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SYMPOSIUM PAPER No. 1.

"AIRCRAFT FIRE STATISTICS"

by

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FIRE RESEARCH STATION

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Melrose Avenue, Boreham Wood, Herts.

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Presented by

Mr. J. F. Fry, B.Sc.(Eng.), A.M.I.C.E.

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MINISTRY OF TECHNOLOGY AND FIRE OFFICES' COMMITTEE
JOINT FIRE RESEARCH ORGANIZATION

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"AIRCRAFT FIRE STATISTICS"

1. Introduction

Although the Joint Fire Research Organization is not involved, on a continuing basis, with the compilation of aircraft fire statistics, ad hoc studies have been undertaken from time to time and the results have been brought together in this paper.

2. Fires attended by Local Authority Fire Brigades

It is probably safe to assume that most aircraft fire incidents occurring in the United Kingdom, at places other than airfields, are likely to be attended by local authority fire brigades; these will then be reported to the Organization in common with other fires attended. The fire brigades are also likely to be called to some major incidents on airfields, but not to the more numerous minor incidents for which outside reinforcement of the normal airfield facilities is unnecessary. Hence, although the picture presented by fire brigade reports cannot be regarded as complete, it does give some indication of the situation in the United Kingdom. The estimated numbers of aircraft fires of all types attended during the period 1952 - 1965 are given in Table 1.

Table 1

Aircraft fires attended
by fire brigades in the United Kingdom

Year	No. of fires
1952	140
1953	90
1954	142
1955	100
1956	116
1957	83
1958	84
1959	68
1960	60
1961	52
1962	60
1963	68
1964	60
1965	41

A change in the method of recording fatality statistics compiled from fire brigade reports has provided some additional information in recent years as shown in Table 2.

Table 2.

Fatalities in aircraft fires attended by fire brigades in the United Kingdon

Year	No. of incidents with fatalities	No. of fatalities
1963	2	6
1964	7	11

From these two tables it appears that the record within the United Kingdom does not at present give cause for great concern. However, it has to be noted that only one or two major incidents, similar to some which have occurred outside the United Kingdom recently (some with British aircraft), would completely alter the statistical picture for the year in which they occurred.

3. Ministry of Aviation records of civil aircraft accidents

In 1962 the Organization made a study of Ministry of Aviation records of 1150 accidents to all British-registered aircraft, and to other aircraft in the British Isles, during the period 1947 - 1960. A statistical summary of the incidents studied is given in Table 3.

Table 3

Summary of information on frequencies

Classification	Number of accidents				Total
	No fire and no fatalities	Fire but no fatalities	No fire but some fatalities	Fire and fatalities	
In the British Isles					
Transport operation, in circuit	72	12	8	15	107
Transport operation, en route	16	4	9	9	38
Non-transport operation, in circuit	368	20	14	14	416
Non-transport operation, en route	197	11	58	25	291
Totals	653	47	89	63	852
Outside the British Isles					
Transport operation, in circuit	71	9	5	8	93
Transport operation, en route	13	9	13	10	45
Non-transport operation, in circuit	63	3	3	3	72
Non-transport operation, en route	58	5	18	7	88
Totals	205	26	39	28	298
All classes Totals	858	73	128	91	1150

"Transport operations" include both scheduled and unscheduled passenger and freight services, and the term "in circuit" is used to describe miscellaneous activities such as taxying, taking-off, landing and maintenance. Accidents in forced landings and emergency landings off air-fields were considered to have occurred "en route".

The figures show that, in general, accidents "in circuit" are more numerous than those occurring "en route" but fatal accidents are fewer. There is a tendency for fatal casualties to arise from accidents in which fire occurs, but the fatalities do not necessarily result directly from fire and all that should be inferred is that the two features tend to be characteristic of the same group of accidents.

To obtain an indication of the effect of the size of aircraft on casualty rates and fire incidence in aircraft accidents, the figures were considered in relation to the all-up weights of the aircraft involved. Statistical tests showed a tendency for fire incidence to increase slightly with the size of aircraft involved in accidents, and there was also some evidence (though not very conclusive) that the fatal casualty rate may increase with the size of aircraft. For this purpose the casualty rate was defined as the percentage of the number of occupants.

