the rapid spread in dust and fluff. In one of these there was severe damage to 7 raising machines and in the other there was damage to 1 carbonising mangle, 3 drying machines, 2 heaters and 2 sets of drying cylinders and 70 ft. by 30 ft. of roof boarding and rafters.

There were no sprinklers installed in any of the premises in which large fires took place.

(b) Fire-fighting devices other than sprinklers

There were fire-fighting devices, other than sprinklers reported to be available in 31 fires; these ranged from major trailer pumps and steam pumps to internal hydrants, yard hydrants, rising mains, stirrup pumps and hand extinguishers. Fire-resisting doors were mentioned in only four reports.

12. CASUALTIES

There were 16 casualties other than Fire Brigade casualties reported in the 175 fires. None of the injuries sustained by the 15 men and 1 woman appears to have been very grave and there were no fatal casualties.

13. CONCLUSIONS

The rate of incidence of fires in textile finishing premises in 1948 was 5.7 fires per year per 100 larger establishments, compared with a rate of approximately 9 fires per 100 larger establishments in the same year in textile manufacturing premises excluding textile finishing premises. As pointed out in Section 4 of this report it is possible that the fire incidence in the textile finishing trade may be lower than that in the remaining part of the textile industry.

It is apparent that the presence of fly, dust and fluff leads to fires which otherwise would not have taken place, through the lack of any material for the source of heat to ignite. This fact accounts to some extent for the relatively greater incidence of fire due to electric motor, electric wire and cable, mechanical heat and sparks, in textile finishing premises compared with other industrial premises and may also contribute to a rapid spread of fire once ignition has taken place. Action to reduce the amount of fluff or dust about, the presence of foreign substances in textiles undergoing processing, the fire risk apparently associated with singeing machines and the careless disposal of smoking materials in processing departments and stores would materially reduce the incidence of fires in these premises. From Tables 6 and 7 it can be seen that 59 fires, just over one-third of the total number, are directly connected with the processes carried on. Tables 8 and 9 show the causes of fires occurring in places other than the processing departments. The sources of ignition in only a few of these fires were peculiar to the textile finishing industry. The impression gained from these tables is that the fire incidence could be reduced by enforcing regulations against smoking, by better organisation of the storage of flammable materials, and by general tidying and cleaning.

The times of discovery of fires show two interesting features. The peak incidence of fires occurs in the hour 7.30 - 8.30 p.m. and just before this time. The explanation of this fact possibly lies in the working schedule of the industry. The other feature is that although 113 of the 175 fires were discovered between 4.30 p.m. and 7.30 a.m. about a quarter of these were discovered by passers-by and policemen, compared with 6 per cent of the fires discovered between 7.30 a.m. and 4.30 p.m.

In the absence of information on the financial loss incurred in each fire it is difficult to assess damage objectively but certain conclusions may be drawn. There were 12 "large" fires (between 1946 and 1950) in which the damage was £10,000 or more; in four of these fires the damage amounted to a total of £690,000. In all the "large" fires there was damage to textiles; in one fire, No.5, to the extent of £150,000. In all but one of the fires causing damage which was severe but costing less than £10,000, the main damage was to textiles. Once the comparatively few fires causing severe damage, but presumably to an extent of less than £10,000, and the 12 large fires have been excluded, it is reasonable to assume that the average damage in the remaining fires is less than £1,000, and is probably, in fact, well below this figure. This average compares with the average damage per large fire of £79,000. It is obvious that the large fires are responsible for by far the greater part of the loss by fire suffered by the industry. In general the main damage in the large fires appears to have been to textiles, though there was also damage to the structure of buildings, and to processing machinery in all the large fires. This suggests that it may be possible to reduce the risk of serious loss by ensuring that large quantities of textiles are not stored, either during processing or after processing, so that a fire once started can spread easily through all the cloth. The division of processing rooms and stores by fire-resisting partitions should ensure this without great expense.

There is a further recommendation which should reduce the fire incidence in textile finishing premises. Only about 10 per cent of the premises in which there were fires attended by Fire Brigades were reported to have sprinkler systems. This figure obviously cannot be used as an estimate of the proportion of premises in the industry in which there are sprinkler systems installed. Evidently far more use could be made of this form of fire protection, which appears to be reasonably effective, since some 60 per cent of the fires in premises where sprinklers were installed were controlled or extinguished by the sprinklers.

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