DOT/FAA/AR-09/18

Air Traffic Organization
NextGen & Operations Planning
Office of Research and
Technology Development
Washington, DC 20591

Determination of Evacuation and Firefighting Times Based on an Analysis of Aircraft Accident Fire Survivability Data

May 2009

Final Report

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U.S. Department of Transportation
Federal Aviation Administration

United Kingdom
Civil Aviation Authority

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/AR-09/18		

4. Title and Subtitle	5. Report Date
DETERMINATION OF EVACUATION AND FIREFIGHTING TIMES BASED ON AN ANALYSIS OF AIRCRAFT ACCIDENT FIRE SURVIVABILITY DATA	May 2009
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
R.G.W. Cherry & Associates Limited	

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
R.G.W. Cherry & Associates Limited The Priory, High Street Ware, Hertfordshire SG12 9AL United Kingdom	11. Contract or Grant No.

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
U.S. Department of Transportation Federal Aviation Administration Air Traffic Organization NextGen & Operations Planning Office of Research and Technology Development Washington, DC 20591	14. Sponsoring Agency Code ANM-115

15. Supplementary Notes

The Federal Aviation Administration Airport Safety R&D Division Technical Monitor was Richard Hill.

16. Abstract

As part of a project commissioned by the Federal Aviation Administration data have been gathered on the relative proportion of accidents that involve Ground Pool Fires and statistical data on the following:

- Time to initiate an evacuation
- Time to complete an evacuation
- Time to arrival of fire-fighters
- Time for fire-fighters to establish control in a Ground Pool Fire accident

The data was extracted from accident reports and other information published by Investigating and Airworthiness Authorities using the Cabin Safety Research Technical Group Aircraft Accident Database as the search facility.

17. Key Words	18. Distribution Statement
Ground pool fires, Evacuation, Fire fighting	This document is available to the U.S. public through the National Technical Information Service (NTIS), Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	29	

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EXECUTIVE SUMMARY

This study gathered data on the relative proportion of large transport aircraft accidents that involved Ground Pool Fires and analyzed statistical data on the following:

- Time to initiate an evacuation
- Time to complete an evacuation
- Time to arrival of fire-fighters
- Time for fire-fighters to establish control in a Ground Pool Fire accident

The data was extracted from accident reports and other information published by Investigating and Airworthiness Authorities using the Cabin Safety Research Technical Group Aircraft Accident Database as the search facility.

For the four areas of interest listed above, the "Curve of Best Fit" was derived, assuming that the data may be represented by a Weibull Distribution. Results of the analysis suggest the following:

1. For Evacuation Initiation Times, 50% of evacuations are initiated within 20 seconds and 90% within 40 seconds.

2. For Evacuation Completion Times, 50% of evacuations are completed within 130 seconds and 90% within 325 seconds.

3. For Time to Arrival of Fire-Fighters, on 50% of occasions, the fire-fighters arrive within 4 minutes (240 seconds) and 90% of occasions within 12 minutes (720 seconds).

4. For Fire-Fighters to Establish Control, on 50% of occasions, the fire-fighters establish control within 10 minutes (600 seconds) and 90% of occasions within 42 minutes (2520 seconds).

1. INTRODUCTION.

As part of a project commissioned by the Federal Aviation Administration data have been gathered on the relative proportion of accidents that involve Ground Pool Fires and statistical data on the following:

- Time to initiate an evacuation
- Time to complete an evacuation
- Time to arrival of fire-fighters
- Time for fire-fighters to establish control in a Ground Pool Fire accident

The data was extracted from accident reports and other information published by Investigating and Airworthiness Authorities using the Cabin Safety Research Technical Group (CSRTG) Aircraft Accident Database (Reference 1) as the search facility. The data selection criteria are described in section 2.

2. ACCIDENT SELECTION CRITERIA.

The CSRTG Aircraft Accident Database, at Issue 24, was used for accident selection. Only accidents with Full Screen 3 information[1] were selected based on the following criteria:

Aircraft Operation:

- Passenger Carrying

Accident Characteristics:

- Accident results in fatalities or the aircraft being destroyed

- Accidents involving Illegal Acts (Sabotage, Suicide, or Terrorism) and ground operations were excluded.

