U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-266 883

U.S. Air Carrier Accidents Involving Fire, 1965 Through 1974 and Factors Affecting the Statistics

National Transportation Safety Board, Washington, D C

17 Feb 77

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB-AAS-77-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Special Study -- U. S. Air Carrier Accidents Involving Fire, 1965 through 1974, and Factors Affecting the Statistics		5. Report Date February 17, 1977
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address Bureau of Technology National Transportation Safety Board Washington, D. C. 20594		10. Work Unit No. 1994 11. Contract or Grant No.
12. Sponsoring Agency Name and Address NATIONAL TRANSPORTATION SAFETY BOARD Washington, D. C. 20594		13. Type of Report and Period Covered Special Study 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This study presents the statistical data on U. S. air carrier accidents involving fire from 1965 through 1974. The statistics are compared with data contained in Bureau of Safety Pamphlet (BOSP) 7-6-3, which treats the same subject for the years 1955 through 1964. The study concludes that there have been significant improvements in occupant survivability. While fire still occurs in about 20 percent of the accidents in scheduled passenger operations, the ratio of fatalities from all causes to exposed occupants has declined 65 percent in this study period and the ratio of fatalities from the effects of fire and smoke to exposed occupants has declined 37 percent. The almost exclusive use, in this study period, of turbojet-powered aircraft, their improved reliability, and the use of kerosene-type fuel are factors influencing the statistics. The anticipated upgrading of the Federal Aviation Regulations and the expected effects of the recently implemented requirements of 14 CFR 139 are expected to improve even further occupant survivability of accidents involving fire.

17. Key Words	18. Distribution Statement
Aircraft accident; fire statistics; occupant survivability; fire exposure; kerosene fuels; Federal Aviation Regulations; flammability of materials; toxic out-gassing; crash/fire/rescue facilities.	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22151.

19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	64	PC A04 MF A01

NTSB Form 1765.2 (Rev. 9/74)

TABLE OF CONTENTS

INTRODUCTION

From 1965 through 1974, fire erupted during 141 United States certificated air carrier aircraft accidents. Of the 7,043 persons aboard those aircraft, 1,848 were killed. About 292 deaths were a result of fire.

From 1955 through 1964, fire erupted during 153 United States air carrier accidents. Of the 4,559 persons aboard, 1,955 were killed; 297 occupants died as a result of fire.

This study updates data from a report entitled, "A Study of United States Air Carrier Accidents Involving Fire, 1955 - 1964," which was published as Bureau of Safety Pamphlet 7-6-3 (BOSP) by the Civil Aeronautics Board on March 30, 1966. In addition, this study will compare two 10-year periods, 1955 through 1964 and 1965 through 1974, and will discuss variables which may have affected the statistics. Fire accidents in passenger-only operations are discussed separately in order to compare overall fire data. In view of the provisions of 14 CFR 139 regarding crash/fire/rescue aspects of airport certification, air carrier accidents on or near airports also are included in this study.

The study includes all U. S. certificated air carrier accidents in which fire or explosion were coded into the NTSB's automated accident files as a cause or as a factor in the accident cause. As in the previous study, accidents are included in which fire or explosion was not a key aspect in the cause or may not have been a factor in survivability. These accidents nevertheless are included to insure consistency with previous data and to provide complete U. S. air carrier fire-related accident data.

RESULTS FROM THE 1955 THROUGH 1964 STUDY

The summary statistics of the previous study (BOSP 7-6-3) are presented in Table 1. These accidents were categorized into four groups according to survivability.

Accidents involving fire were divided into the following four categories:

- Group I -- Accidents in which all occupants were killed;
- Group II -- Accidents in which some occupants survived;
- Group III -- Accidents in which all occupants survived, but some were injured seriously;
- Group IV -- Accidents in which all occupants received either minor or no injuries.

TABLE 1

SUMMARY OF ALL U.S. AIR CARRIER ACCIDENTS INVOLVING FIRE

1955 THROUGH 1964

YEAR	ACCIDENTS													AIRCRAFT DAMAGE			OCCUPANT STATUS											
	TOTAL	GROUP I			GROUP II			GROUP III			GROUP IV						EXPOSURE			INJURIES								
																				FATAL			SERIOUS			MINOR/NONE		
		A	B	C	A	B	C	A	B	C	A	B	C	TOTAL	DEST.	SUB.	TOT.	C	P	TOT.	C	P	TOT.	C	P	TOT.	C	P
1955	16	1	6	0	0	3	0	1	0	0	2	2	1	16	12	4	446	59	387	109	27	172	15	3	12	232	29	203
1956	13	0	2	0	0	2	0	0	1	0	2	5	1	*14	* 6	8	248	48	200	156	14	142	10	4	6	74	22	52
1957	24	0	2	0	0	5	0	0	3	0	5	7	2	*25	*11	14	494	89	405	85	16	69	50	10	40	359	63	296
1958	18	0	4	0	1	2	0	1	2	0	3	4	1	*19	*12	7	514	74	440	142	18	124	46	6	40	326	50	276
1959	22	4	5	0	1	3	0	0	1	0	3	4	1	22	17	5	497	94	403	205	49	156	14	7	7	278	38	240
1960	13	0	7	0	1	2	0	0	0	0	1	2	0	13	11	2	671	70	601	375	43	332	20	1	19	276	26	250
1961	11	1	4	0	0	2	0	0	1	0	0	3	0	11	8	3	518	56	462	218	22	196	13	1	12	287	33	254
1962	13	1	4	0	1	2	0	0	2	0	0	2	1	13	11	2	511	70	441	281	39	242	16	3	13	214	28	186
1963	9	1	4	0	0	2	0	0	2	0	0	0	0	9	9	0	264	38	226	152	26	124	37	4	33	75	8	69
1964	14	1	4	0	0	1	0	0	0	0	2	5	1	14	7	7	404	56	348	142	21	121	13	2	11	249	35	214
TOTALS	153	9	42	0	4	26	0	2	12	0	18	34	5	*156	*104	52	4558	648	3911	1955	277	1678	234	41	193	2378	338	2040
		51			28			14			80																	

*INCLUDES MID-AIR COLLISIONS.

The accidents were further classified within each group according to the phase of operation in which fire erupted, as follows:

- Phase A -- Fire began in flight.
- Phase B -- Fire began as a result of impact.
- Phase C -- Fire began on the ground, but was not related to impact.

More extensive details on each of the accidents included in this study are contained in Appendix C. The study concluded that fire deaths and injuries can be reduced substantially through improvements in the areas of aircraft crashworthiness design, evacuation provisions and procedures, and airport firefighting and rescue provisions. Specifically, the study stated that occupant protection and survival in fire-involved accidents might be enhanced by improvements in the following general areas:

1. Increased strength of environmental structures and occupant restraint systems.
2. Further development of fuel inerting, fire suppression, and fire extinguishing systems.
3. Suppression or elimination of toxic fumes from burning cabin materials.
4. Improved mobility and effectiveness of airport firefighting and rescue facilities.

During the 10 years following this study, almost all of these areas have been the subject of numerous Safety Board recommendations and have, indeed, been improved.

- The inherently stronger design features of the new pressurized jet aircraft, which have virtually dominated the fleet since the study, have improved the structural environment for aircraft occupants. Furthermore, improvements in occupant restraint systems, such as increased seat strength requirements, have increased occupant survivability in accidents, including surviability in fire-involved accidents.

- Although fuel inerting has not been incorporated in air carrier aircraft, the dominant use of the less volatile kerosene-type fuel by jet aircraft has contributed to improved fire accident statistics. Considerable advances have been made also in suppression and extinguishing systems to prevent engine fires.

- No substantive improvements have been made regarding toxic outgassing from burning cabin materials; however, there are numerous efforts

in progress by the Federal Government and by the aviation industry. There have been positive improvements in the flammability standards for cabin interiors since the previous study.

• Advances have been made in many areas regarding the complex problem of evacuation systems. For example, improved and enlarged egress systems, including the development of the evacuation slide, are foremost in these efforts. Considerable progress also has been made in crew training and the development of emergency procedures.

• The most recent requirements for crash/fire/rescue facilities and emergency plans at air carrier airports in the U. S. have not been in effect long enough to have influenced the data in this study. However, the efforts of many organizations, including those of the Aircraft Fire-fighting and Rescue Committee of the National Fire Protection Association (NFPA) have impacted this area favorably so that firefighting and rescue facilities have improved since the publication of BOSP 7-6-3.

U. S. AIR CARRIER ACCIDENTS INVOLVING FIRE 1965 THROUGH 1974

One hundred and forty-one accidents were studied for the period 1965 through 1974. The summary statistics are presented in Table 2. (See Appendix A.)

Group I Accidents

Thirty-eight accidents involved such severe impact forces that survival was impossible regardless of the presence of fire. There were 169 crewmembers and 768 passengers involved in Group I accidents.

There were 10 Group I accidents in which fire began in flight; 6 were midair collisions, 1 was a wing failure, 2 involved smoke or fire in flight, and 1 was a bomb explosion. These 10 accidents involved 334 occupants all of whom were killed by the impact forces.

Twenty-eight Group I accidents involved fire which began after impact. In 14 of those accidents, fire was the result of impact following controlled flight into ground or water. These planes crashed either during landing approaches or while en route. The remaining 14 accidents were those in which fire followed uncontrolled flight into the ground or water. In these cases, aircraft control was lost because of such factors as airframe icing, structural failure, and jammed controls. One accident resulted from a near midair collision from which recovery was not successful.

Impact forces in these 28 accidents were severe; 603 aircraft occupants were killed. A detailed review of the causes of death in these accidents revealed only one case where death may have been attributed primarily to fire and smoke. That case was the Delta Air Lines DC-9 accident at Fort Worth,

TABLE 2

SUMMARY OF U.S. AIR CARRIER ACCIDENTS INVOLVING FIRE

1965 THROUGH 1974

	ACCIDENTS													AIRCRAFT DAMAGE				OCCUPANT STATUS										
	TYPE ACCIDENT	GROUP I			GROUP II			GROUP II			GROUP IV							TOTAL EXPOSURE			INJURIES							
	TOTAL	A	B	C	A	B	C	A	B	C	A	B	C	DE-STROYED	SUB-STANTIAL	MINOR	NONE	TOTAL	CREW	PAS-SENGER	FATAL			SERIOUS			MINOR/NONE		
																					TOTAL	CREW	PAX	TOTAL	CREW	PAX	TOTAL	CREW	PAX
1965	20	–	4	–	–	3	–	–	1	1	2	8	1	11	9	–	–	1012	188	887	252	29	223	87	15	87	663	81	582
1966	15	2	4	–	–	1	–	–	3	–	3	1	1	10	5	–	–	353	51	302	161	24	137	28	2	18	172	25	147
1967	22	4	4	–	–	2	–	–	3	–	6	3	–	10	12	–	–	732	91	641	239	38	196	18	2	16	484	53	431
1968	16	–	3	–	–	5	–	–	3	–	1	3	1	12	4	–	–	388	81	299	167	20	147	62	6	46	141	35	106
1969	6	–	2	–	–	1	–	–	–	1	–	1	1	4	2	–	–	281	29	252	38	10	28	16	0	16	245	19	226
1970	18	–	3	–	–	3	–	–	1	3	1	2	3	8	5	1	2	990	101	879	138	20	118	72	16	56	779	65	705
1971	10	1	3	–	–	1	–	–	–	1	1	2	1	5	4	1	–	463	52	411	197	23	174	4	1	3	262	28	234
1972	14	1	1	–	–	3	–	–	1	4	2	–	2	8	4	3	1	1038	92	946	161	15	146	96	15	81	781	62	719
1973	11	1	2	–	–	2	–	–	1	1	1	3	–	8	4	1	–	732	59	712	148	18	130	14	4	10	582	39	572
1974	11	1	2	–	–	2	–	1	2	2	1	–	–	8	1	4	–	1052	93	959	366	35	331	21	2	19	665	58	609
TOTALS	141	10	28	0	0	23	0	1	15	13	18	23	10	78	50	10	3	7063	725	6318	1848	228	1620	418	63	347	4785	434	4351
		38			23			29			51																		

Texas, on May 30, 1972. (See Appendix B, Case No. 7.) During landing, the aircraft went out of control and crashed because of wake turbulence. One occupant, who was riding in the cabin, had an elevated carbon monoxide level in his blood and minimal impact trauma. That occupant was alive after impact, but died in the fire which resulted from impact.

There were no Group I accidents during which fire began on the ground.

Group II Accidents

Twenty-three aircraft accidents involved both survivors and fatalities. Of the 133 crewmembers and 1,468 passengers, 59 crewmembers and 852 passengers were killed, 38 crewmembers and 292 passengers were injured seriously, 15 crewmembers and 132 passengers were injured slightly, and 21 crewmembers and 192 passengers were not injured.

A review of the records showed that at least 291 persons involved in Group II accidents died as a result of fire and smoke. There were no Group II accidents involving in-flight fire.

Twenty-three Group II accidents involved fire after impact. Three of these accidents were on takeoff; two involved an aborted takeoff following collision with another aircraft on the ground; and one involved an overrun on takeoff because of dragging brakes. One accident resulted from a forced landing following a midair collision.

The remaining 16 Group II accidents involved crashes during final approach or during arrival maneuvers. The crash forces were moderate to severe in most cases; however, many of the occupants survived the impact only to die in the postcrash fire. Ten of the accidents included all but one of the deaths attributed to fire or smoke in U. S. air carrier accidents. (See Appendix B.) There were no Group II accidents in which fire began on the ground.

Group III Accidents

There were 29 fire-related accidents in which there were no fatalities, but in which persons were seriously injured; 2,582 occupants were involved, of which 80 were seriously injured. Most injuries in Group III accidents were attributable to impact forces. One of these accidents resulted from an in-flight explosion of a coffee maker, which seriously injured a flight attendant.

Fifteen accidents in which fire erupted after impact involved 717 occupants. Eight of the accidents followed problems on takeoff, such as engine fire, brake or wheel fire, engine failure, or loss of directional control. The other seven accidents resulted from landing problems; four aircraft landed short, one was a hard landing, and two resulted from loss of control during landing roll.

During 13 Group III accidents, fire erupted on the ground not as a result of impact forces. Six of these were on takeoff -- two were brake or wheel fires and four were engine fires. Three occurred while the aircraft were parked at the gate -- an engine fire, torching of an auxiliary power unit (APU), and an oxygen fire. Three accidents occurred during taxi -- an engine fire, smoke in the cockpit, and a wheel-brake fire. The remaining accident involved an engine fire during landing roll. Twenty-five persons were injured seriously in the 13 accidents; 1,788 persons received minor or no injuries.

Group IV Accidents

There were 51 Group IV accidents which involved 1,923 occupants. These accidents usually involved low-impact forces. During 18 accidents, fire began in flight and involved 783 persons. All persons received minor or no injuries. Fourteen of these accidents resulted from engine failures and engine fires. Two accidents followed wheelbrake fires; one was an electrical fire in the cabin; and one was an airframe fire.

In twenty-three accidents involving 614 occupants, fire began as a result of impact. Fifteen accidents occurred during landing, seven occurred during takeoff, and one during taxi when the aircraft hit a ground power unit. The impact forces generated in these accidents were minor to moderate.

Ten accidents involved fire that began on the ground; impact forces were not involved. The 526 occupants received minor or no injuries. Two accidents occurred on landing, one on takeoff, and the remaining seven while parked or taxiing.

COMPARISON OF THE 10-YEAR PERIODS

Accident data for 1965 through 1974 are comparable to the data from the previous 10-year study. The total number of fire accidents for the two periods has decreased only slightly -- 153 between 1955 and 1964 and 141 between 1965 and 1974. The total number of persons exposed to fire increased from 4,559 in the first 10-year study to 7,043 in the second 10-year study.

U.S. certificated air carriers experienced a tremendous growth during the 20 years covered by the two studies. The total aircraft-miles flown by U. S. certificated air carriers in all operations grew from 819,581,000 in 1955 to 2,385,000,000 in 1974 (a three-fold increase). Similarly, the number of passenger-miles flown by U. S. air carriers (scheduled passenger service) grew from 25,152,000,000 in 1955 to 173,350,000,000 in 1974 (a seven-fold increase). During the same period, the number of passengers carried by the U. S. air carriers in domestic and international passenger operations grew from 41,444,000 in 1955 to 207,449,000 in 1974 (a five-fold increase). This period of

growth was accompanied by a generally steady decline in the total accident rates and fatal accident rates.

However, these data may not illustrate the entire situation. For 1955 through 1964, the ratio of the number of fatalities from all causes to the total number of all occupants involved in fire accidents was .43 and, for the years 1965 through 1974, this ratio was .26 fatalities per exposed occupant. Therefore, an occupant involved in a fire accident in the second 10-year period had a 65-percent better chance of surviving the accident than his counterpart in the previous 10-year period.

