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## FIRE RESEARCH NOTE

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WATER USED IN FIRE FIGHTING

by

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SUMMARY

A study has been made of the quantities of water used in fire fighting by 11 fire brigades during a period of 12 months. Although there were some differences between brigades the general distribution patterns of quantities used were similar. Over 80 per cent of the fires attended were extinguished with 100 gallons or less.

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## Introduction

To form some estimate of the water requirements of fire brigades and to compare these with the quantities found necessary to extinguish fires in the laboratory, a study has been made of the quantities of water actually used in fire fighting by eleven fire brigades in England and Wales. The brigades asked to co-operate in this work were selected to give a reasonable geographical spread and to include different types of area; they included 5 county boroughs and 6 counties.

The eleven brigades were asked to estimate the quantity of water used at each fire attended during the period April 1960 to March 1961 and to add this information to that given in their routine fire reports.

For convenience in handling the information was processed as part of the normal statistical analysis of fire reports and, in consequence, a 1 in 4 sample of reports was used. Fires confined to heath and grassland, and to railway embankments were excluded from the analysis as some of the brigades did not report the quantities of water used in these incidents. Chimney fires which were confined to chimneys were also excluded.

## Brigade Differences

The actual frequencies with which different quantities of water were used by individual brigades on the fires in the 1 in 4 sample are shown in Table 1 and, to simplify comparison, the percentage frequencies are given in Table 2. It will be seen that, although there is a general similarity in the distribution patterns, there are differences between brigades. For example Brigade B2 used between 30 and 100 gallons on almost 40 per cent of its fires, a much higher proportion than any of the other brigades. In Brigades B4 and C2 quantities between 100 and 300 gallons were used proportionately more often than in other brigades.

The spread of frequencies is indicated by the maximum and minimum lines of the diagram in Fig. 1. The greatest difference between brigades occurs in the 30 to 100 gallon region and the frequency range is small for the larger quantities.

## Assessment of Requirements

The total frequencies of the quantities of water reported are given in Table 3 and, in the form of a frequency distribution diagram, in Fig. 2. About 30 per cent of the fires were extinguished with 3 gallons of water or less (this includes those fires on which no water was used); apart from this group the quantities most frequently required lay between 30 and 100 gallons (20 per cent of the fires). There were, however, marked differences between the quantities used to fight fires in different occupancies and, as may be seen from Table 3, the smaller quantities were used comparatively less frequently on outdoor fires than on fires in buildings, probably because water damage is a less important consideration. In general it appears that less water is used on fires in dwellings than on those in other buildings.

From the cumulative distribution diagrams of Fig. 3 it may be seen that half the fires in dwellings were extinguished with 6 gallons of water or less (the median value) and 75 per cent with 30 gallons or less (the upper quartile). The median value for fires in other buildings was 25 gallons and the upper quartile 170 gallons.

Four hundred gallons of water, the amount carried in one tank on many appliances, appear to have been sufficient to deal with 95 per cent of the fires in dwellings, 81 per cent of those in other buildings and about 86 per cent of all the fires attended.

#### Comparison with Experimental Results

Experiments at the Joint Fire Research Organization (1) have shown that a fully developed fire in a 1000 ft<sup>3</sup> room can be extinguished with about 2½ gallons of water. Unfortunately fire brigade reports give no information either on the state of fires when the brigades arrive or on the volumes of rooms involved, so that no strict comparison between experimental results and fire ground experience is possible. However, from the large proportion (81 per cent) of fires in dwellings extinguished with 50 gallons or less it appears highly probably that the quantities used in practice are at least comparable with those found necessary in experiments.

#### Conclusions

A large proportion of fires, particularly those in dwellings, could be extinguished with no more water than the amount carried in the tank of a water tender. It would, however, be impossible to rely on water carried by first attendance appliances, even in entirely residential areas, because of the need for considerably larger quantities on many occasions. On the other hand a large proportion (over 80 per cent) of the fires attended required only 100 gallons of water or less, and if a small, fast vehicle carrying quantities of this order could be constructed, it might well be a useful additional first attendance in congested areas, or in country districts where narrow or rough roads slow down larger vehicles.

It appears that, although the quantities of water used in operational fire fighting may be larger than those found necessary to extinguish experimental fires, they are nevertheless of the same order of magnitude.

#### Acknowledgment

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Cardiff, Durham, Essex, Lancashire, Liverpool, London, Manchester, Middlesborough, Southampton, Worcester City and County, Yorkshire West Riding.