The study was concerned with accidents only and does not provide any evidence on the relative safety of flying in large and small aircraft. If it can be assumed, however, that the chance of an accident remains unaltered by increasing the size of aircraft, then the indications are that both the frequency of fire and the number of fatal casualties in flying accidents are likely to increase with the size of aircraft in use.

4. Reports from air field fire and rescue teams

In the two years 1958 and 1959 the Organization received 460 incident reports involving all types of aircraft from the two sources, Air Ministry and Ministry of Aviation (then Ministry of Civil Aviation). Since the reports were concerned with the activities of the airfield fire and rescue organizations it would be expected that most of the incidents would have occurred on airfields and, in fact, this was true of over 80 per cent. It is worthy of note, however, that it was also true of the transport operation accidents referred to in Table 3 (71 per cent) in which the figures could not have been biassed in the same manner by selective reporting.

The causes of the accidents reported are summarised in Table 4 which indicates that a large proportion, about 45 per cent, occurred without either crash or collision and this included nearly three quarters of those in which there was fire.

Table 4
Causes of accidents

Cause	Incidents with fire		Incidents with no fire		All incidents	
	No.	Per cent	No.	Per cent	No.	Per cent
Crash	39	22.8	183	63.3	222	48.3
Collision with ground hazard	4	2.3	18	6.2	22	4.8
Collision with other aircraft	4	2.3	4	1.4	8	1.7
No crash or collision	124	72.5	84	29.1	208	45.2
Total	171	100	289	100	460	100

It is also of interest that in a high proportion of the crash incidents (about 82 per cent) no fire occurred.

The circumstances in which the accidents arose are indicated in Table 5 from which it appears that although over half of all the incidents occurred while aircraft were landing this did not apply to those in which there was fire; outbreaks of fire were more frequently associated with taxying, stationary and airborne aircraft.

Table 5
Circumstances in which incident occurred

Aircraft activity	Incidents with fire		Incidents with no fire		All incidents	
	No.	Per cent	No.	Per cent	No.	Per cent
Taking off	14	8.2	21	7.3	35	7.6
Landing	28	16.4	215	74.4	243	52.8
Taxying	43	25.1	30	10.4	73	15.9
Airborne	39	22.8	10	3.5	49	10.7
Stationary	46	26.9	9	3.1	55	12.0
Not stated	1	0.6	4	1.4	5	1.1
Total	171	100	289	100	460	100

A large proportion of the fire indidents were small and of a type which, when dealt with expeditiously, cause little damage and present no serious life hazard. For example over 30 per cent were caused by overheated brakes and these incidents, though troublesome, are usually dealt with effectively; this is also true of fires caused by electrical faults and faulty starts.

As already mentioned the majority, 82.6 per cent, of the incidents reported occurred on airfields. In over two thirds of these there was no fire. From Table 6 it can be seen that there was fire in a greater proportion of the accidents that occurred off airfields than in those on airfields. It has already been shown from the Ministry of Aviation figures of civil aircraft accidents that the fatality rate tends to be higher in accidents in which there is fire and this was confirmed by the reports from the fire and rescue services of Air Ministry and Ministry of Aviation. It is clear, therefore, that the most dangerous accidents, both in respect of outbreaks of fire and in respect of fatalities, are generally those that happen away from an airfield.

Table 6

Location of incidents

Where incident occurred	Incidents with fire		Incidents with no fire		All incidents	
	No.	Per cent	No.	Per cent	No.	Per cent
On airfield	118	69.0	262	90.7	380	82.6
Off airfield	33	19.3	23	8.0	56	12.2
During flight	20	11.7	4	1.4	24	5.2
Total	171	100	289	100	460	100

Of the 171 incidents in which fire played a part 118 occurred on airfields, but in only 10 of this 118 were serious damage or casualties reported. In most other cases damage to the aircraft was said to be negligible. Six of the aircraft in accidents in which there was fire appear to have disintegrated on impact, and these were the only accidents on airfields in which there were fatal casualties (15 fatalities, all in small aircraft).