Similarly, the number of fatalities which could be attributed directly to fire for the two periods was compared with the total occupants exposed to fire accidents. A ratio of .065 fire fatalities per total occupants was calculated for the years 1955 through 1964 and a ratio of .041 was calculated for the years 1965 through 1974. Therefore, an occupant who survived the impact and was exposed to fire in the second 10-year period had a 37-percent better chance of escaping the fire than he had in the first 10-year period.

The fire accidents for the years 1955 through 1974 were examined further to determine how the fire accident data compared with overall accident data. Additionally, fire accidents in passenger operations were compared to overall passenger operations data.

U. S. air carriers in all operations.

The fire accident data contained in Tables 1 and 2 pertain to all U. S. air carrier operations. Thus, training flights, ferry flights, and cargo flights are included.

The total accident rate per million miles flown by U. S. certificated air carriers (all operations) has declined steadily from 1955 through 1974. The rate of fire-involved accidents has declined by about the same factor during the same period. (See Figure 1.)

The total number of air carrier accidents in all operations and the total number of fire-involved accidents for the years 1955 through 1974 are shown in Figure 2. When the rapid growth in operations is considered, the resultant decline in rates is explained. However, the percentage of fire-related accidents to total accidents indicates an upward trend in fire accident potential. (See Figure 3.) That is, the percentage of fire-related accidents has increased from an average of 18.6 percent during 1955 through 1964 to 25.3 percent from 1965 through 1974. Therefore, although the overall accident rates and the fire accident rates for all air carrier operations are declining, when an accident does occur, the likelihood that fire will be a factor has increased.

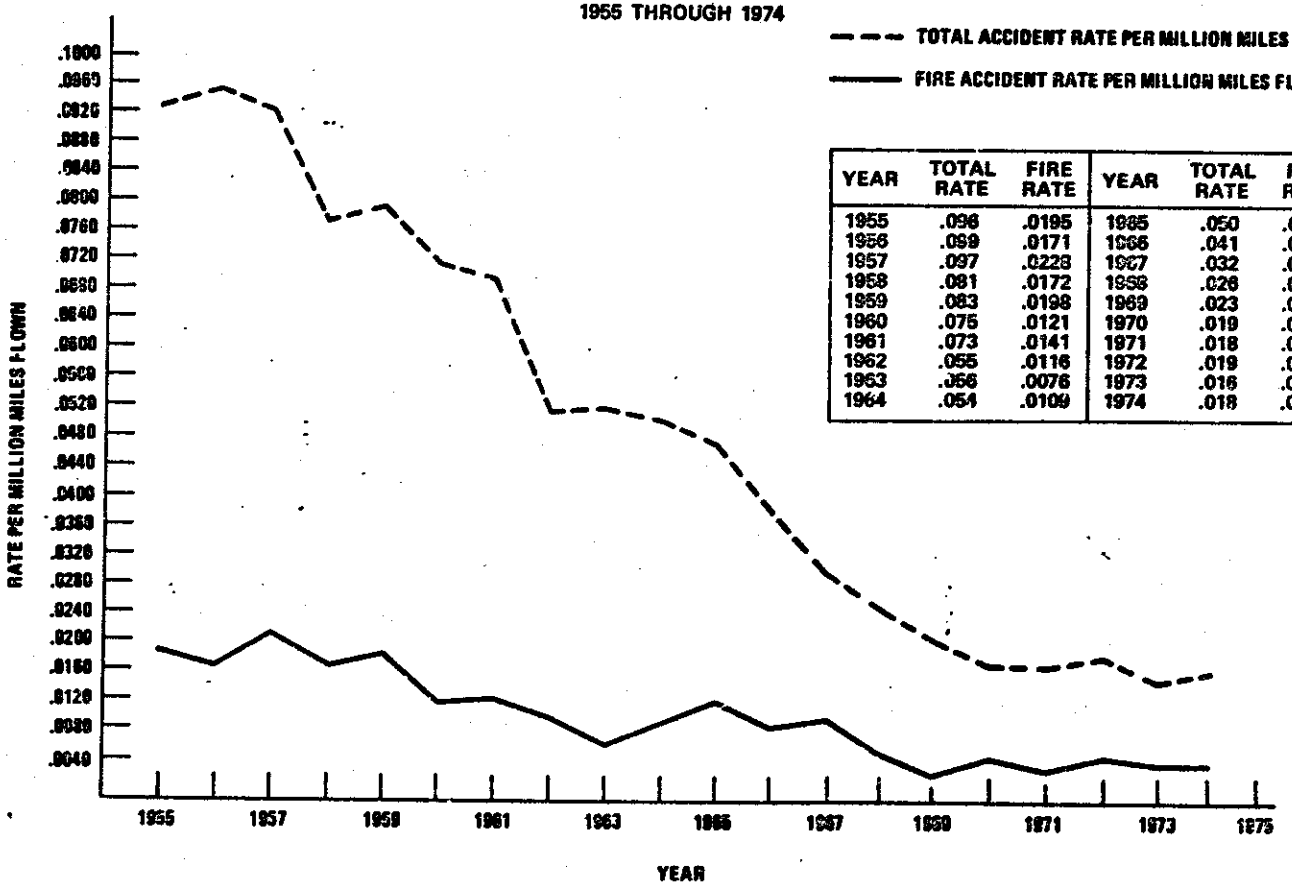
U. S. air carriers in passenger service.

Accident rates for U. S. certificated air carriers in scheduled domestic and international passenger service are based on passenger-

FIGURE 1

U.S. CERTIFICATED ROUTE AIR CARRIERS
(ALL OPERATIONS)

1955 THROUGH 1974

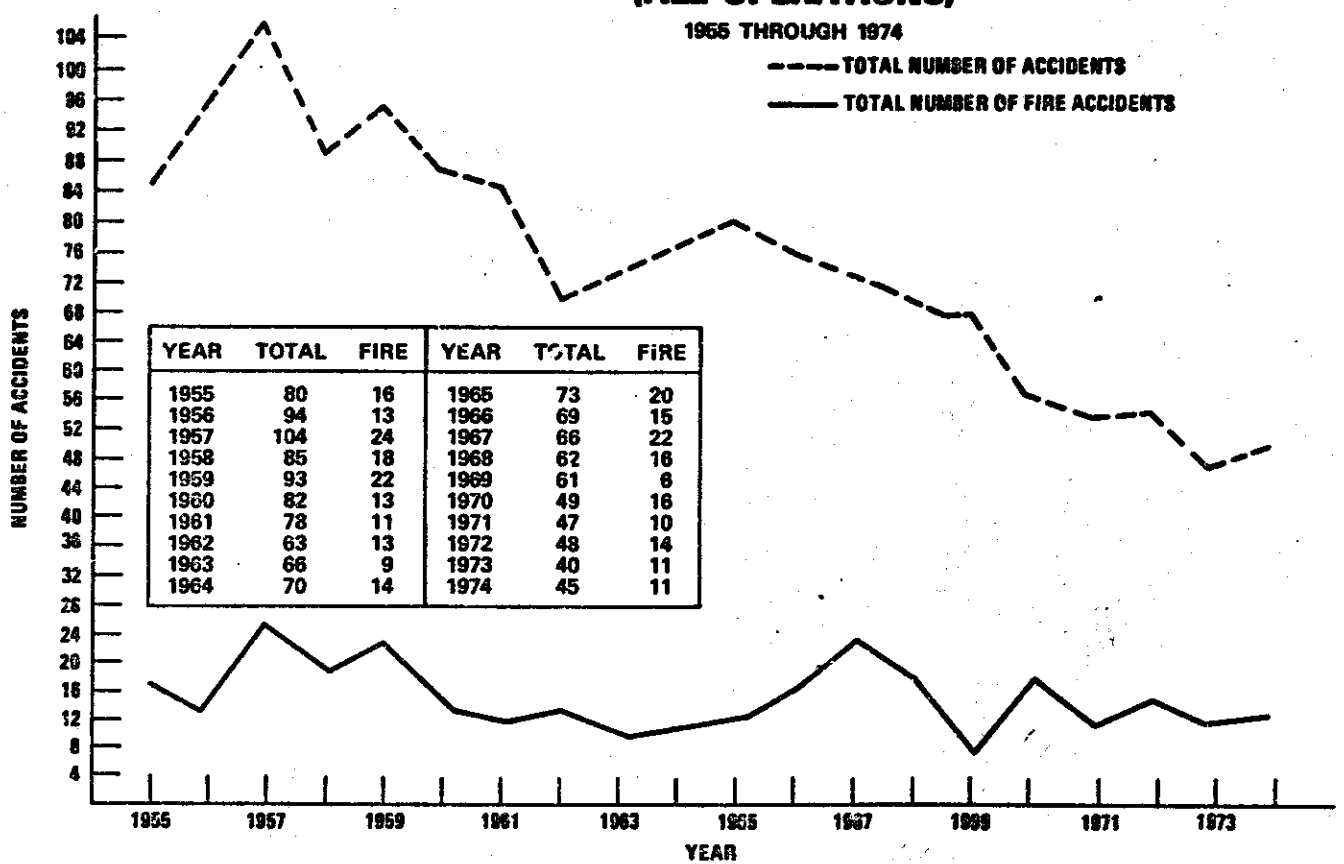


YEAR	TOTAL RATE	FIRE RATE	YEAR	TOTAL RATE	FIRE RATE
1955	.096	.0195	1965	.050	.0136
1956	.099	.0171	1966	.041	.0089
1957	.097	.0228	1967	.032	.0106
1958	.081	.0172	1968	.026	.0087
1959	.083	.0198	1969	.023	.0023
1960	.075	.0121	1970	.019	.0046
1961	.073	.0141	1971	.018	.0039
1962	.055	.0116	1972	.019	.0055
1963	.056	.0076	1973	.016	.0043
1964	.054	.0109	1974	.018	.0046

FIGURE 2

U.S. CERTIFICATED ROUTE AIR CARRIERS
(ALL OPERATIONS)

1955 THROUGH 1974



YEAR	TOTAL	FIRE	YEAR	TOTAL	FIRE
1955	80	16	1965	73	20
1956	94	13	1966	69	15
1957	104	24	1967	66	22
1958	85	18	1968	62	16
1959	93	22	1969	61	6
1960	82	13	1970	49	16
1961	78	11	1971	47	10
1962	63	13	1972	48	14
1963	66	9	1973	40	11
1964	70	14	1974	45	11

FIGURE 3

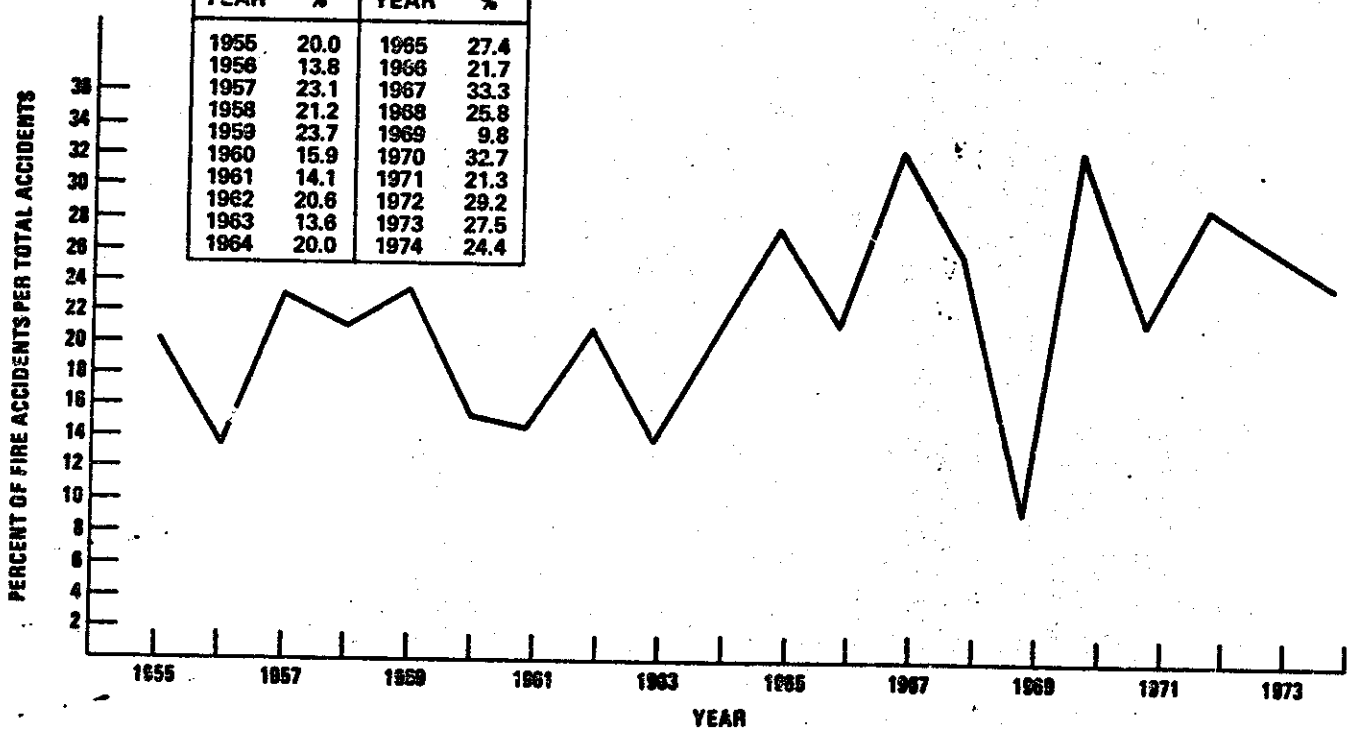
RATIO OF FIRE ACCIDENTS TO TOTAL ACCIDENTS

U.S. CERTIFICATED ROUTE AIR CARRIERS

(ALL OPERATIONS)

1955 THROUGH 1974

YEAR	%	YEAR	%
1955	20.0	1965	27.4
1956	13.8	1966	21.7
1957	23.1	1967	33.3
1958	21.2	1968	25.8
1959	23.7	1969	9.8
1960	15.9	1970	32.7
1961	14.1	1971	21.3
1962	20.6	1972	29.2
1963	13.6	1973	27.5
1964	20.0	1974	24.4



miles flown. The curve for all accidents shows a sharp decrease in the accident rate, while that for fire-involved accidents decreased at a lesser rate. (See Figure 4.)

The correlation between the accident rates based on aircraft miles flown in all operations and those based on passenger-miles flown in passenger operations only was determined by statistical test method. A high degree of correlation was found between the rates shown in Figures 1 and 4; therefore, trends in air carrier accident statistics for all operations can be expected to be reflected in passenger operations statistics. The curves for all passenger operations accidents and for fire-related accidents over the 20-year period are shown in Figure 5. While the total accident curve shows a gradual decline, the fire-involved accidents curve remains relatively constant. When the percentage of fire-involved accidents in passenger operations to total accidents is compared, a relatively constant percentage is indicated. (See Figure 6.) In fact, the average percentage of fire accidents to all accidents in passenger service was 20 percent for 1955 through 1964 and 20.6 percent for 1965 through 1974. Thus, air carrier aircraft in passenger service have maintained an even rate of fire-involved accidents while the rate for fire-involved accidents has increased, as shown in Figure 3.

There are several possible reasons for the different ratios of fire accidents to total accidents between domestic and international passenger operations and all operations. First, the nonpassenger operations have apparently experienced a greater incidence of fire because of the type of accidents which occurred. For example, several training accidents involved severe impacts and postcrash fires.