#### Reference

- (1) Hird D. et al. The use of high and low pressure water sprays against fully developed room fires. Joint Fire Research Organization F. R. Note No. 388.

Table 1

## FREQUENCY OF USEAGE OF DIFFERENT QUANTITIES OF WATER BY 11 BRIGADES, 1960/61

Water used gal.	Frequency of use by Brigade											
	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5	C6	Total
<u>Fires in dwellings</u>												
Not more than 3*	13	77	94	9	12	323	43	83	145	25	91	915
(3 +) to 10	11	5	40	4	2	133	22	42	67	15	35	376
(10 +) to 30	11	10	33	10	2	177	19	31	56	8	35	392
(30 +) to 100	10	87	22	3	3	115	17	29	44	8	21	359
(100 +) to 300	3	18	7	-	-	24	8	15	13	2	11	101
(300 +) to 1000	2	3	8	1	-	18	2	3	15	1	9	62
(1000 +) to 3000	-	4	1	-	-	15	2	3	3	-	3	31
(3000 +) to 10,000	2	3	-	-	-	4	1	4	2	2	-	18
(10,000 +) to 30,000	-	-	-	-	-	1	-	1	-	-	-	2
More than 30,000	-	-	-	-	-	-	-	-	-	-	-	-
Total	52	207	205	27	19	810	114	211	345	61	205	2 256
<u>Fires in other buildings</u>												
Not more than 3*	10	59	59	12	16	190	22	57	92	24	61	602
(3 +) to 10	6	1	23	2	1	80	13	16	37	3	19	201
(10 +) to 30	4	6	24	6	2	116	12	14	36	7	23	250
(30 +) to 100	5	56	21	3	2	138	22	23	46	12	26	354
(100 +) to 300	6	8	18	4	1	39	17	20	38	2	21	174
(300 +) to 1000	2	5	12	2	2	45	17	15	33	5	18	156
(1000 +) to 3000	1	9	4	-	1	38	2	9	16	3	17	100
(3000 +) to 10,000	1	4	5	-	1	23	4	14	20	3	9	84
(10,000 +) to 30,000	-	3	1	-	-	11	-	4	11	2	6	38
More than 30,000	-	5	-	-	1	5	1	3	9	-	8	32
Total	35	156	167	29	27	685	110	175	338	61	208	1 991

\*Includes fires on which no water was used.

Table 1 (Cont'd.)

## FREQUENCY OF USEAGE OF DIFFERENT QUANTITIES OF WATER BY 11 BRIGADES, 1960/61

Water used gal.	Frequency of use by Brigade											
	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5	C6	Total
<u>Fires not in buildings</u>												
Not more than 3*	15	58	63	12	8	212	27	95	86	14	60	650
(3 +) to 10	5	4	16	1	8	135	9	34	37	12	10	271
(10 +) to 30	5	22	34	5	4	292	19	39	36	12	15	483
(30 +) to 100	13	104	35	5	14	306	33	77	79	27	42	735
(100 +) to 300	3	32	18	8	5	87	33	36	52	16	34	324
(300 +) to 1000	6	15	13	3	7	60	21	34	44	8	33	244
(1000 +) to 3000	3	21	6	1	-	28	10	27	22	6	27	151
(3000 +) to 10,000	3	4	5	2	1	8	9	16	28	3	21	100
(10,000 +) to 30,000	1	2	-	1	-	1	3	7	13	-	18	46
More than 30,000	-	-	1	-	-	1	1	3	11	-	-	16
Total	54	262	191	38	47	1 129	165	368	408	98	260	3 020

\*Includes fires on which no water was used.

Table 2

PERCENTAGE FREQUENCIES OF USEAGE OF DIFFERENT QUANTITIES OF WATER BY 11 BRIGADES, 1960/61  
(ALL FIRES EXCEPT THOSE CONFINED TO CHIMNEYS, GRASSLAND, HEATH, RAILWAY EMBANKMENTS)