Examination of the 118 reports of incidents involving fire on airfields leads to the general conclusion that the airfield fire and rescue arrangements were adequate for dealing with any of the emergencies in which the aircraft

did not disintegrate on impact. It should be noted, however, that in the two years considered there was no report of a major accident involving large aircraft on an airfield. It is not possible to say whether some of the minor incidents in large aircraft dealt with might have assumed major proportions in the event of non-attendance or delayed attendance by the fire and rescue services.

From descriptions of the major incidents reported by the Ministry of Aviation it was clear, not only that there is a strong tendency for the most serious crashes to occur at some distance from airfields but that fire and rescue teams are liable to encounter a variety of difficulties in dealing with them. In several of the cases it appeared unlikely that effective rescue work could have been carried out wherever the crash had occurred since the aircraft was completely destroyed, most of the damage being due to impact with the ground.

5. Report of the Working Party on aviation kerosene and wide-cut gasoline

The Organization was represented on the Working Party set up in 1961 to examine the properties of aviation kerosene and wide-cut gasoline, and took part in the examination of accident reports collected from various sources by the Ministry of Aviation. Although the main purpose of the study was to assess the relative hazards of two different fuels it also provided some incidental information on the importance of the role of fire in fatal accidents. There were 17 fatal accidents to aircraft fuelled with aviation gasoline in which 295 persons died. Eight per cent of the deaths were definitely attributed to fire, 12 per cent to impact but with some degree of burning present and the remainder to impact injuries. From this it appears that deaths by fire constituted between 8 and 20 per cent of the total deaths in these accidents and the Working Party concluded that "an estimate of 10 per cent burnt to death and 90 per cent killed by impact injuries would probably not be wide of the mark".

6. Discussion

Among the most important current trends in air transport are the development of very large aircraft and the increasing distances flown. The statistics given in this paper indicate that the percentage of occupants

killed in an accident to an aircraft tends to increase with the size of the aircraft. Even if this fatality rate remained constant the absolute number of fatalities in an accident would increase with the size of aircraft. From this it is clear that, unless the likelihood of an accident can be reduced or the number of flights is considerably smaller, the change to larger aircraft is almost certain to result in an increase in fatalities. Andrew Wilson in a recent article in The Observer Week end Review (Sept.4th.1966) quoted Bo Lundberg of Sweden as having calculated a figure of 60,000 air fatalities a year by the end of the century. This estimate was presumably based on a combination of existing casualty data and expected increases in air traffic.

Also apparent from the statistics studied is the fact that, at present, fire plays a comparatively small part in the loss of life in air accidents. This situation could alter radically however, if, by some means or other, the frequency of fatal impact injuries could be reduced (backward-facing seats have often been suggested as a simple method of achieving this). In these circumstances it would become even more important than it is at present to improve methods of rescue from fire. It must be remembered also that this improvement, to be effective, would be more urgently required for accidents at some distance from airfields than for those actually on the airfield, since these are the accidents in which most lives are lost. The extent to which improved facilities are likely to be required on the airfield can be assessed only from a study of the practical difficulties that may be encountered with new types of aircraft. Here statistics can offer little guidance.

7. Conclusions

The conclusions which can be drawn from the statistics referred to in this paper are summarised below:-

(i) Aircraft fire statistics do not, at present, show that the situation in the United Kingdom gives cause for great concern.

(ii) Accidents "in circuit" are more frequent than those "en route", but are less likely to result in fatalities.

(iii) Fatalities tend to occur most frequently in accidents in which there is fire, but most of the deaths result from impact injuries.

(iv) There is some indication of a tendency for the fatal casualty rate and the fire incidence to increase with the size of aircraft involved in accidents.

(v) Fire occurs more frequently in accidents off the airfield than in those on it.

(vi) A high proportion of fire incidents on airfields are small and, given adequate facilities for dealing with them, present little hazard.

(vii) Greatly improved fire-fighting facilities would not, in present circumstances, be likely to result in a large reduction in the loss of life in aircraft accidents.