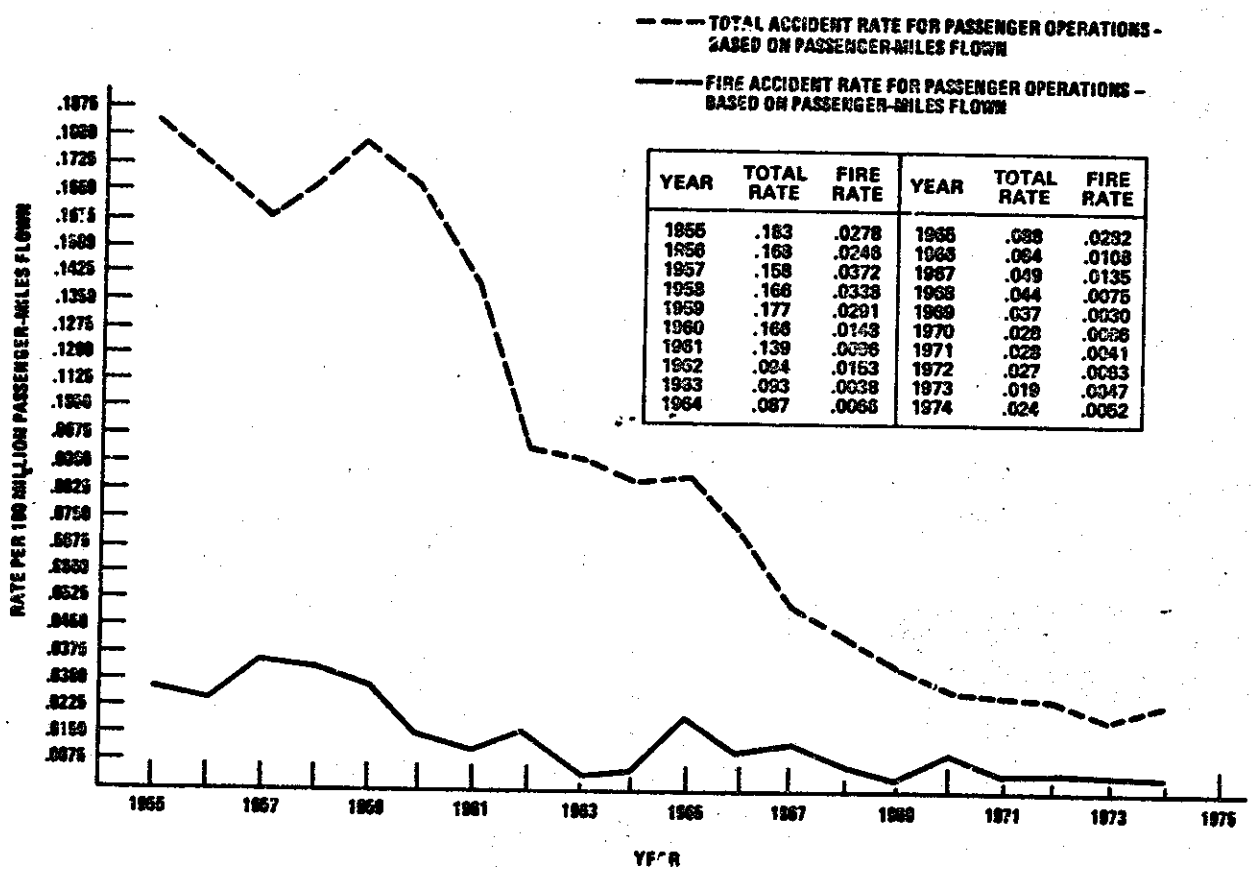
The type of accident has also influenced the passenger service data. For example, in the latter part of the 20-year period covered by the data, turbulence accidents made up an increasing percentage of the total passenger operations accidents. Turbulence accidents generally involve in-flight injuries to occupants and rarely involve aircraft damage. Hence, they virtually never involve fire. Therefore, the denominator for determining the percentage of fire accidents to total accidents in passenger operations has been inflated by a type of accident not experienced in nonpassenger operations.

Exposure per accident also has influenced the passenger service data. Although records for the entire 20-year period were not available, the data in Figure 7 for the 13 years depicted are sufficient to illustrate that the number of passengers exposed per accident nearly doubled during that period. Since aircraft passenger load influences these data, the average passenger load in all passenger service for those years was also plotted in Figure 7. The curves are approximately parallel, which shows an increase of nearly 70 percent in passenger load per aircraft.

FIGURE 4

U.S. CERTIFICATED ROUTE AIR CARRIERS
SCHEDULED DOMESTIC AND INTERNATIONAL PASSENGER OPERATIONS

1955 THROUGH 1974

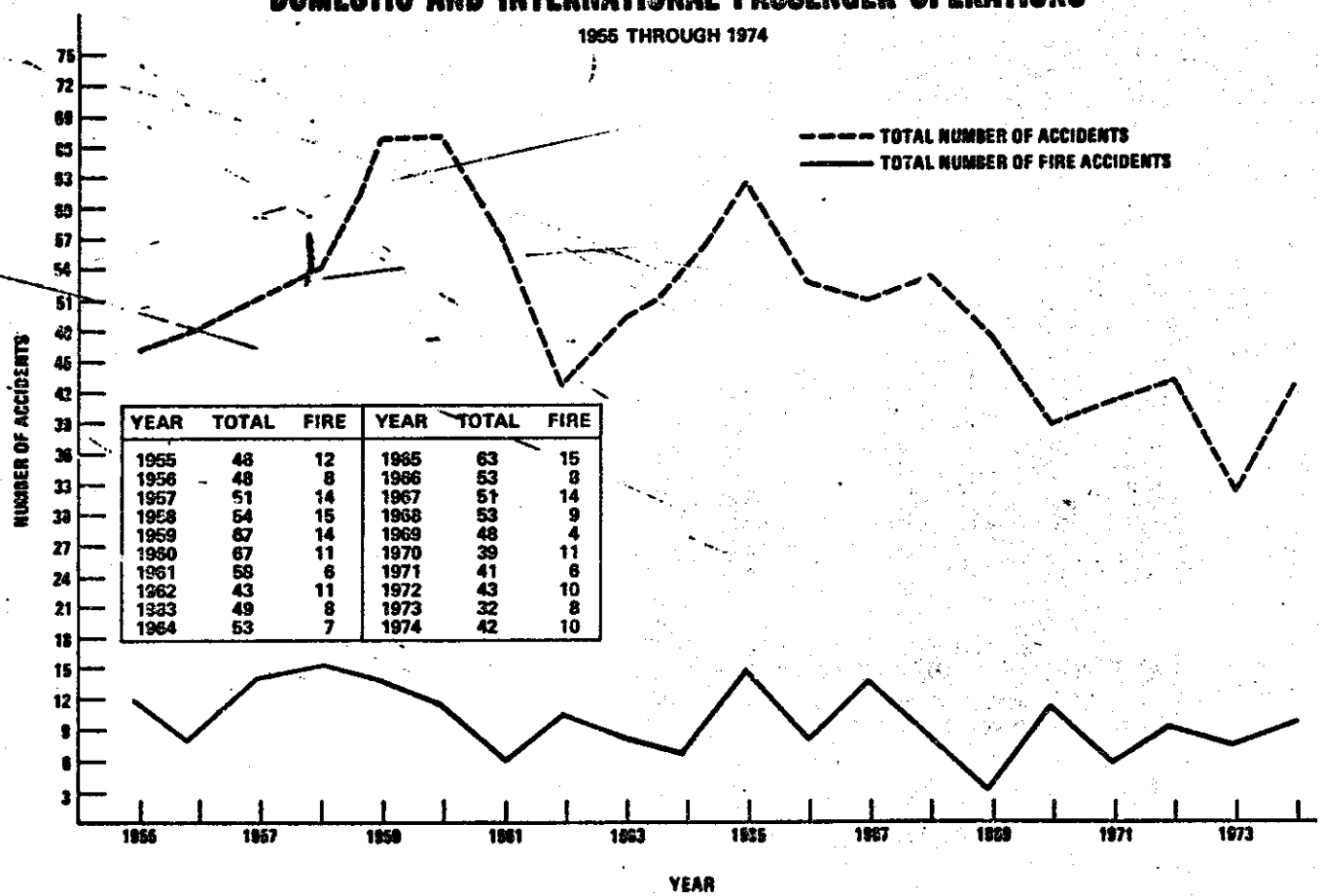


YEAR	TOTAL RATE	FIRE RATE	YEAR	TOTAL RATE	FIRE RATE
1955	.183	.0278	1965	.098	.0292
1956	.168	.0248	1966	.064	.0108
1957	.158	.0372	1967	.049	.0135
1958	.166	.0338	1968	.044	.0075
1959	.177	.0291	1969	.037	.0030
1960	.166	.0143	1970	.028	.0026
1961	.139	.0096	1971	.028	.0041
1962	.094	.0153	1972	.027	.0083
1963	.093	.0038	1973	.019	.0047
1964	.087	.0066	1974	.024	.0052

FIGURE 5

U.S. CERTIFICATED ROUTE AIR CARRIERS
DOMESTIC AND INTERNATIONAL PASSENGER OPERATIONS

1955 THROUGH 1974



YEAR	TOTAL	FIRE	YEAR	TOTAL	FIRE
1955	48	12	1965	63	15
1956	48	8	1966	53	8
1957	51	14	1967	51	14
1958	64	15	1968	53	9
1959	67	14	1969	48	4
1960	67	11	1970	39	11
1961	58	6	1971	41	6
1962	43	11	1972	43	10
1963	49	8	1973	32	8
1964	53	7	1974	42	10

FIGURE 6

RATIO OF FIRE ACCIDENTS TO TOTAL ACCIDENTS

U.S. CERTIFICATED ROUTE AIR CARRIERS

IN DOMESTIC AND INTERNATIONAL PASSENGER OPERATIONS

YEAR	%	YEAR	%
1956	26.1	1965	23.8
1956	16.6	1966	15.0
1957	27.4	1967	27.4
1958	27.7	1968	16.9
1959	20.8	1969	8.3
1960	16.4	1970	28.2
1961	10.3	1971	14.6
1962	25.5	1972	23.2
1963	16.3	1973	25.0
1964	13.2	1974	23.8

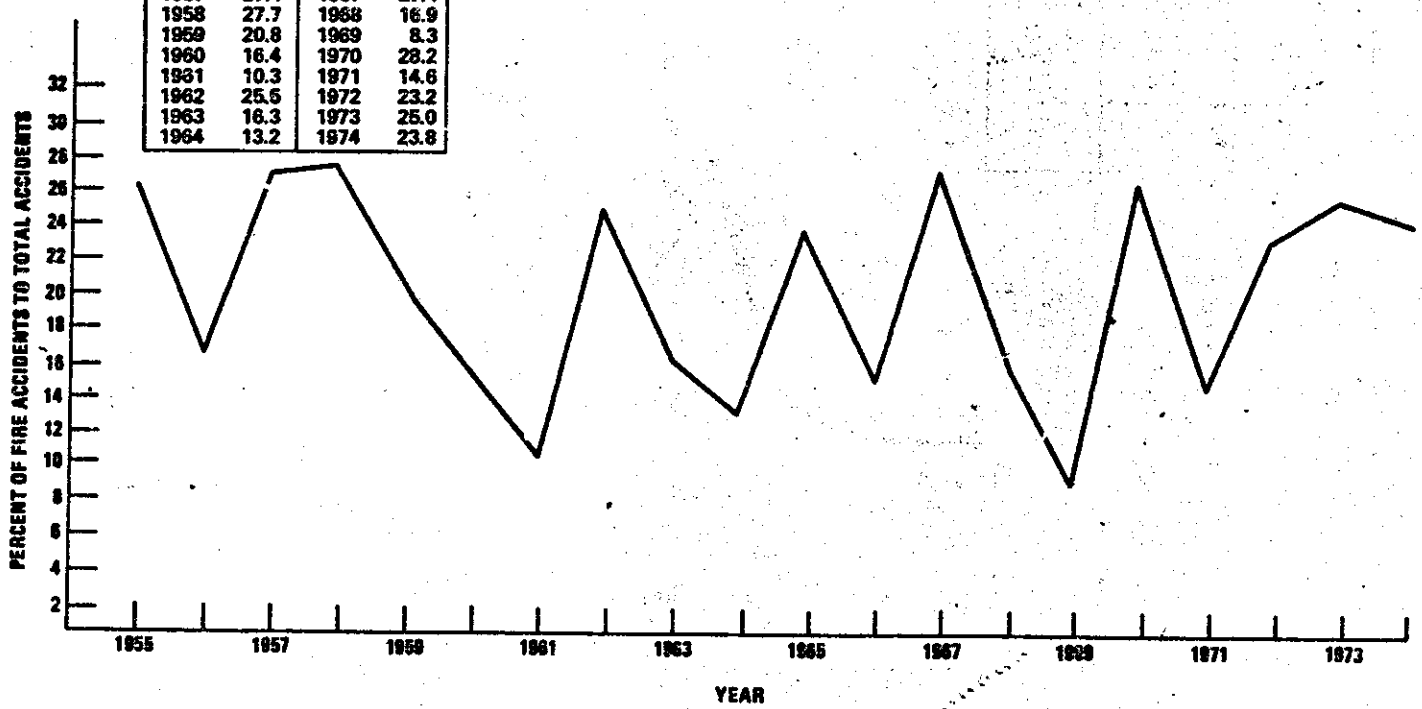
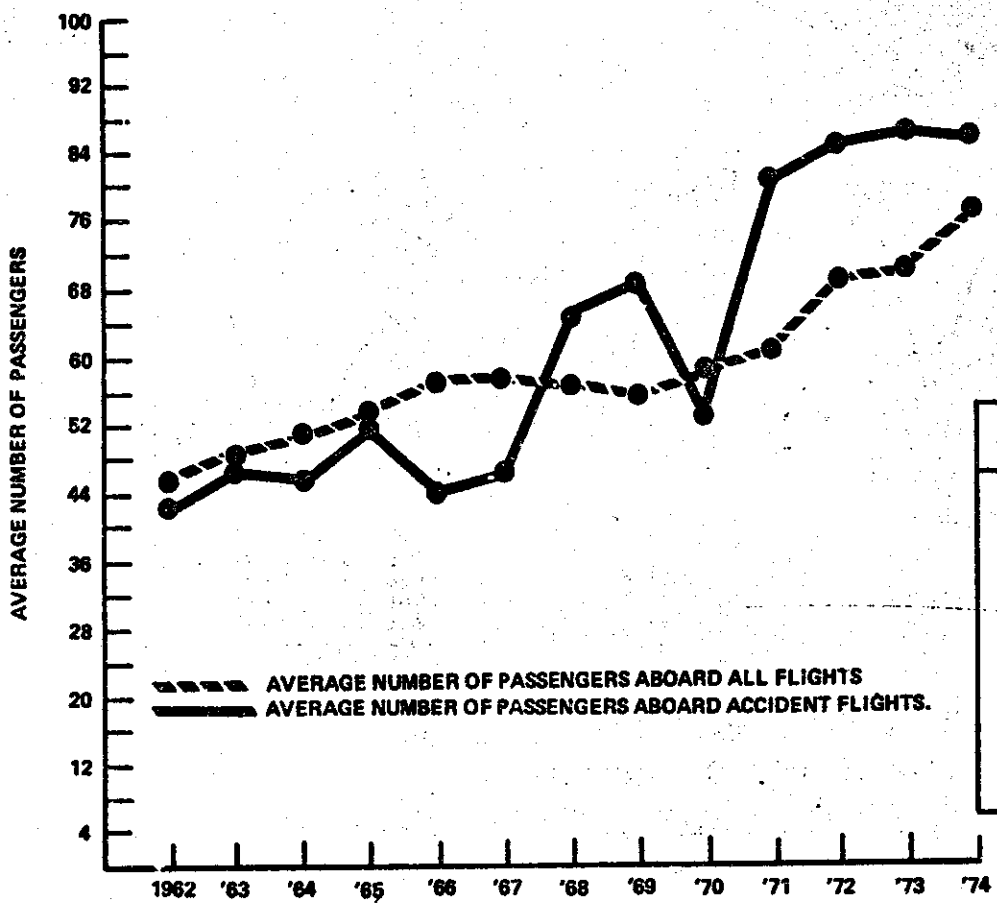


FIGURE 7

U.S. CERTIFICATED ROUTE AIR CARRIERS

(SCHEDULED PASSENGER SERVICE)

1962 THROUGH 1974



YEAR	ALL FLIGHTS	ACCIDENT FLIGHTS
1962	45.5	42.7
1963	48.1	48.1
1964	51.4	45.5
1965	53.2	51.9
1966	56.9	44.0
1967	57.1	46.2
1968	56.4	64.5
1969	55.9	68.5
1970	58.1	52.6
1971	60.6	80.7
1972	68.1	84.8
1973	70.3	86.6
1974	76.6	85.4

The passenger load for fire-involved accidents was not plotted; however, an analysis of these data shows that the average number of occupants exposed per fire accident in all operations was 29.8 for the years 1955 through 1964 and 49.9 for the years 1965 through 1974 -- a 67-percent increase. Therefore, despite the improving fire accident rates discussed previously, the increased number of occupants exposed in each accident has caused the number of fatalities caused by fire to remain relatively constant (297 killed between 1955 and 1964 and 292 killed between 1965 through 1974).

FACTORS INFLUENCING FIRE ACCIDENT DATA

There are several factors which affect the air carrier accident data; however, for purposes of this study, only those factors which directly affect fire potential will be discussed. Three factors which can influence fire data significantly are aircraft type (engine and fuel type); Federal regulations governing aircraft fire protection; and crash/ fire/rescue facilities.

Aircraft Type (Engine and fuel type).

During the 20-year study period, the type of engine power used in the air carrier fleet virtually reversed from the use of reciprocating engines (piston-powered) to the almost exclusive use of turbojet engines. Figure 8 shows the accident rates per 100,000 hours flown by type of engine power for the years 1960 through 1969; the accident rate of turbo-prop powered aircraft also is shown. A steady decline of the accident rate of turbojet aircraft is indicated.

For comparison, the fire-involved air carrier accident rates by type of engine power are plotted in Figure 9. The quantum jump in the piston-powered accident rate is explained by the fact that, while these aircraft were being phased out, a few fire-involved accidents affected significantly the accident rate because of the small number of operations.

The principal characteristics of the turbojet aircraft which account for the accident rate improvement are: Reliability, increased structural integrity, automation, the changed operating environment, and the use of a different fuel.