Water used gal.	Percentage frequency of use by Brigade											
	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5	C6	All
Not more than 3*	26.9	31.1	38.4	35.1	38.7	27.6	23.7	31.2	29.6	28.6	31.5	29.8
(3 +) to 10	15.6	1.6	14.0	7.4	11.8	13.3	11.3	12.2	12.9	13.6	9.5	11.7
(10 +) to 30	14.2	6.1	16.2	22.4	8.6	22.6	12.9	11.1	11.7	12.3	10.8	15.5
(30 +) to 100	19.9	39.5	13.9	11.7	20.5	21.6	18.5	17.1	15.5	21.4	13.2	19.9
(100 +) to 300	8.5	9.3	7.6	12.8	6.5	5.7	14.9	9.4	9.4	9.1	9.8	8.2
(300 +) to 1000	7.1	3.7	5.9	6.4	9.7	4.7	10.3	6.9	8.4	6.4	8.9	6.4
(1000 +) to 3000	2.8	5.4	2.0	1.1	1.1	3.2	3.6	5.2	3.8	4.1	7.0	3.9
(3000 +) to 10,000	4.3	1.8	1.8	2.1	2.2	1.3	3.6	4.5	4.6	3.6	4.5	2.8
(10,000 +) to 30,000	0.7	0.8	0.2	1.1	-	0.5	0.8	1.6	2.2	0.9	3.6	1.2
More than 30,000	-	0.8	0.2	-	1.1	0.2	0.5	0.8	1.8	-	1.2	0.7

\*Includes fires on which no water was used.

Table 3

## OVERALL FREQUENCIES OF QUANTITIES OF WATER USED BY 11 BRIGADES 1960/61

Amount of water used (gallons)	Fires in dwellings			Fires in other buildings			Fires not in buildings			Total fires		
	Fire frequency	Percentage of total	Cumulative percentage	Fire frequency	Percentage of total	Cumulative percentage	Fire frequency	Percentage of total	Cumulative percentage	Fire frequency	Percentage of total	Cumulative percentage
over Not more than 3*	915	40.6	40.6	602	30.2	30.2	650	21.5	21.5	2 167	29.8	29.8
3 but not more than 10	376	16.7	57.2	201	10.1	40.3	271	9.0	30.5	848	11.7	41.5
" 10 " " " 30	392	17.4	74.6	250	12.6	52.9	483	16.0	46.5	1 125	15.5	57.0
" 30 " " " 100	359	15.9	90.5	354	17.8	70.7	735	24.3	70.8	1 448	19.9	76.9
" 100 " " " 300	101	4.5	95.0	174	8.7	79.4	324	10.7	81.6	599	8.2	85.1
" 300 " " " 1000	62	2.7	97.7	156	7.8	87.2	244	8.1	89.6	462	6.4	91.5
" 1000 " " " 3000	31	1.4	99.1	100	5.0	92.3	151	5.0	94.6	282	3.9	95.4
" 3000 " " " 10,000	18	0.8	99.9	84	4.2	96.5	100	3.3	97.9	202	2.8	98.2
" 10,000 " " " 30,000	2	0.1	100.0	38	1.9	98.4	46	1.5	99.5	86	1.2	99.3
" 30,000	-			32	1.6	100.0	16	0.5	100.0	48	0.7	100.0
Total	2 256	100.0		1 991	100.0		3 020	100.0		7 267	100.0	

\*Includes fires on which no water was used.