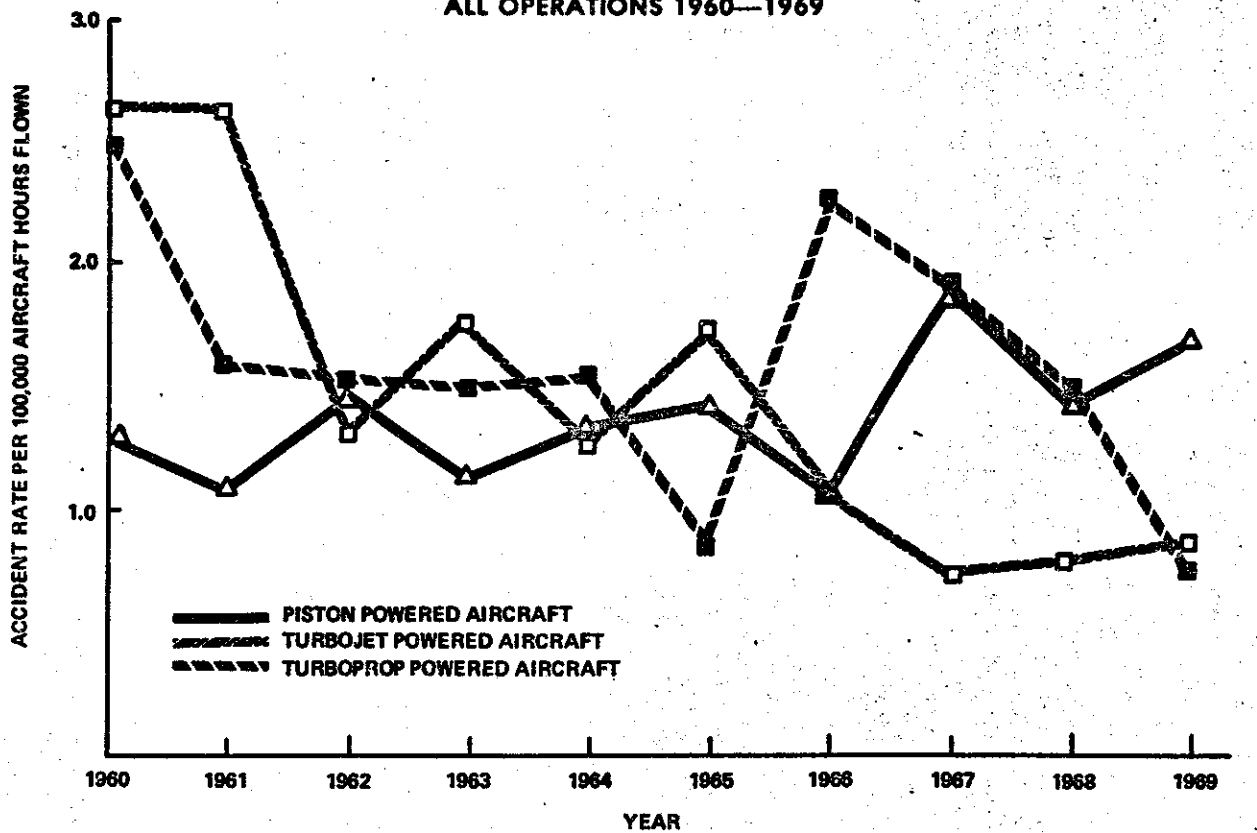
The turbojet aircraft operated by U. S. carriers generally use kerosene-type fuel, while the piston aircraft use gasoline exclusively. It has been well documented that the overall fire hazards for kerosene-type fuel are less than for the more volatile gasoline fuels. 1/ The kerosene-type fuels have been found to be less hazardous than gasoline in ground handling and refueling situations. Moreover, the kerosene-type fuel is less likely to produce a flammable or explosive mixture in-flight than the gasoline-type fuel. Lastly, the fire hazards after a survivable crash or following a minor incident on the ground are reduced by the use of kerosene-type fuels.

1/ NASA TMX 71437, "An Evaluation of the Relative Hazards of Jet A and Jet B for Commercial Flight," Hibbard and Hacker, 1973.

FIGURE 8

TOTAL ACCIDENT RATE PER 100,000 AIRCRAFT HOURS FLOWN

U.S. CERTIFICATED ROUTE AIR CARRIERS
PISTON, TURBOPROP, TURBOJET AIRCRAFT
ALL OPERATIONS 1960—1969

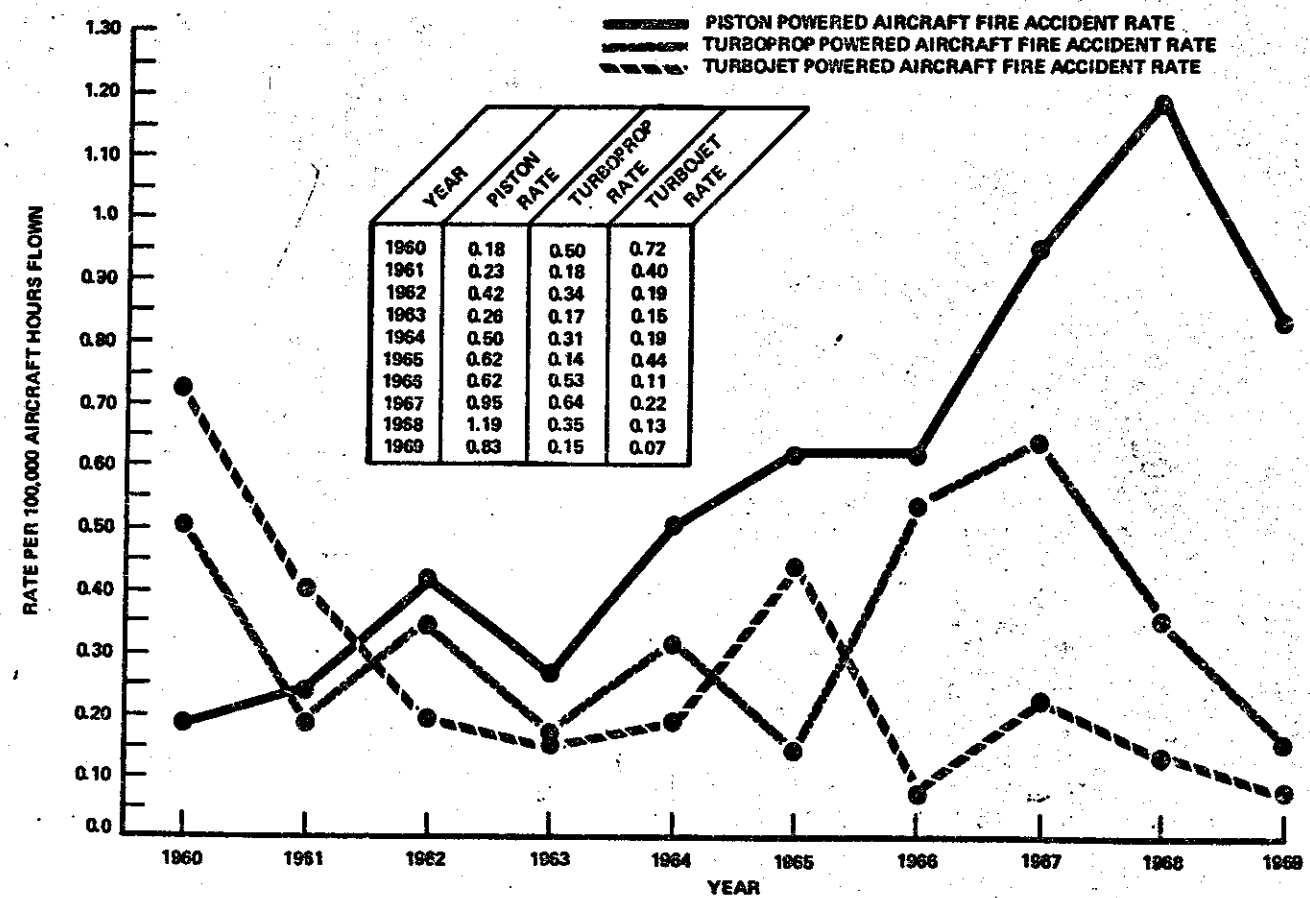


NOTE: EXCLUDES HELICOPTERS AND SMALL FIXED-WING AIRCRAFT.

FIGURE 9

FIRE—INVOLVED ACCIDENT RATE BY TYPE OF ENGINE POWER

U.S. CERTIFICATED ROUTE AIR CARRIERS
(ALL OPERATIONS) 1960 THROUGH 1969



YEAR	PISTON RATE	TURBOPROP RATE	TURBOJET RATE
1960	0.18	0.50	0.72
1961	0.23	0.18	0.40
1962	0.42	0.34	0.19
1963	0.26	0.17	0.15
1964	0.50	0.31	0.19
1965	0.62	0.14	0.44
1966	0.62	0.53	0.11
1967	0.95	0.64	0.22
1968	1.19	0.35	0.13
1969	0.83	0.15	0.07

Fire Protection Regulations for Transport Category Aircraft Interiors

During the second 10-year period covered by this study, there were numerous postcrash fires in which the flammability of cabin materials and the smoke generation characteristics of such materials were an issue. There also were incidents and accidents involving in-flight fires which originated in the cabin areas. Additionally, there was a fatal crash of a Boeing 707 operated by a foreign carrier in which 124 persons died as the direct result of a fire that originated in-flight in the aft cabin area.

Before 1946, fire protection regulations in the Civil Aviation Regulations were mainly concerned with preventing ignition of the large quantities of highly flammable fuel carried aboard the aircraft. At that time, the regulation pertaining to the flammability of cabin materials read: "In compartments where smoking is to be permitted, the materials of the cabin linings, floors, upholstery, and furnishings shall be sufficiently flame resistant to preclude ignition by cigarettes or matches.... All other compartments shall be placarded against smoking."

Following amendments in 1946, 1947, and 1948, the regulation regarding flammability of materials was upgraded, and tests were specified to determine compliance with the regulation. As a result of these amendments, new aircraft manufactured after September 30, 1947, were required to contain cabin materials, all of which had to be at least flash-resistant, but wall and ceiling linings, the coverings of all upholstery, floors, and furnishings had to be flame resistant.

Flame-resistant material was defined as that which would not support combustion to the point of propagating, beyond "safe limits," a flame after removal of the ignition source. "Safe limits" in this context meant that the material to be considered flame-resistant could not burn in excess of 4 inches per minute, when tested in a horizontal position.

Flash-resistant material was defined as that which would not burn "violently" when ignited. The test for flash-resistance required that the material must not burn faster than 20 inches per minute when tested horizontally.

To cover existing aircraft with equal flammability standards, the operating rgulations also were amended to require that all air carrier aircraft meet the flammability standards of flame and flash-resistance established in 1946, 1947, and 1948 by amendments to the airworthiness rules. Existing aircraft were required to comply with those standards by November 1, 1948.

No further amendments regarding flammability of materials were incorporated in the regulations between 1948 and 1967. However, as a result of numerous aircraft fires in the early 1960's, several studies were initiated and reports were published by both Government and industry.

During this time, concern was expressed regarding the problem of smoke emissions from burning aircraft materials. Consequently, both industry and Government groups engaged in research to develop smoke standards for aircraft materials.

On July 29, 1966, the FAA issued Notice of Proposed Rule Making (NPRM) 66-26. This NPRM proposed more stringent standards for cabin materials flammability. However, when the FAR's were eventually amended on October 24, 1967, some of the proposed standards were relaxed because the materials which could meet the proposed specifications at that time were not commercially available in sufficient quantities for aircraft production.

The new standards required that some specified interior materials must be self-extinguishing after flame removal while all other materials not specified to be self-extinguishing had to be at least flame-resistant. These standards were effective on October 24, 1967, for new aircraft. To cover aircraft already in-service, the amendments added a paragraph to Sub-part K of Part 121 of the FAR's requiring that during the first major overhaul or refurbishing of a cabin interior after October 24, 1968, all materials had to meet the new standards for flammability.

The FAA continued research in cabin materials flammability and smoke emission characteristics, but no regulations were issued to establish minimum standards for smoke emissions from burning aircraft materials.

On August 12, 1969, the FAA issued NPRM 69-33 which proposed to improve air carrier crashworthiness standards, including flammability of materials requirements. During the time of consideration of this NPRM, the Boeing Company, the McDonnell-Douglas Company, and the Lockheed Aircraft Company were issued type certificates for the Boeing 747, the DC-10, and the L-1011, respectively. Because of the unique and novel characteristics of these airplanes, the FAA issued Special Conditions for these three "wide-bodied" aircraft, which specified updated cabin materials flammability standards essentially identical to the standards proposed in NPRM 69-33. NPRM 69-33 subsequently was adopted in May 1972. The Special Conditions for the wide-bodied aircraft, as well as these new amendments, effective May 1, 1972, required more stringent flammability standards for some cabin materials, while the standards for other materials remained unchanged.

There were no smoke emission standards adopted in the regulations as a result of this rulemaking.

To cover existing aircraft, the amendments specified that during refurbishing or major overhaul of the interior of an aircraft, for which application for a type certificate was made before May 1, 1972, the replacement materials must meet the requirements in effect on April 30, 1972. On aircraft for which application for a type certificate was made after May 1, 1972, the materials must meet the requirements which were in effect on the date of certification. Thus, aircraft certificated before May 1, 1972, need only meet the flammability standards established in 1967 and then only at the time of refurbishing or major overhaul.

In the preamble to the May 1972 amendment, the FAA noted that several responses to the NPRM cited difficulties with the requirement to replace materials during the first major overhaul or refurbishing of the cabin interiors. These comments noted that cabins were being maintained in an "on condition" 2/ basis and that the rule should be so clarified. The FAA believed that incorporating an "on condition" requirement in the regulations was beyond the scope of the NPRM; however, this proposal would be studied to clarify the rule with a view to initiating appropriate rulemaking. To this date, no further rulemaking has been initiated on this subject.

Therefore, the development and language of the regulations pertaining to cabin interior materials allows air carrier aircraft manufactured in the early or mid-1960's to be operated with cabin materials which merely comply with flammability standards established in 1948. This is because, technically, an aircraft interior could be maintained in an "on-condition" basis with no major overhaul or refurbishing for many years. Furthermore, when the interior of an air carrier aircraft, excluding the wide-bodied types, is refurbished or overhauled, it merely needs to comply with flammability standards established in 1967 because of the certification cutoff date of May 1, 1972. This is not to say that air carriers have not installed the most advanced materials available; they have done so in most instances. However, there are no regulatory requirements to do so.

Three regulatory actions currently under study by the FAA may have considerable impact on cabin materials flammability and smoke generation characteristics. First, as a result of proposals in the FAA's First Biennial Airworthiness Review in December 1974, NPRM 75-31 was issued. One of the proposed rule changes included an amendment to the FAR's governing cabin interior materials. Specifically, it was proposed to require that, after a date 3 years from the effective date of the proposed amendment, all materials, finishes, and decorative surfaces used in each compartment occupied by crew or passengers must conform to the fire protection airworthiness requirements in effect on May 1, 1972. This proposed change would require that all aircraft be furnished with self-extinguishing materials regardless of certification or refurbishing date.

Secondly, Advanced Notice of Proposed Rule Making (ANPRM) 74-38 was issued in December 1974 to obtain data to determine the feasibility of establishing minimum standards for toxic emissions from burning cabin materials. The FAA stated in the ANPRM that the state-of-the-art may have progressed to a point that standards could be established, but that more data were necessary to develop the technical aspects of such standards. This subject is currently under study by the FAA.

2/ "On condition" -- repair and replacement as necessary.

Finally, NPRM 75-3 was issued in February 1975 to establish smoke density standards for emissions from burning cabin materials. This NPRM proposed to specify smoke emission optical density limits for burning cabin furnishings. Also, a test method to show compliance with such rules was proposed. The proposed rules also contained a retroactive requirement for compliance by all air carrier aircraft, 5 years after the effective date of the proposed amendment.

In summary, the fire prevention efforts for transport category aircraft regarding engine fires and other in-flight fires have proved highly successful in eliminating such fires in recent years. Proposals for new cabin fire prevention rules and rules governing smoke emission characteristics of burning cabin materials currently are under study. When such rules are implemented, it is expected that the occupant survivability rates will improve.

Crash/Fire/Rescue Aspects

The data contained in this study and those in the previous study (BOSP-7-6-3) were examined to determine the effect of crash/fire/rescue (CFR) facilities on the overall fire accident statistics.

The previous study determined that 18 persons involved in 2 accidents would have survived had adequate CFR facilities been available. Those 2 cases were among the 13 accidents which accounted for all of the fatalities from fire for that period. In eight other accidents, the crash site was inaccessible to rapid CFR response because of dense fog or adverse terrain features. The remaining three accidents involved adequate CFR response; however, the exits were badly damaged in one accident which prevented rescue while, in the other two cases, extremely rapid fire propagation prevented evacuation and precluded effective CFR activities.

In the current study, 11 accidents accounted for all the fire fatalities. Six accidents were inaccessible to CFR facilities and one other accident was difficult to locate because of dense fog. In the remaining four cases, response of the CFR facilities was timely; however, their effectiveness was minimal because of rapid fire propagation and explosions.

There has been considerable controversy recently regarding the need for and the effectiveness of CFR equipment and personnel at air carrier airports, as a result of the requirements levied on owners and operators of air carrier airports by the provisions of 14 CFR 139. These requirements were a result of the Airport and Airway Development Act of 1970, passed by the U. S. Congress in May 1970 and authorized the FAA to establish minimum safety standards for the operation of airports. Specifically, the Act provided that airports serving CAB certificated air carriers be awarded an operating certificate if they met standards established by the FAA. Among those standards were requirements for CFR facilities and emergency plans to minimize the effects of aircraft accidents.

For various reasons, less than half of the airports initially certificated under 14 CFR 139 met the new standards for CFR facilities as of March 1975. Similarly, many of the airports failed to meet certain requirements for the emergency plans which required the establishment of mutual aid agreements with off-airport CFR facilities. This situation has improved significantly; however, because of the recent implementation of 14 CFR 139, no appreciable effect on air carrier fire-involved accident statistics is noticeable. Consequently, justification for or against CFR facilities at airports cannot be established by this study.

The Safety Board believes, however, that these requirements eventually may influence favorably fire accident data. For example, Table 3 illustrates that about one-half (69 out of 141) of the fire-involved accidents for the years 1965 through 1974 occurred "on the airport." Similarly, Table 4 shows that 31 of the accidents occurred within 5 miles of the airport. The importance of rapid-response CFR facilities on the airport and the capability for CFR response to areas immediately surrounding the airports are obvious. The considerable number of persons exposed to fire in accidents on and near the airport further supports the need for adequate CFR facilities at the airports and for well designed and tested emergency plans. (See Table 4.)

Perhaps the full implementation of 14 CFR 139 will have a favorable impact on occupant survivability in future years.

FINDINGS AND CONCLUSIONS

The National Transportation Safety Board finds that the results of this comparative study on fire-involved accidents in air carrier operations show an encouraging trend in passenger survival. While the potential of fire after an accident in all air carrier operations has increased, the ratio of fire accidents to total accidents in air carrier passenger service has remained relatively constant over the two 10-year study periods. There was an increase of almost 70 percent in average passenger load per aircraft in the latter study period and a seven-fold increase in the number of passenger miles flown.

The Safety Board further concludes that:

1. While the accident rate for U. S. air carriers in all operations and in air carrier passenger service has declined steadily from 1955 through 1974, the rate of fire-involved accidents in air carrier passenger service has not declined as rapidly.

2. The percentage of accidents in which fire occurred for U. S. air carriers in all operations has increased from an average of 18.6 percent in the 1955 through 1964 period to 25.3 percent in the 1965 through 1974 period. These percentages are 20.0 percent and 20.6 percent, respectively, for U. S. air carriers in passenger service.

TABLE 3

ACCIDENT LOCATION TO AIRPORT PROXIMITY FOR ACCIDENTS INVOLVING FIRE

U.S. CERTIFICATED ROUTE AIR CARRIERS
(ALL OPERATIONS)
1965 THROUGH 1974

ACCIDENT LOCATION	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	TOTAL
ON THE AIRPORT	7	2	9	6	4	12	5	11	8	5	69
IN THE TRAFFIC PATTERN	1		2	2		1					6
WITHIN ¼ MILE	1	1									2
WITHIN ½ MILE		1	1	1		1					4
WITHIN ¾ MILE	1	1		1							3
WITHIN 1 MILE		1				1	1				3
WITHIN 2 MILES	2	2						1			5
WITHIN 3 MILES	1			1					1		3
WITHIN 4 MILES			1							1	2
WITHIN 5 MILES			2		1						3
BEYOND 5 MILES	7	7	7	5	1	1	4	2	2	4	40
UNKNOWN/NOT REPORTED										1	1
TOTAL	20	15	22	16	6	16	10	14	11	11	141

TABLE 4

ACCIDENT LOCATION TO AIRPORT PROXIMITY AND OCCUPANT INJURIES FOR ACCIDENTS INVOLVING FIRE

U.S. CERTIFICATED ROUTE AIR CARRIERS
(ALL OPERATIONS)

1965 THROUGH 1974

LOCATION		1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	TOTAL
ON THE AIRPORT	ACCIDENTS	7	2	9	6	4	12	5	11	8	5	69
	FATALITIES	0	0	3	27	5	60	5	14	91	96	301
	SURVIVORS	378	133	375	34	244	807	227	782	610	451	4041
WITHIN 5 MILES OF AIRPORT	ACCIDENTS	6	6	6	5	1	3	1	1	1	1	31
	FATALITIES	101	37	89	64	11	78	28	43	38	75	614
	SURVIVORS	252	40	22	89	17	8	3	8	6	11	456
BEYOND 5 MILES OF AIRPORT	ACCIDENTS	7	7	7	5	1	1	4	2	2	5	41
	FATALITIES	151	74	138	76	14	0	164	104	17	199	937
	SURVIVORS	130	19	105	70	0	27	36	77	0	224	688

3. From 1965 through 1974, 11 accidents accounted for all of the 292 deaths attributable to the effects of fire and smoke.

4. While the average number of persons exposed to fire accidents has increased 67 percent from 1955 through 1974, the actual number of occupants killed by fire has not changed significantly (297 killed from 1955 through 1964 and 292 killed between 1965 and 1974).

5. Because 14 CFR 139, which includes requirements for crash/fire/rescue facilities at airports, was only recently implemented, no appreciable effects on air carrier fire-involved accident statistics are noticeable. Consequently, justification for or against expanded CFR facilities at airports cannot be established by this study.

RECOMMENDATIONS

This study primarily is of a statistical and informational nature. Since the major areas that appear to warrant further improvement already are being addressed by the FAA and other organizations, this study does not support additional safety recommendations.

However, to afford the reader the benefit of experience in this aspect of air carrier safety, some of the significant fire safety recommendations that have been made by the Safety Board are listed below:

Lightning Strike Protection. -- Following the Pan American Boeing 707 accident in Elkton, Maryland, on December 8, 1963, the Safety Board recommended that:

". . . static discharge wicks be installed on all turbine-powered aircraft not so equipped.

". . . the FAA reevaluate problems associated with the incorporation of flame arrestors in fuel tank vent outlets.

". . . the mixture being emitted from the vent outlet be rendered nonignitable by the introduction of air into the vent tube.

". . . an inner wall to the surge tank be provided instead of utilizing the wing skin as part of the surge tank walls.

". . . consideration be given to limiting fuel for commercial use to Jet A only.

". . . every effort be expanded to practically eliminate flammable air/vapor mixtures from the fuel tanks, either by introduction of an inert gas in space above fuel or sufficient air circulation into tanks to maintain too lean a mixture for combustion."

Fuel System Explosions Following Exposure to Ground Fire. -- Following the Trans World Boeing 707 accident in Rome, Italy, on November 23, 1964, the Safety Board recommended that:

". . . expansion of the scope of the Technical Committee on Lightning Protection to undertake a broader review of the overall fuel system and explosion protection problem (to include consideration of all likely ignition sources).

". . . the FAA expedite approval of surge tank detection and suppression systems and issue an early mandatory installation requirement on all B-707 type aircraft."

Internal Fire Following Landing Gear Failure. -- Following the United Boeing 727 accident at Salt Lake City, Utah, on November 11, 1965, the Safety Board recommended that:

". . . B-727 fuel lines be rerouted to near the centerline of the aircraft.

". . . fuel lines and shrouds be stainless steel.

". . . the generator leads be rerouted, each in its own strong and flexible, separate plastic conduit, so there is maximum separation between these leads and the fuel lines.

". . . if the FAA cabin materials fire tests do not include testing of the toxicity of fire by-products when various combinations of materials and fuels are burned together, that the tests be expanded to include same.

". . . FAR be updated to require newly certificated airplanes be fitted with newer, less flammable materials and that carriers be encouraged to utilize same when refurnishing."

Cabin Interior Fire Following Unsuccessful Takeoff Attempt/ -- Following the Capitol International DC-8 accident at Anchorage, Alaska, on November 27, 1970, the Safety Board recommended that:

". . . the FAA initiate action to incorporate in its airworthiness requirements a provision for fuel system fire safety devices which will be effective in the prevention and control of both in-flight and postcrash fuel system fires and explosions.

". . . the FAA, in cooperation with aircraft manufacturers and NASA, utilize extensive research and accident investigation data to develop and implement major improvements in the design of transport aircraft interiors (including the flammability of cabin interior materials)."

Fuel Fire and Rapid Propagation of Fire by Explosions. -- Following the Allegheny CV-580 accident at New Haven, Connecticut, on June 7, 1971, the Safety Board recommended that:

". . . the FAA initiate action to incorporate in its airworthiness requirements a provision for fuel system fire safety devices which will be effective in the prevention and control of both in-flight and postcrash fuel system fires and explosions.

". . . the rulemaking action (called for in the above recommendation) specifically apply to future passenger-carrying aircraft in transport category, and consideration be given to an adaption of all other passenger-carrying aircraft now in service."

In-Flight Cabin Interior Fire. -- Following the Varig Boeing 707 accident in Paris, France, on July 11, 1973, the Safety Board recommended that:

". . . the FAA require a means for early detection of lavatory fires on all turbine-powered, transport-category aircraft operated under FAR Part 121.

". . . full-face smoke masks be required on emergency oxygen bottles for each cabin attendant on turbine-powered transport aircraft to permit attendants to combat lavatory and cabin fires.

". . . the FAA reevaluate certification compliance with Section 4b.381(d) of the CAR on Boeing 707 series aircraft.

". . . the FAA organize a government/industry task force on aircraft fire prevention to review design criteria and formulate specific modifications for improvements with respect to fire potential of enclosed areas, such as lavatories, in turbine-powered aircraft operating under Part 121 of FAR."

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ WEBSTER B. TODD, JR.
Chairman

/s/ KAY BAILEY
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

/s/ WILLIAM R. HALEY
Member

February 17, 1977

APPENDIX A

GROUP I ACCIDENTS

Accidents in Which All Occupants Sustained Fatal Injuries

Date	Air Carrier	Type Aircraft	-Injuries- Fatal	Serious	Minor/None	Total	Remarks
PHASE A --- Fire Inflight			334	--	--	334	10 Accidents
8/6/66	Braniff	BAC 111	42	--	--	42	Wing Failure in Turbulence
6/16/66	Zantop	C-46	2	--	--	2	Midair Collision
3/9/67	TWA	DC-9	25	--	--	25	Midair Collision
6/23/67	Mohawk	BAC 111	34	--	--	34	Fire Inflight--Loss of Control
7/19/67	Piedmont	B-727	79	--	--	79	Midair Collision
6/22/67	Airlift	L-1049A	7	--	--	7	Midair Collision
6/6/71	Hughes Airwest	DC-9	49	--	--	49	Midair Collision
6/29/72	North Central	CV-580	5	--	--	5	Midair Collision
11/3/73	Pan Am	B-707	3	--	--	7	Smoke in Cockpit-Loss of Control-Detonation of Explosive Device
9/8/74	TWA	B-707	88	--	--	88	Loss of Control
PHASE B --- Fire After Impact			603			603	28 Accidents
8/16/65	United Air Lines	B-727	30	--	--	30	Crashed into Lake Michigan during Approach
2/8/65	Eastern Air Lines	DC-7B	84	--	--	84	Near Midair Collision - Crashed into Ocean
12/15/65	Flying Tiger	L-1049	3	--	--	3	Pilot Disoriented-Hit Mountain
9/17/65	Pan Am	B-707	30	--	--	30	Crashed during Descent--Pilot Lost
10/1/66	West Coast Airlines	DC-9	18	--	--	18	Descent Below Clearance Limit - Reason Unknown
8/21/66	Alaska Coastal-Ellis	G-21A	9	--	--	9	Uncontrolled Crash into Glacial Crevasse - Reason Unknown.
11/15/66	Pan Am	B-727	3	--	--	3	Crashed During Approach-Undetermined
12/24/66	Flying	CL-44	4	--	--	4	Crashed on Final Approach.

GROUP I ACCIDENTS - Cont'd

Date	Air Carrier	Type Aircraft	-Injuries- Fatal	Serious	Minor/ None	Total	Remarks
PHASE B--- Fire After Impact-Continued							
3/30/67	Delta Air Lines	DC-8	6	--	--	6	Loss of Control During Engine Out Approach
3/10/67	West Coast Airlines	F-27	4	--	--	4	Loss of Control - Airframe Ice
12/21/67	Frontier Airlines	DC-3C	2	--	--	2	Loss of Control on Takeoff-Gust Lock Engaged
1/31/67	Saturn Airways	DC-6A	3	--	--	3	Crashed on Final Approach
5/27/68	Los Angeles Airways	S-612	23	--	--	23	Loss of Control - Main Rotor Failure
8/14/68	Los Angeles Airways	S-612	21	--	--	21	Loss of Control- Rotor Assembly Failure
12/26/68	Pan Am	B-707	3	--	--	3	Crashed on Takeoff- Failed to Use Flaps
7/26/69	TWA	B-707	5	--	--	5	Loss of Control- Rudder System Failure
11/19/69	Mohawk	FH-227B	14	--	--	14	Loss of Control - Flew into Downdraft
9/8/60	TIA	DC-8F	11	--	--	11	Loss of Control - Elevator Jammed by Debris
11/14/70	Southern	DC-9	75	--	--	75	Descent Below Glide Path - Undetermined
10/10/70	Saturn	L-382B	3	--	--	3	Crash During Final Approach
3/31/71	Western	B-720	5	--	--	5	Loss of Control - Rudder System Failure
9/4/71	Alaska	B-727	111	--	--	111	Hit Mountain En Route to Initial Approach
7/25/71	Pan Am	B-707	4	--	--	4	Crashed During Landing Approach
5/30/72	Delta	DC-9	4	--	--	4	Loss of Control During Landing - Vortex Turbulence
9/27/73	Texas Int'l	CV-600	11	--	--	11	Hit Mountain While Enroute - Lost
9/8/73	World	DC-8	6	--	--	6	Hit Mountain During Descent for Landing
5/23/74	Saturn	L-382	4	--	--	4	Loss of Control- Wing Failure

GROUP I ACCIDENTS - Cont'd

Date	Air Carrier	Type Aircraft	-Injuries- Fatal	Serious	Minor/None	Total	Remarks
PHASE B --- Fire After Impact-Continued							
4/22/74	Pan Am	B-707	107	--	--	107	Hit Mountain During Descent for Landing

NOTE: There were no Group I accidents which occurred on the ground (Phase C).

GROUP II ACCIDENTS

Accidents in Which Some Occupants Survived While Others Sustained Fatal Injuries

NOTE: There were no Group II accidents involving inflight fire (Phase A).

Date	Air Carrier	Type Aircraft	-Injuries- Fatal	Serious	Minor/None	Total	Remarks
PHASE B --- Fire After Impact			911	330	360	1601	23 Accidents
11/8/65	American	B-727	58	4	--	62	Crashed Short on Final Approach
11/11/65	United	B-727	43	35	13	91	Hit Runway with Excessive Descent
12/4/65	Eastern	L-1049C	4	34	16	54	Forced Landing Off Airport - Midair Collision
4/22/66	American Flyers	L-188C	83	15	--	94	Struck Hill During Circling Approach
11/6/67	TWA	B-707	1	1	34	36	Aborted Takeoff Following Collision on Ground
11/20/67	TWA	CV-880	69	13	--	82	Undershot Runway During Approach
8/10/68	Piedmont	FH-227	35	2	--	37	Crashed Short in Fog on Final Approach
10/25/68	Northeast	FH-227C	32	8	2	42	Crashed During Descent for Landing
12/24/68	Allegheny	CV-580	20	12	15	47	Hit Trees During Landing Approach
12/27/68	North Central	CV-580	27	16	2	45	Crashed into Hangar - Disorientation
6/17/68	Pan Am	B-707	6	10	47	63	Crashed During Landing- Failed to Use Flaps
1/6/69	Allegheny	CV-440	11	14	3	28	Hit Trees During Landing- Undetermined
11/27/70	Capitol Int'l	DC-8	47	49	133	229	Crashed During Takeoff- Brakes Dragging
12/28/70	Trans Caribbean	B-727	2	11	42	55	Bounce During Landing
11/30/70	TWA	B-707	-*	--	3	3	Hit Another Aircraft Being Towed - Both Burned
6/7/71	Allegheny	CV-580	28	3	--	31	Crashed into Houses on Approach
12/23/72	Eastern	L-1011	99	60	17	176	Crashed into Everglades Maneuvering to Land

* This accident is counted as Group II, Phase B although none of the primary aircraft's occupants were killed.