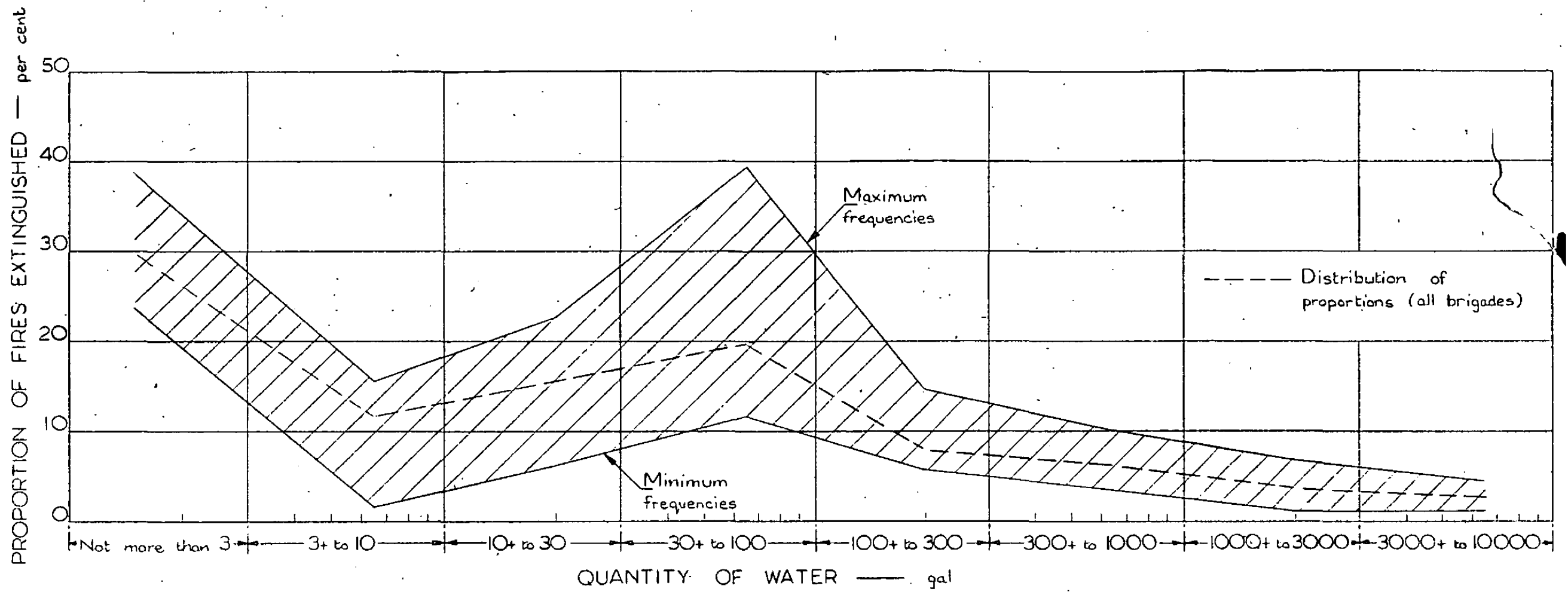


FIG. 1. DISTRIBUTION OF MAXIMUM AND MINIMUM PROPORTIONAL FREQUENCIES

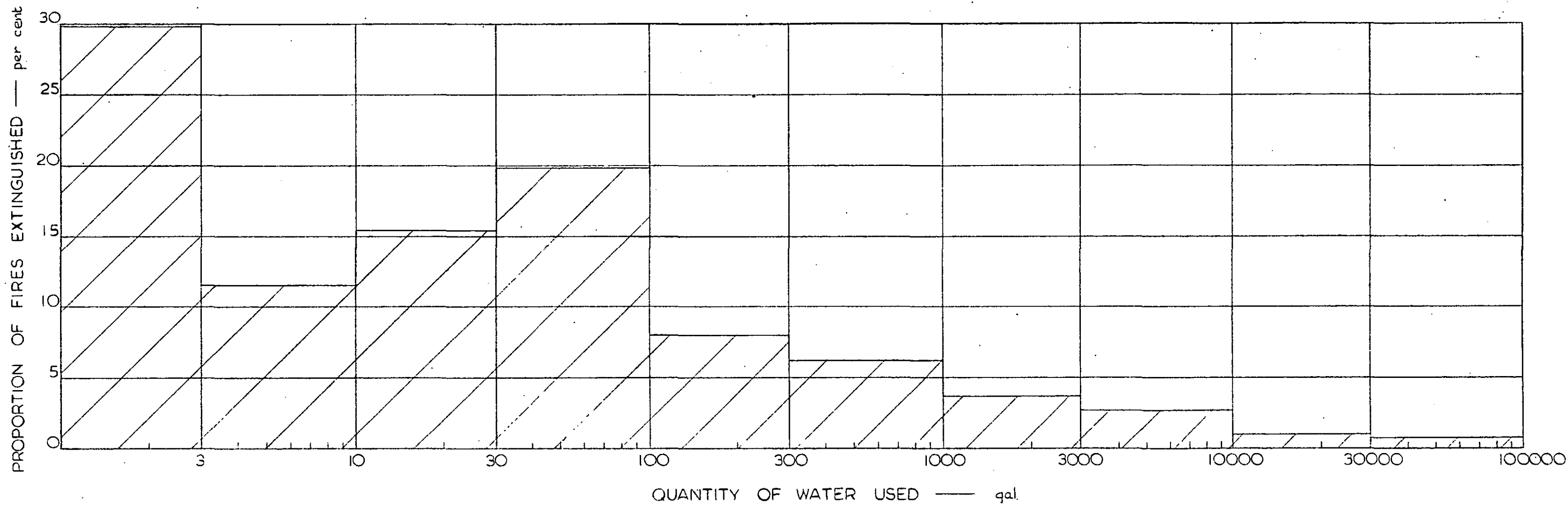
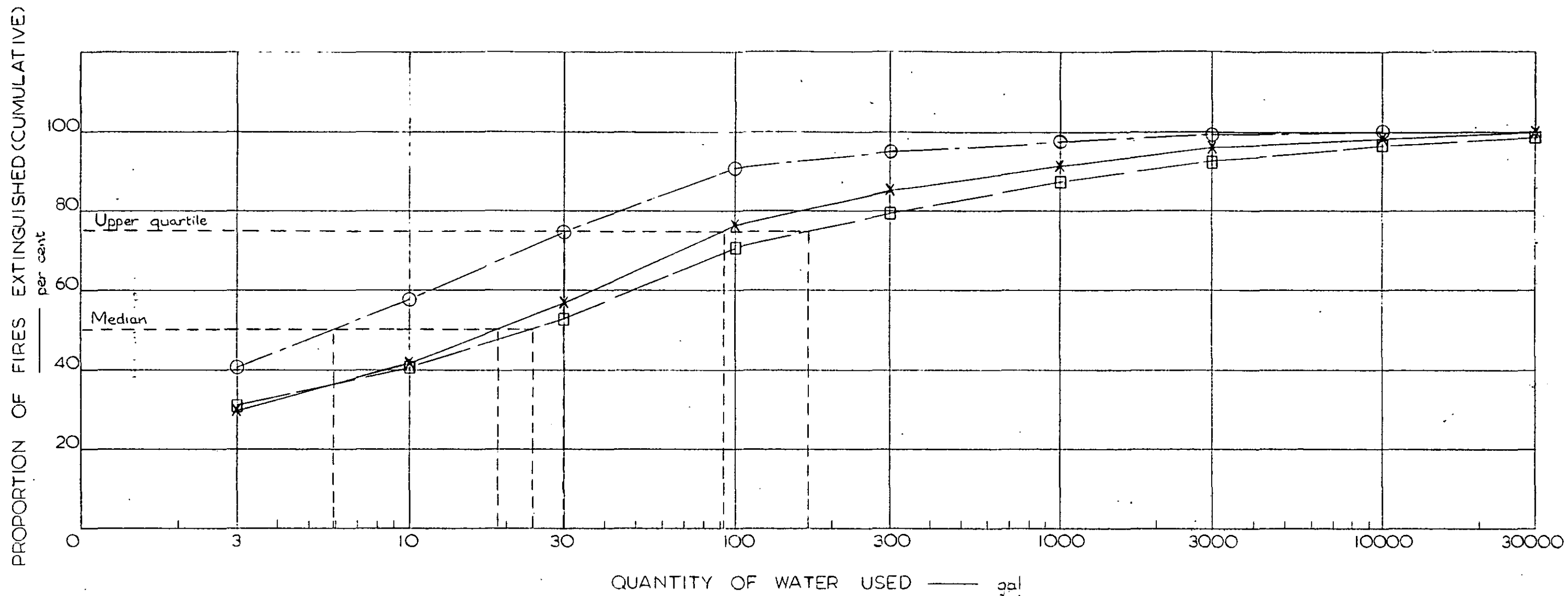