GROUP II ACCIDENTS - Cont'd

Date	Air Carrier	Type Aircraft	-Injuries- Fatal	Serious	Minor	Total	Remarks
PHASE B --- Fire After Impact - Continued							
12/20/72	North Central	DC-9	10	9	26	45	Crashed After Collision with Other Aircraft During Takeoff
12/8/72	United	B-737	43	12	6	61	Crashed into Houses on Final Approach
7/31/73	Delta	DC-9	88	1	--	87	Struck Seawall During Landing
7/23/73	Ozark	FH-227B	38	6	--	44	Loss of Control - Downdraft and Rain
1/30/74	Pan Am	B-707	96	5	--	101	Hit Trees During Final Approach
9/11/74	Eastern	DC-9	71	10	1	82	Crashed During Approach for Landing

GROUP III ACCIDENTS

Accidents In Which All Occupants Survived But Some Received Serious Injuries

Date	Air Carrier	Type Aircraft	- Injuries - Fatal	Serious	Minor/None	Total	Remarks
PHASE A -- Fire Inflight			0	1	51	52	1 Accident
2/16/74	TWA	B-707	-	1	51	52	Coffee Maker Exploded
PHASE B --- Fire After Impact			0	54	663	717	15 Accidents
7/23/65	Allegheny	CV-440	-	23	17	40	Loss of Control on Takeoff--Engine Failure
9/12/66	Airlift Int'l	DC-7C	-	1	3	4	Aborted Takeoff - Gear Collapsed
7/27/66	Frontier	DC-3	-	3	13	13	Loss of Directional Control on Takeoff
7/28/66	Zantop	C-46F	-	1	1	2	Crashed on Takeoff Following Engine Failure
6/26/67	United	VC-745D	-	1	32	33	Aborted Takeoff Due to Vibration
11/28/67	United	VC-745D	-	1	42	43	Gear Collapsed During Landing Roll
9/9/67	Pan Am	B-707	-	2	172	174	Crash During Takeoff-Engine Failure
4/28/68	Capitol	DC-8	-	2	2	4	Loss of Control on Landing Roll
3/21/68	United	B-727	-	1	2	3	Off runway - aborted takeoff
9/28/68	Universal	DC-7C	-	1	2	.3	Crashed Short During Final Approach
8/8/70	Modern Air Trans.	CV-990	-	8	-	8	Hit Approach Lights on Final Approach
5/18/72	Eastern	DC-9	-	3	7	10	Landed Short in Thunderstorm
11/27/73	Delta	DC-9	-	4	75	79	Crashed Short During Approach in Rain
1/16/74	TWA	B-707	-	2	63	65	Hard Landing - Nose Wheel Collapsed
3/27/74	World	DC-8	-	1	232	233	Aborted Takeoff - Brake Fire
PHASE C --- Fire on Ground			0	25	1788	1813	13 Accidents
3/14/65	United	Caravelle	-	1	53	54	Aborted Takeoff-Engine Fire
2/9/69	Pan Am	B-727	-	2	114	116	Aborted Takeoff-Engine Fire

GROUP III ACCIDENTS - Cont'd

Date	Air Carrier	Type Aircraft	- Injuries - Fatal	Serious	Minor/ None	Total	Remarks
PHASE C --- Fire on Ground - Continued							
3/2/70	United	B-720	-	1	94	95	Engine Fire During Start
6/9/70	Trans Caribbean	DC-8	-	2	226	228	Brake Fire During Takeoff
5/18/70	United	B-727	-	1	71	72	Smoke in Cabin During Taxi
7/23/71	United	B-747	-	1	198	199	Engine Fire During Taxi
9/1/72	TWA	B-747	-	8	345	353	Wheel Brake Fire During Taxi
3/3/72	United	DC-8	-	1	128	129	APU Torched During Engine Start
11/1/72	TWA	B-707	-	1	80	81	Engine Fire During Landing Roll
6/10/72	American	B-727	-	2	75	77	Oxygen Fire While at Gate
6/20/73	Overseas National	DC-8	-	3	258	261	Fire in Brakes on Takeoff
1/4/74	United	B-727	-	1	117	118	Fire in Brakes on Takeoff
11/25/74	Pan Am	B-707	-	1	29	30	Engine Fire on Takeoff

GROUP IV ACCIDENTS

Accidents in Which All Occupants Sustained Either Minor or No Injuries

Date	Air Carrier	Type Aircraft	-Injuries- Fatal	Serious	Minor/None	Total	Remarks
PHASE A --- Fire Inflight			--	--	783	783	18 Accidents
6/28/65	Pan Am	B-707	--	--	153	153	Engine Fire Inflight-Engine Fell Off
6/4/65	National	DC-8	--	--	77	77	Engine Fire Inflight
2/13/66	Wien Alaska	Cessna 185	--	--	3	3	Engine Fire and Failure
6/17/66	North Central	CV-440	--	--	2	2	Engine Failure and Fire
8/11/66	Lake Central	Nord 262	--	--	17	17	Engine Fire During Airstart
6/24/67	Delta	CV-880	--	--	59	59	Turbine Disc Failure-Penetrated Wing
4/8/67	Lake Central	Nord 262	--	--	9	9	Engine Fire-Hydraulic Leak
7/7/67	Aloha	VC-745D	--	--	33	33	Fire in Cabin-Electrical system
7/23/67	Braniff	CV-340	--	--	9	9	Engine Fire - Oil Leak
4/25/67	Caribbean Atlantic	CV-640	--	--	57	57	Fire in Brakes -- Forced Landing
2/10/67	Flying Tiger	L-1049	--	--	4	4	Airframe Fire - Forced Landing
11/19/68	American	B-707	--	--	38	38	Engine Disintegrated-Damaged Fuel Line
3/28/70	Western	B-720	--	--	27	27	Engine Failure -- Separation Inflight
11/17/71	United	B-727	--	--	36	36	Engine Failure - Damaged Vertical Stabilizer
3/19/72	Universal	L-188	--	--	3	3	Prop Overspeed
2/16/72	Texas Int'l	CV-660	--	--	3	3	Prop Failure - Part of Engine Separated
8/8/73	Braniff	B-727	--	--	81	81	Tire Failure and Brake Fires
7/8/74	National	DC-10	--	--	172	172	Foreign Object Damage-Engine Failure
PHASE B --- Fire After Impact			0	0	614	614	23 Accidents
5/18/65	American Air Export	DC-6A	--	--	3	3	Collided with Trees on Final Approach
1/21/65	Piedmont	M-404	--	--	28	28	Hit Snowbank on Landing Roll

GROUP IV ACCIDENTS - Cont'd

Date	Air Carrier	Type Aircraft	-Injuries- Fatal	Serious	Minor/ None	Total	Remarks
PHASE B - Fire After Impact - Continued							
5/29/65	Reeve-Aleutian	DC-3	--	--	5	5	Crashed on Takeoff - Wind Shift
4/13/65	TWA	CV-880	--	--	4	4	Stalled on Initial Takeoff
3/26/65	Pan Am	B-707	--	--	170	170	Dragged Wingtop on Landing Roll
10/16/65	Eastern	DC-7	--	--	62	62	Gear Collapsed on Landing
10/14/65	Zantop	AW-650	--	--	3	3	Engine Failure - Forced Landing
10/17/65	United	DC-6	--	--	16	16	Gear Retracted on Takeoff
3/21/66	Flying Tiger	CL-44	--	--	6	6	Hard Landing - Nosed Over
3/23/67	Universal	DC-7	--	--	3	3	Taxied into APU
6/26/67	Northern Consolidated	DC-6A	--	--	2	2	Loss of Directional Control During Landing
1/23/67	Caribbean Atlantic	CV-640	--	--	28	28	Landed Short - Stall Mush
1/1/68	Southern	M-404	--	--	3	3	Gear Collapsed-Landing
6/24/68	North Central	CV-580	--	--	22	22	Hit Guy-Wire During Circling Approach
7/2/68	Universal	DC-7	--	--	3	3	Loss of Directional Control-Hydroplaning
10/16/69	Seaboard	DC-8	--	--	5	5	Aborted Takeoff-Gear Collapsed
8/24/70	Universal	L-188	--	--	3	3	Nosed Over on Takeoff.
9/29/70	Braniff	B-720	--	--	54	54	Gear Retracted-Landing Roll
3/18/71	Saturn	GA-382	--	--	4	4	Ground Loop - Wind Gusts
3/18/71	Saturn	GA-882	--	--	4	4	Gear Collapsed-Landed Short
8/16/71	Wien	PC 6-HZ	--	--	2	2	Loss of control on Takeoff - Engine Out
3/5/73	American	B-707	--	--	3	3	Hydroplaning-Overran Runway
10/28/73	Piedmont	B-737	--	--	96	96	Loss of Directional Control-- Landing Ice on Runway
12/17/73	Eastern	DC-9	--	--	89	89	

GROUP IV ACCIDENTS - Cont'd

Date	Air Carrier	Type Aircraft	- Injuries - Fatal	Serious	Minor/ None	Total	Remarks
PHASE C --- Fire On the Ground			--	--	526	526	10 Accidents
3/25/65	Mohawk	CV-440	--	--	43	43	Fire in Baggage Compartment - While Taxiing
2/13/66	Braniff	B-720	--	--	127	127	Engine Exploded During Landing Roll
8/5/68	Flying Tiger	B-707	--	--	3	3	Engine Fire During Reverse on Landing
11/21/69	Eastern	DC-8	--	--	123	123	Engine Failure on Takeoff Run
6/3/70	Eastern	B-727	--	--	105	105	APU Caught Fire on Engine Start
3/4/70	New York Airways	S-61L	--	--	9	9	Cabin Heater Fire-- Fumes in Cabin
5/18/70	Delta	L-382	-	-	3	3	Aborted Takeoff-- Brake Fire
8/8/71	Aloha	VC-745	--	--	22	22	Battery Thermal Run-away
3/19/72	Delta	DC-9	--	--	87	87	Cabin Fire From Engine Failure
5/10/72	Eastern	DC-9	--	--	4	4	Fire in Cabin - Electrical Short

APPENDIX B

CASE HISTORIES

Eleven Group II accidents accounted for all but one of the fatalities from fire in air carrier operations for the years 1965 through 1974. The following synopses contain relevant facts, conditions, and circumstances regarding these accidents including the fire aspects.

Case 1. On November 8, 1965, American Airlines Flight 383, a Boeing 727, N1996, en route from LaGuardia Airport, N. Y., to the Greater Cincinnati Airport at Covington, Kentucky, struck a tree with its right wing and crashed into a wooded hillside about 2 miles from the intended landing runway. There were 55 passengers and a crew of 6 aboard.

The aircraft remained relatively intact as it slid through scrub trees and ground foilage for about 340 feet. It then struck and came to rest among a group of large trees. A survivor stated that he saw flames coming forward from the rear of the cabin as he escaped out of the front of the aircraft which was completely missing. He said that shortly after he had escaped, the aircraft exploded and began to burn intensely. Only 4 occupants out of the 62 aboard survived the impact and ensuing fire. The number of occupants who died from fire was not determined, although the circumstances of the accident suggest that some occupants probably survived the impact and died in the postcrash fire.

The accident site was inaccessible to the firefighting personnel and equipment which arrived in the accident vicinity about 15 minutes after the accident. (File No. 1-0031.)

Case 2. On November 11, 1965, United Air Lines Flight 227, a Boeing 727, N703U, en route from Denver, Colorado, to Salt Lake City, Utah, crashed during an attempted landing 335 feet short of the runway threshold and slid about 2,838 feet along the runway. The aircraft came to rest off the right side of the runway.

During the crash, the main gear was sheared off and the right main gear ruptured fuel lines. The aircraft caught fire during the ground slide and 41 of the 91 occupants died in the fire. Two others died several days after the accident as a result of their burns. The fatalities sustained no traumatic injuries which would have prevented their escape.

The airport firetrucks arrived at the accident scene about 3 1/2 minutes after the accident. Since the fire was generally propagating inside the fuselage, the effectiveness of the firefighting was reduced. It took about 38 minutes to bring the fire under control. Three survivors were rescued from the aft stairway area between 25 and 30 minutes after the accident. The other survivors escaped without assistance. (File No. 1-0032.)

Case No. 3. On December 4, 1965, Eastern Air Lines Flight 853 (EA 853) N6218C, a Lockheed 1049C and Trans World Airlines Flight 42, N748TW, Boeing 707, collided in a midair over the Carmel, New York, VORTAC. EA 833 made a forced landing during which the left wing struck a tree just before the aircraft contacted the ground. The emergency landing was in an open field on a hillside with an upslope. The fuselage was broken into three main sections which remained in their respective positions at varying angles to each other.

Of the 54 occupants aboard EA 853, 4 were killed in the accident. Nearly all of the aircraft wreckage was exposed to fire. The survivors exited through the fuselage breaks, the right forward cockpit crew door, the left main cabin door, and through an opening at the aft pressure door area. Two occupants failed to evacuate and their deaths were caused by inhalation of combustion products.

Firefighting personnel and equipment could not reach the accident site to assist. (File No. 1-0033.)

Case No. 4. On November 27, 1970, Capitol International Airways Flight C2C3/26, a Douglas DC-8-63C, N4904C, crashed during takeoff at Anchorage, Alaska. The aircraft failed to become airborne and overran the runway when its wheels failed to rotate during the takeoff run. The aircraft struck a low wooden barrier, an ILS facility, and a 12-foot drainage ditch before coming to rest approximately 3,400 feet beyond the runway end. The fuselage broke apart in the aft cabin area and the right wing was torn free.

There were 219 passengers and a crew of 10 aboard the aircraft which was destroyed in the intense fire that developed after the crash. The fire erupted on the left side of the aircraft during the crash sequence. When the aircraft came to rest, a large fire erupted on the right side where the damaged right wing released fuel. Survivors evacuated through cabin doors, overwing exits and through the break in the aft fuselage. All of the 47 fatally injured occupants were killed by fire.

A dry chemical unit of the airport fire department was on the scene fighting the fire within 3 minutes of the crash. The remaining airport units were on scene within 5 minutes after the crash. The intensity of the fire and several explosions hampered firefighting activities. Fire and rescue units from off-airport facilities also participated in the firefighting and rescue activities (NTSB AAR-72-12, File No. 1-0025).

Case No. 5. On December 28, 1970, Trans Caribbean Airways Flight 505, a Boeing 727-200, N8790R, crashed during landing at St. Thomas, Virgin Islands. There were 55 occupants aboard the aircraft which was destroyed by impact and postcrash fire. During the landing, the aircraft bounced which failed the right main landing gear; the aircraft went through a chain-link fence, struck a raised concrete walk and a truck on

the perimeter road. It came to rest on the slope of a hill beyond the road. The aircraft sustained extensive structural damage; an explosion near the left wing root occurred before fire erupted. The propagation of the fire reportedly was slow. The two fatally injured occupants died from burns.

The airport firefighting units responded instantly because the crash was witnessed by firefighting personnel. The equipment was not effective because of the location of the wreckage. The units had to retreat and the fire was not extinguished until the fuselage was destroyed.. (NTSB AAR 72-8, File No. 1-0026.)

Case No. 6. On June 1971, Allegheny Airlines Flight 485, a Convair 340/440, N5832, crashed while attempting to land at Tweed-New Haven Airport, Connecticut. The aircraft struck three beach houses and power-lines before coming to rest about 4,890 feet short of the landing runway. There were 31 occupants aboard. The aircraft was destroyed in an intense fire which erupted immediately after the initial impact. Flame propagation was accelerated as fuel spilled from the fractured wings and secondary explosions occurred shortly after the impact. Twenty-seven of the 28 fatally injured occupants died from fire.

Two firefighting units arrived at the crash site about 5 minutes after the crash; however, they did not immediately see the burning aircraft and began to extinguish the burning buildings. (NTSB-AAR-72-20, File No. 1-0006.)

Case No. 7. On May 30, 1972, Delta Air Lines, Flight 9570, a Douglas DC-9, N3305L, crashed while attempting a go-around at the Greater Southwest International Airport, Fort Worth, Texas. Flight 9570 was a training flight with three crewmembers and one captain trainee aboard. The aircraft encountered turbulence from a Douglas DC-10 which preceded Flight 9570 on a "touch-and-go" landing. The aircraft oscillated about its longitudinal axis, rolled 90° to the right, and its right wing hit the runway. The main fuselage then struck the runway nearly inverted causing the fuselage and empennage to separate and slide about 2,400 feet along the runway. When the right wingtip contacted the runway, the wing fuel tank ruptured, initiating the fire. The one occupant of the passenger cabin died as a result of the fire.

The airport fire department crash crew responded to the crash before the alarm was sounded. They were on the scene very quickly and the fire was extinguished but not before the fuselage was extensively burned. (NTSB-AAR-73-3, File No. 1-0003.)

Case No. 8. On December 8, 1972, United Air Lines Flight 553, a Boeing 737, N9031U, crashed while making a nonprecision-approach to Midway Airport, Chicago, Illinois. The aircraft stalled, impacted trees,

houses, utility poles, and garages about 2 miles from the airport. It came to rest across the foundation of one of the houses the aircraft destroyed. There were 61 occupants aboard the aircraft which was destroyed by the impact and subsequent fire.