FIG. 2. FREQUENCY DISTRIBUTION OF QUANTITIES OF WATER USED BY 11 BRIGADES 1960/61



- x ————— x      All fires except heath and grassland
- o ————— o      Fires in dwellings
- ————— □      Fires in buildings other than dwellings

FIG. 3. CUMULATIVE FREQUENCY OF QUANTITIES OF WATER USED BY 11 BRIGADES 1960/61

Table 2

## WATER USED IN FIREFIGHTING, 1960/61

Amount of water used (Gallons)	Percentage of Fires			
	In Dwellings	In other Buildings	Not in Buildings	TOTAL
RM1	30.1	24.6	19.1	24.0
Not more than:-				
1/2	31.1	24.7	19.2	24.4
1	34.2	26.1	19.8	26.0
2	39.4	28.7	21.2	28.9
3	40.9	29.6	21.5	29.7
4	43.0	30.5	22.0	30.9
5	48.7	33.5	24.1	34.3
10	59.0	40.5	31.3	42.4
20	62.3	48.8	42.0	53.2
30	77.6	53.8	48.0	58.0
40	80.7	56.5	52.9	62.5
50	85.6	61.2	60.2	68.3
60	86.7	63.5	62.3	70.2
70	87.0	64.1	63.2	70.8
80	88.5	65.7	65.3	72.6
90	88.7	66.2	65.8	73.0
100	90.9	70.0	71.0	76.9
200	93.7	75.4	77.9	82.1
300	95.0	79.1	81.3	84.9
400	95.6	81.4	84.6	87.2
500	96.5	83.4	86.1	88.6
800	97.3	85.6	88.1	90.3
1 000	97.9	87.3	89.6	91.5
5 000	99.5	94.8	96.1	96.8
10 000	99.95	96.6	97.8	98.1
20 000	100.0	98.0	98.9	99.0