Witnesses stated that the fire began immediately and that structures on both sides of the aircraft wreckage were burning with white smoke. They said that the fire was very intense around the center section of the aircraft with thick black smoke obscuring part of the fuselage. Forty-three aircraft occupants were killed in the accident. Toxicology and autopsy findings showed that at least 27 of the occupants succumbed to the effects of fire.

The Chicago City Fire Department arrived at the scene within 2 to 3 minutes of the crash. The main fire was controlled and extinguished almost entirely by water and was controlled in 20 to 30 minutes; however, smoke, heat, and small "flare-ups" continued for more than 3 hours after the crash. The sole survivor of the forward part of the aircraft was the flight attendant who had been seated on the forward jumpseat. She was rescued from beneath debris after a 30-minute rescue effort. Water was sprayed onto her during the rescue to prevent flames from reaching her. (NTSB-AAR-73-16, File No. 1-0048.)

Case No. 9. On December 20, 1972, North Central Airlines Flight 575, a Douglas DC-9, N954N, collided with Delta Air Lines Flight 954, a Convair 880, N8807E, while attempting a takeoff at O'Hare International Airport Chicago, Illinois. Flight 575 touched down on the runway and skidded to a stop. There were 45 occupants aboard Flight 575 which burst into flames and was destroyed in the fire.

Ten of the occupants died as a result of the fire. None of the injured received traumatic impact injuries.

Because of restricted visibility, the crash/fire/rescue units were not activated immediately. The first unit reached the burning aircraft about 3 minutes after the crash. The fire was extinguished in about 16 minutes.

Nine of the 10 fatally burned passengers failed to evacuate the aircraft. Four of them had left their seats; two were found in the aft section of the aircraft. The other five remained in their seats. (NTSB-AAR-73-15, File No. 1-0017.)

Case No. 10. On January 3, 1974, Pan American World Airways Flight 806, a Boeing B-707-321, N454PA, crashed while making a night time ILS approach to Pago Pago, American Samoa. The aircraft impacted trees and the ground about 3,900 feet short of the runway. There were 101 accupants aboard the aircraft which was destroyed by impact and postcrash fire.

The fire progressed very rapidly and only four occupants survived. All of the fatally injured occupants were burned severely. Only one fatality received traumatic impact injuries.

The cabin area was entirely intact following this crash; however, none of the primary exits were opened and fire prevented the use of exits on the right side. Only the left overwing exits were used by survivors.

The airport fire department had difficulty reaching the crash site. Their response, which took about 14 minutes, was hampered by weather, obstacles across the response route, and uncertainty about the location of the fire. No rescue efforts could be accomplished until after the fire was extinguished. (NTSB-AAR-74-15, File No. 1-0001.)

Case No. 11. On September 11, 1974, Eastern Air Lines Flight 212, a Douglas DC-9 crashed while conducting a nonprecision approach to Douglas Municipal Airport, Charlotte, North Carolina. The aircraft crashed 3.3 miles from the airport after striking trees and the ground before breaking up and bursting into flames. There were 82 occupants aboard the aircraft.

The aircraft wreckage came to rest about 1,000 feet from the initial impact point. The cockpit section broke off as did the aft fuselage. Both wings had struck trees and were sheared off before the fuselage came to rest.

Thirty-nine of the occupants succumbed to the effects of fire or a combination of impact and fire injuries.

Volunteer Fire Department units were on the scene within 11 to 12 minutes of the accident. Rescue activities were confined to the outside of the aircraft, and the fire was under control within 5 minutes of arrival at the scene.

The survivors were either thrown clear of the wreckage or escaped through holes in the fuselage. Three occupants escaped through a cockpit window. (NTSB-AAR-75-9, File No. 1-0020.)

APPENDIX C

GROUP I

Accidents In Which All Occupants Sustained Fatal Injuries

Date	Air Carrier	Type Aircraft	Fatalities Total	Crew	Pagrs.	Remarks
A. FIRE IN FLIGHT			299	41	258	NINE ACCIDENTS
8/4/55	AA	CV-240	30	3	27	Fire burned wing off in flight.
1/20/59	WE	BE-18	1	1	0	Inflight cabin fire. Crashed on forced landing.
3/30/59	RDLX	C-46R	2	2	0	Inflight cargo fire burned flight controls
9/29/59	BNF	L-188	34	7	27	Disintegrated and burned in flight.
11/24/59	TWA	L-1049H	3	3	0	Engine fire. Hit house in landing approach.
1/22/61	Capitol Airways	C-46F	2	2	0	Engine fire burned wing off in flight.
3/15/62	FTLX	L-1049	107	11	96	Demolished in flight. Fell in flames in ocean.
12/8/63	PanAm	B-707	81	8	73	Explosion in flight. Fell in flames.
7/9/64	UAL	V-745D	39	4	35	Inflight fire caused loss of control.
B. FIRE AT IMPACT			1168	181	987	FORTY-TWO ACCIDENTS
1/12/55	TWA	M-202	13	3	10	Collided with corporate DC-3. Crashed and burned.
2/19/55	TWA	M-404	16	3	13	Hit mountain in clouds. Burned at impact.
4/4/55	UAL	DC-6	3	3	0	Prop reversal on takeoff. Burned at impact.
10/6/55	UAL	DC-4	66	3	63	Flew into mountain. Burned at impact.
12/17/55	RDLX	C-46	2	2	0	Structural failure in flight.
12/21/55	EAL	L-749	17	5	12	Struck ground during ILS approach.
6/30/56	TWA	L-1049	70	6	64	Midair collision, Grand Canyon.
	UAL	DC-7	58	5	53	
12/16/56	AS	Stinson V-77	4	1	3	Hit cliff during landing approach.
3/2/57	AS	DC-4	5	3	2	Hit hill in clouds and burned.
11/8/57	PanAm	B-377	44	8	36	Crashed in ocean. Cause unknown.

APPENDIX C

Accidents In Which All Occupants Sustained Fatal Injuries (continued)

Date	Air Carrier	Type Aircraft	Fatalities Total	Crew	Psgrs.	Remarks
4/6/58	CAP	V-700D	47	3	44	Stalled, spun in during weather.
4/21/58	UAL	DC-7	47	5	42	Hit F-100 head on. Crashed and burned.
5/20/58	CAP	V-700D	11	4	7	Hit T-33 in air. Crashed and burned.
11/16/58	Capitol Airways	C-46F	2	2	0	Hit mountain after engine failure in instrument conditions.
6/26/59	TWA	L-1649A	68	9	59	Broke up in flight. Burned at impact.
8/15/59	AA	B-707	5	5	0	Lost control and crashed.
9/12/59	PanAm	DC-4	3	3	0	Hit ridge of valley and burned.
9/24/59	RV	DC-4	16	5	11	Hit mountain and burned.
11/16/59	NAL	DC-7B	42	6	36	Cause unknown. Burned on water contact.
1/18/60	CAP	V-700D	50	4	46	Loss of engine power in icing conditions. Crashed.
3/17/60	NWA	L-188C	63	6	57	Broke up in flight. Burned at impact.
5/23/60	DAL	CV-880	4	4	0	Lost control and crashed.
7/27/60	CH	S-58	13	2	11	Structural failure in flight.
10/15/60	Capitol Airways	C-46F	2	2	0	Inflight wing failure.
10/28/60	NWA	DC-4	12	4	8	Lost control in mountainous terrain.
12/16/60	UAL	DC-8	84	7	77	Midair collision over New York
	TWA	L-1049	44	5	39	City
7/21/61	AS	DC-6	6	6	0	Hit short of runway on GCA approach.
9/1/61	TWA	L-049	78	5	73	Control failure in flight.
9/17/61	NWA	L-188C	37	5	32	Mechanical failure in flight.
10/4/61	CH	Bell 47G2	1	1	0	Mechanical failure in flight.
3/1/62	AA	B707-123B	95	8	87	Control system malfunction.
4/18/62	Purdue	DC-3	3	3	0	Stalled after takeoff. Lost control.
11/23/62	UAL	V-700D	17	4	13	Collided with swan. Lost horizontal stabilizer.
12/14/62	FTLX	L-1049H	5	3	2	Loss of control after pilot became incapacitated.
1/29/63	CAL	V-812	8	3	5	Loss of control due to ice accumulation
2/12/63	NWA	B-720B	43	8	35	Broke up in flight. Widely scattered.
10/14/63	NY	Vertol 107-11	6	3	3	Rotors hit together and failed.

Accidents In Which All Occupants Sustained Fatal Injuries (continued)

Date	Air Carrier	Type Aircraft	Fatalities Total	Crew	Pssgrs.	Remarks
12/7/63	ZANX	C-46	3	2	1	Hit mountain and burned.
3/10/64	SLIX	DC-4	3	3	0	Loss of control due to ice accretion.
3/12/64	FAL	DC-3	5	3	2	Crashed and burned during landing approach.
5/7/64	PAC	F-27	44	3	41	Flight crew shot by passenger in flight.
12/24/64	FTLX	L-1049H	3	3	0	Crashed and burned after takeoff.
TOTAL GROUP I			1467	222	1245	FIFTY-ONE ACCIDENTS

NOTE: No accidents occurred on the ground.

APPENDIX C

GROUP II

Accidents In Which Some Occupants Survived
While Others Sustained Fatal Injuries

Date	Air Carrier	Type Aircraft	Total	Occupants Crew F	Crew S	Crew M/N	Pssgrs. F	Pssgrs. S	Pssgrs. M/N	Remarks
A. FIRE IN FLIGHT			177	6	4	13	33	8	113	FOUR ACCIDENTS
3/25/58	BNF	DC-7C	24	0	3	2	9	7	3	Inflight engine fire. Crashed during emergency landing.
10/26/59	PAL	DC-3	19	1	1	1	0	1	15	Inflight engine fire. Crashed during emergency landing.
7/14/60	NWA	DC-7C	58	0	0	7	1	0	50	Inflight engine fire. Aircraft successfully ditched.
9/23/62	FTLX	L-1049H	76	5	0	3	23	0	45	Inflight engine fire. Ditching procedures poorly executed.
B. FIRE AT IMPACT			984	49	23	28	400	158	326	TWENTY-FOUR ACCIDENTS
7/17/55	BNF	CV-340	43	2	1	0	20	11	9	Hit signboard on landing approach. Crashed and burned.
9/8/55	Currey Air Transpt.	DC-3	33	2	1	0	0	1	29	Hit power line during approach for emergency landing.
11/17/55	Peninsular Air Transpt	DC-4	74	1	0	3	27	0	43	Power stalled after takeoff due to engine overspeed.
4/1/56	TWA	M-404	36	1	2	0	21	5	7	Struck ground after takeoff. Windmilling propeller.
8/19/56	AK	PA-20S	3	1	0	0	1	1	0	Stalled on approach to landing on lake
2/1/57	NEA	DC-6A	101	0	3	3	20	25	50	Crashed after takeoff in instrument weather.
5/13/57	USOA	DC-4	3	2	1	0	0	0	0	Crashed on ice cap in instrument weather.
6/22/57	WE	UC-64AS	4	1	0	0	0	2	1	Stalled and crashed in narrow canyon.
9/15/57	NEA	DC-3	24	2	1	0	10	11	0	Struck trees during instrument approach.
10/19/57	NY	Bell 47H	3	0	1	0	1	1	0	Rotor blade struck flagpole and crashed.
6/4/58	CAP	DC-3	3	1	2	0	0	0	0	Struck trees during single engine climbout. Training.

GROUP II (continued)

Date	Air Carrier	Type Aircraft	Occupants Total	Crew F	Crew S	Crew M/N	Pagrs. F	Pagrs. S	Pagrs. M/N	Remarks
8/15/58	NEA	CV-240	34	3	0	0	22	9	0	Struck ground short of runway during instrument approach.
2/1/59	General Airways	DC-3	28	2	1	0	1	3	21	Fuel depletion short of airport. Icing conditions.
5/12/59	CAP	L-049	44	1	3	2	1	2	35	Slid down embankment from slick runway.
12/1/59	AAL	M-202	26	4	0	0	21	1	0	Crashed into mountain during landing approach.
9/19/60	World Airways	DC-6B	94	7	1	0	73	9	4	Hit mountain shortly after takeoff.
10/29/60	Arctic Pacific	C-46	48	2	0	1	20	10	15	Lost control during takeoff and crashed.
7/11/61	UAL	DC-8	122	0	0	7	17	12	86	Thrust reversal failure on landing. Hit runway construction.
11/8/61	Imperial	L-049	79	3	0	2	74	0	0	Crashed short of runway. Lack of crew coordination.
3/15/62	FTLX	L-1049H	7	1	0	6	0	0	0	Struck ground short of runway during instrument approach.
11/30/62	EAL	DC-7	51	4	2	0	21	12	12	Struck ground during an attempted go-around.
2/3/63	SLIX	L-1049H	8	2	1	0	2	3	0	Struck ground short of runway during instrument approach.
7/2/63	MOH	M-404	43	2	1	0	5	29	6	Loss of control on takeoff in a severe thunderstorm.
11/23/64	TWA	B-707	73	5	2	4	43	11	8	Struck construction equipment during aborted takeoff.
TOTAL GROUP II			1161	55	27	41	433	166	439	TWENTY-EIGHT ACCIDENTS

NOTE: No accidents occurred on the ground.

APPENDIX C

GROUP III

Accidents In Which All Occupants Survived But Some Received Serious Injury

Date	Air Carrier	Type Aircraft	Occupants Total	Crew S	Crew M/N	Psgrs. S	Psgrs. M/N	Remarks
A. FIRE IN FLIGHT			**74**	**1**	**12**	**1**	**60**	**TWO ACCIDENTS**
11/14/55	AL	M-202	3	1	2	0	0	Inflight engine fire. Gear collapse on landing.
8/25/58	TWA	L-1649A	71	0	10	1	60	Inflight engine fire and loss of propeller.
B. FIRE AT IMPACT			**249**	**13**	**24**	**26**	**186**	**TWELVE ACCIDENTS**
11/30/56	NY	S-55	2	2	0	0	0	Hard landing followed by fire during demonstration.
3/10/57	EAL	N-404	34	0	3	1	30	Hard landing caused wing separation and fire.
4/30/57	PanAm	DC-7C	6	2	4	0	0	Gear retraction before becoming airborne. Nosed over.
11/6/57	ASA	C-46A	2	2	0	0	0	Engine failure. Remaining engine inadequate to reach airport.
2/13/58	WAL	CV-240	21	0	3	5	13	Wing leading edge separated in flight. Crash landed.
8/28/58	NWA	DC-6B	62	1	3	18	40	Hit airport boundary fence on take-off. Crashed.
10/15/59	USOA	DC-54G	2	2	0	0	0	Lost engine power. Hit trees when ditching in lake.
8/3/61	EAL	L-1049C	3	1	2	0	0	Gear collapsed during taxi for takeoff.
3/5/62	WE	BE-D-18	3	0	1	1	1	Hit ground short of runway during snowstorm.
12/21/62	FAL	CV-340	42	1	2	0	39	Struck ground short of runway. Severe impact.
2/16/63	ZANX	C-46F	2	2	0	0	0	Engine overspeed during takeoff. lost control. Crashed.
5/28/63	Standard	L-1049G	70	0	6	1	63	Landed short of runway due to engine reversal.
TOTAL GROUP III			**323**	**14**	**36**	**27**	**246**	**FOUTEEN ACCIDENTS**

NOTE: No accidents occurred on the ground.

GROUP IV

Accidents In Which All Occupants Received Either Minor Or No Injuries

Date	Air Carrier	Type Aircraft	Occupants Total	Crew	Psgrs.	Remarks
A. FIRE IN FLIGHT			499	69	430	EIGHTEEN ACCIDENTS
4/24/55	Capitol Airways	DC-4	64	4	60	Inflight engine fire extinguished prior to emergency landing.
10/30/55	EAL	DC-7	39	5	34	Inflight engine overspeed and fire. Orderly evacuation.
3/18/56	Westair Transport	C-46	2	2	0	Inflight engine fire. Extinguished prior to emergency landing.
7/15/56	CAP	V-700D	14	4	10	Inflight engine fire. Extinguished prior to emergency landing.
6/8/57	EAL	DC-7B	77	5	72	Inflight engine overspeed and fire. Extinguished on ground.
8/3/57	TWA	L-749A	16	6	10	Inflight engine fire. Extinguished prior to emergency landing.
8/21/57	AA	DC-6A	3	3	0	Propeller separation on takeoff. Cut hydraulic lines and electrical wiring.
8/30/57	NEA	C-46	36	3	33	Inflight engine fire. Extinguished by ground firefighting equipment.
12/20/57	RDLX	C-46R	2	2	0	Inflight engine fire. Extinguished by ground firefighting equipment.
4/12/58	DAL	DC-7	3	3	0	Inflight engine fire. Extinguished by ground firefighting equipment
9/3/58	BNF	DC-7C	35	5	30	Inflight engine failures and fire. Extinguished on ground.
9/21/58	UAL	DC-7	63	5	58	Inflight engine fire. Extinguished prior to landing.
1/17/59	EAL	L-1049G	17	5	12	Inflight engine fire. Extinguished on ground.
8/6/59	California Hawaiian	DC-4	71	4	67	Inflight engine fire. Extinguished on ground.
11/14/59	EAL	L-188	38	5	33	Inflight electrical fire. Safe landing and evacuation.
9/6/60	OZA	DC-3	14	3	11	Inflight engine fire. Extinguished on ground.
10/10/64	Capitol Airways	C-46	2	2	0	Engine fire after takeoff. Extinguished on ground.
11/19/64	ZAMX	Argosy	3	3	0	Fire in stabilizer due to heater malfunction.

GROUP IV (continued)

Date	Air Carrier	Type Aircraft	Occupants Total	Crew	Psgrs.	Remarks
B. FIRE AT IMPACT			949	142	807	THIRTY-FOUR ACCIDENTS
1/10/55	NAL	L-18	13	3	10	Crashed on takeoff. Fuel tank ruptured and aircraft burned.
1/22/55	Resort	C-46F	2	2	0	Hit trees on ILS approach. Struck ground and burned.
1/31/56	WE	Noorduyn	2	1	1	Lost control on takeoff and hit parked airplane.
4/24/56	Capitol Airways	C-46	2	0	2	Right gear collapsed on landing roll.
5/4/56	WE	DC-3	9	3	6	Bounced off runway after hard landing.
6/7/56	TWA	M-404	31	3	28	Hit approach lights on landing.
7/25/56	CAP	V-700D	4	4	0	Wheels up landing due to loss of electrical power.
1/7/57	SLIX	C-46	2	2	0	Hit dike on landing, collapsing gear. Slid to stop.
3/26/57	Capitol Airways	C-46F	2	2	0	Prop blade failure on takeoff tore off engine. Aborted.
4/18/57	CAP	DC-4	55	4	51	Engine fire on go-around after hitting embankment.
6/28/57	EAL	DC-7B	4	4	0	Nose steering malfunction.
	EAL	L-1049	0	0	0	Hit parked aircraft. Burned.
8/29/57	NWA	DC-4	2	2	0	Turned off wet runway and struck ditch.
8/30/57	NY	S-58C	2	2	0	Hard landing dislodged engine, starting small fire.
11/14/57	EAL	M-404	5	3	2	Hard landing tore engine from aircraft.
3/1/58	AA	CV-240	8	3	5	Premature gear retraction on takeoff. Engine caught fire.
3/17/58	EAL	M-404	10	3	7	Hit gravel pile on landing. Gear collapsed on rollout.
8/6/58	Westair Transport	C-46F	47	5	42	Landed gear up. Engine fire developed.
11/10/58	SB	L-1049D	5	5	0	Prop reversal on takeoff. Hit
	TCA	Viscount	0	0	0	parked aircraft on ramp.
1/15/59	EAL	DC-7B	55	5	50	Wheels up landing. Started fire in #2 engine.
2/20/59	PanAm	DC-7C	3	3	0	Hard landing caused structural damage and fire.
3/15/59	AA	CV-240	2	2	0	Hit Tower on approach. Slid into railroad yard and burned.
4/10/59	PanAm	B-377	10	5	5	Hit embankment on approach and burned.

B. FIRE AT IMPACT (continued)

Date	Air Carrier	Type Aircraft	Occupants Total	Crew	Psgrs.	Remarks
5/9/60	TWA	B-707	109	9	100	Inadvertent gear up landing. slid to stop.
9/14/60	AA	L-188	76	6	70	Hit dike on approach. Nosed over, caught fire
7/29/61	AA	B-707	52	8	44	Nose gear collapsed on hard landing. Friction and electrical fire.
9/16/61	PanAm	DC-8	133	9	124	Gear failure during landing due to faulty thrust reverser.
9/26/61	Overseas National	DC-7	5	5	0	Hit embankment on landing due to hydraulic failure.
4/27/62	PanAm	B-707	53	10	43	Gear collapsed during hard landing.
7/8/62	CAL	V-812	16	3	13	Premature gear retraction on takeoff caused props to hit runway. Crash followed.
7/1/64	AA	B-720 A	12	7	5	Gear failure on misaligned landing.
7/16/64	EAL	DC-7B	76	5	71	Landed short of runway, hit concrete pad. Sheared L.G. slid.
8/26/64	TWA	B-707	138	8	130	Undershot landing. Collapsed gear and slid to stop.
9/22/64	CBA	DC-3	2	2	0	Lost control on takeoff and nosed over.
11/20/64	ZANX	C-46	2	2	0	Lost power after takeoff and bellied in.
C. FIRE ON GROUND			160	42	118	EIGHT ACCIDENTS
5/29/55	TWA	L-749	28	10	18	Fire in right main gear prior to takeoff. Occupants evacuated.
6/21/56	AS	Pilgrim	3	3	0	Fire in nacelle during engine start.
7/28/57	NWA	B-377	21	5	16	Hydraulic fire in wheel well prior to takeoff.
12/12/57	PanAm	B-377	41	10	31	Hydraulic fire in wheel well taxiing to ramp.
8/27/58	PAC	M-202	21	3	18	Electrical fire in belly when battery cart was disconnected.

C. FIRE ON GROUND (continued)

Date	Air Carrier	Type Aircraft	Occupants Total	Crew	Psgrs.	Remarks
6/21/59	PanAm	DC-6A	8	6	2	Aborted takeoff when engine separated and aircraft burned.
11/1/62	PI	F-27	36	3	33	Electrical short caused gear to collapse after engine start..
1/5/64	PanAm	DC-3	4	2	0	Fuel vent leak torched and exploded on engine start.
	TOTAL GROUP IV		1608	252	1355	SIXTY ACCIDENTS

CAUSE OF DEATH
ALL U. S. AIR CARRIER ACCIDENTS INVOLVING FIRE
1955-1964

Date	Air Carrier	Type Aircraft	Total Occupants	Fatalities Total	Crew	Pagrs.	Cause of Death: Impact Total	Crew	Pagrs.	Fire Total	Crew	Pagrs.	Other Total	Crew	Pagrs.
1/12/55	TWA	M-202	13	13	3	10	13	3	10						
2/19/55	TWA	M-404	16	16	3	13	16	3	13						
4/4/55	UAL	DC-6	3	3	3	0	3	3	0						
7/27/55	BNF	CV-340	43	22	2	20	22	2	20						
8/4/55	AA	CV-240	30	30	3	27	30	3	27						
9/8/55	Currey	DC-3	33	2	2	0	2	2	0						
10/6/55	UAL	DC-4	66	66	3	63	66	3	63						
11/17/55	PATX	DC-4	28	28	1	27	28	1	27						
12/17/55	RDLX	C-46	2	2	2	0	2	2	0						
12/21/55	EAL	L-749	17	17	5	12	17	5	12						
4/1/56	TWA	M-404	23	22	1	21	22	1	21						
6/30/56	TWA	L-1049	70	70	6	64	70	6	64						
	UAL	DC-7	58	58	5	53	58	5	53						
8/19/56	AK	PA-20S	3	2	1	1	2	1	1						
12/16/56	AS	ST-V-77	4	4	1	3	4	1	3						
2/1/57	NEA	DC-6A	101	20	0	20				20	0	20			
3/2/57	AS	DC-4	5	5	3	2	5	3	2						
5/13/57	USOA	DC-4	3	2	2	0	2	2	0						
6/22/57	WE	UC-64AS	4	1	1	0	1	1	0						
9/15/57	NEA	DC-3	24	12	2	10	12	2	10						
10/19/57	NY	Bell 47H	3	1	0	1	1	0	1						
11/8/57	PanAm	B-377	44	44	8	36	44	8	36						
3/25/58	BNF	DC-7C	24	9	0	9	9	0	9						
4/6/58	CAP	V-700D	47	47	3	44	47	3	44						
4/21/58	UAL	DC-7	47	47	5	42	47	5	42						
5/20/58	CAP	V-700D	11	11	4	7	11	4	7						
6/4/58	CAP	DC-3	3	1	1	0				1	1	0			
8/15/58	NEA	CV-240	34	25	3	22	15	3	12	10	0	10			
11/16/58	Capital Airways	C-46F	2	2	2	0	2	2	0						
11/20/59	WE	BE-18	1	1	1	0	1	1	0						
2/1/59	General	DC-3	28	3	2	1	3	2	1						
3/30/59	RDLX	C-46R	2	2	2	0	2	2	0						
5/12/59	CAP	L-049	44	2	1	1				2	1	1			
6/26/59	TWA	L-1649A	68	68	9	59	68	9	59						

Cause of Death (continued)

Date	Air Carrier	Type Aircraft	Total Occupants	Fatalities Total	Crew	Psgrs.	Cause of Death: Impact Total	Crew	Psgrs.	Fire Total	Crew	Psgrs.	Other Total	Crew	Psgrs.
8/15/59	AA	B-707	5	5	5	0	5	5	0						
9/12/59	PanAm	DC-4	3	3	3	0	3	3	0						
9/24/59	RV	DC-4	16	16	5	11	16	5	11						
9/29/59	BNF	L-188	34	34	7	27	34	7	27						
10/26/59	PAL	DC-3	19	1	1	0	1	1	0						
11/16/59	NAL	DC-7B	42	42	6	36	42	6	36						
11/24/59	TWA	L-1049H	3	3	3	0	3	3	0						
12/1/59	AAL	M-202	26	25	4	21	25	4	21						
1/18/60	CAP	V-700D	50	50	4	46	50	4	46						
3/17/60	NWA	L-188C	63	63	6	57	63	6	57						
5/23/60	DAL	CV-880	4	4	4	0	4	4	0						
7/14/60	NWA	DC-7C	58	1	0	1							(1)1	0	1
7/27/60	CH	S-58	13	13	2	11	13	2	11						
9/19/60	World	DC-6B	94	80	7	73				80	7	73			
10/15/60	Airways Capitol	C-46F	2	2	2	0	2	2	0						
10/28/60	Airways NWA	DC-4	12	12	4	8	12	4	8						
10/29/60	Arctic	C-46	48	22	2	20	9	1	7	13	1	13			
12/16/60	Pacific TWA	L-1049	44	44	5	39	44	5	39						
	UAL	DC-8	84	84	7	77	84	7	84						
1/22/61	Capitol	C-46F	2	2	2	0	2	2	0						
7/11/61	Airways UAL	DC-8	122	17	0	17				17	0	17			
7/21/61	AS	DC-6	6	6	6	0	6	6	0						
9/1/61	TWA	L-049	78	78	5	73	78	5	73						
9/17/61	NWA	L-188C	37	37	5	32	37	5	32						
10/4/61	CH	Bell 47G2	1	1	1	0	1	1	0						
11/8/61	Imperial	L-049	79	77	3	74				77	3	74			
3/1/62	AA	B-707	95	95	8	87	95	8	87						
3/15/62	FTLX	L-1049	107	107	11	96	107	11	96						
3/15/62	FTLX	L-1049H	7	1	1	0				1	1	0			
4/18/62	Purdue	DC-3	3	3	3	0	3	3	0						
9/23/62	FTLX	L-1049H	76	28	5	23							(2)28	5	23
11/23/62	UAL	V-700D	17	17	4	13	17	4	13						

Cause of Death (continued)

Date	Air Carrier	Type Aircraft	Total Occupants	Fatalities Total	Crew	Pagrs.	Cause of Death: Impact Total	Crew	Pagrs.	Fire Total	Crew	Pagrs.	Other Total	Crew	Pagrs.
11/30/62	EAL	DC-7	51	25	4	21	5	0	5	20	4	16	(3)		
12/14/62	FTLX	L-1049H	5	5	3	2	5	3	2						
1/29/63	CAL	V-812	8	8	3	5	8	3	5						
2/12/63	SLIX	L-1049H	8	4	2	2				4	2	2			
2/16/63	NWA	B-720B	43	43	8	35	43	8	35						
7/2/63	MDH	M-404	43	7	2	5	7	2	5						
10/14/63	NY	V-107-11	6	6	3	3	3	2	1	3	1	2			
12/7/63	ZANX	C-46	3	3	2	1	3	2	1						
12/8/63	PanAm	B-707	81	81	8	73	81	8	73						
3/10/64	SLIX	DC-4	3	3	3	0	3	3	0						
3/12/64	FAL	DC-3	5	5	3	2	5	3	2						
5/7/64	PAC	F-27	44	44	3	41	44	3	41				(4)		
7/9/64	UAL	V-745D	39	39	4	35	38	4	34				(5)1	0	1
11/23/64	TWA	B-707	73	48	5	43				48	5	43			
12/24/64	FTLX	L-1049H	3	3	3	0	3	3	0						
TOTALS			2628	1955	277	1678	1628	246	1382	297	26	271	30	5	25

Reference (1) - Probable heart attack, female passenger
" (2) - Most probably drowned from entrapment
" (3) - Possible heart attack, Captain
" (4) - Possible death by gunshot, Captain and First Officer
" (5) - Freefall victim, male passenger

U. S. AIR CARRIER ACCIDENTS IN WHICH FATALITIES RESULTED FROM FIRE

1955-1964

Accident	Total Occupants	Total Survivors	Fatalities Total	Fatalities Crew	Fatalities Pssgrs.	Fire Fatalities Total	Fire Fatalities Crew	Fire Fatalities Pssgrs.	"X"	"Y"	Accident on Airport	Impact Severity (Occupied Area)	Circumstances	Remarks
6/1/57, Wikers Island, N.Y., NEA, DC-6A	101	81	20	0	20	20	0	20	20	0	No	Mod.	Crashed shortly after takeoff.	Crashed on island across river from airport. Fourteen serious fire injuries.
6/4/58, Martinsburg, W. Va., CAP, DC-3	3	2	1	1	0	1	1	0	1	0	No	Mod.	Stalled and crashed after abandoned single engine approach.	Crashed in wooded area not easily accessible. Two serious fire injuries.
8/15/58, Nantucket, Mass., NEA, CV-240	34	9	25	3	22	10	0	10	10	0	No	Extreme	Crashed ½ mile short on landing approach.	Site not easily accessible from airport. Two serious fire injuries.
5/12/59, Charleston, W. Va., EAL, L-049	44	42	2	1	1	2	1	1	2	0	Yes	Minor	Overshoot. Crashed off end of runway.	Crash site not accessible by fire eqpt. One serious fire injury.
9/19/60, Guam, M.I. WRLD, DC-6B	94	14	80	7	73	80	7	73	80	0	No	Mod.	Crashed shortly after takeoff.	Crashed upslope on mountainside 2 miles from airport. Not easily accessible by fire eqpt. Seven serious fire injuries.
10/29/60, Toledo, Ohio, APAX, C-46F	48	26	22	2	20	14	1	13	14	0	Yes	Mod.	Crashed during takeoff.	Intense fog. Burning wreckage not seen by control tower. One serious fire injury.
7/11/61, Denver, Colo., UAL DC-8	122	105	17	0	17	17	0	17	17	17	Yes	Minor	Crashed during landing roll.	Standby emergency eqpt. utilized plus off field eqpt. Poor evacuation. Eleven serious fire injuries.

U. S. Air Carrier Accidents In Which Fatalities Resulted From Fire (continued)

Accident	Total Occupants	Total Survivors	Fatalities			Fire Fatalities			"X"	"Y"	Accident on Airport	Impact Severity (Occupied Area)	Circumstances	Remarks
			Total	Crew	Pssgrs.	Total	Crew	Pssgrs.						
11/8/61, Richmond, Va., IMAX L-049	79	2	77	3	74	77	3	74	77	0	No	Minor	Crashed on approach to landing.	One-half mile thick forest between airport emergency eqpt. and accident site.
3/15/62, Adak, Alas. PTLX L-1049	7	6	1	1	0	1	1	0	1	1	Yes	Mod.	Crashed on approach to landing.	Crew member trapped in cockpit by nose landing gear. Inadequate fire-fighting eqpt. Unable to put out fire before crew member died in fire.
11/30/62, New York, N.Y., EAL DC-7	51	26	25	4	21	20	4	16	20	0	Yes	Mod.	Crashed on attempted go-around during landing.	Fog. Fire fatals burned during immediate evacuation.
2/3/63, San Fran., Calif. SLIX L-1049H	8	4	4	2	2	4	2	2	4	0	Yes	Mod.	Crashed on approach to landing.	Adequate emergency equipment. Most exits damaged at impact.
10/14/63, New York, N.Y., V-107-11	6	0	6	3	3	3	1	2	3	0	Yes	Severe	Rotor drive failure on takeoff.	Quick response by emergency eqpt. Cockpit area not burned.
11/23/64, Rome, Italy, TWA B-707	73	25	48	5	43	48	5	43	48	0	Yes	Minor	Struck ground obstacle during aborted takeoff.	Fire fatals burned during immediate evacuation. Nine serious fire injuries.
TOTALS	670	342	328	32	296	297	26	271	297	18	8 yes 5 no			

"X" = No. of occupants (over and above those who did survive) who would have survived had fire not occurred.
"Y" = No. of occupants (over and above those who did survive) who would have survived had adequate ground mobile fire fighting and rescue equipment and personnel been available at airport nearest to the scene of the accident.