Aircraft type:

- Western World Built
- Turbo Jet
- Maximum Gross Weight greater than 60,000 pounds

The aircraft selection criteria are comparable with those used in the Boeing Statistical Summary of Commercial Jet Airplane Accidents (Reference 2).

[1] "Screen 3" information is textual data contained in the CSRTG Accident Database that is extracted from Accident Reports produced by the Investigating Authority. Further analysis of selected accidents was supported by the library of Accident Reports and Data held by RGW Cherry & Associates Limited.

The Accident Database yielded 147 accidents meeting the accident selection criteria. These accidents are listed in appendix A.

3. ACCIDENTS INVOLVING A GROUND POOL FIRE.

The 147 accidents selected using the criteria defined in section 2 may be subdivided into the categories shown in figure 1. One hundred and one of these accidents are considered to be survivable using the following definition of a Survivable Accident: "An aircraft accident where there were one or more survivors or there was potential for survival."[2]

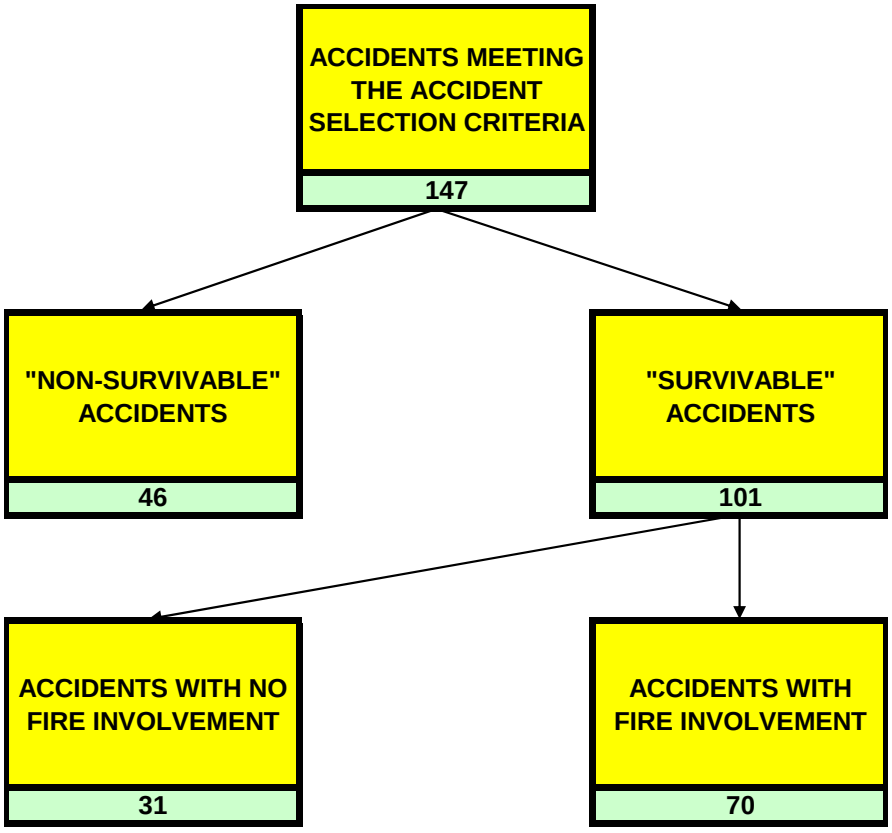

Figure 1. Categorization of Selected Accidents

Of the one hundred and one "Survivable Accidents" seventy had a fire involvement.

Of these seventy fire-related accidents, thirty six were confirmed as Ground Pool Fire accidents.

[2] The International Civil Aviation Organisation definition of a Survivable Accident has not been used in order to eliminate any subjective judgment in the categorization.

A further seven were thought likely, although not confirmed, to involve a Ground Pool Fire, as shown in table 1. Figure 2 shows the relative proportion of fire related accidents involving a Ground Pool Fire.

Table 1. Relative Number of Accidents Involving a Ground Pool Fire

Relative Number of Accidents involving a Ground Pool Fire	
Pool Fire	**Number of Accidents**
Yes	**36**
Yes?	**7**
?	**3**
No?	**5**
No	**19**
Total	**70**

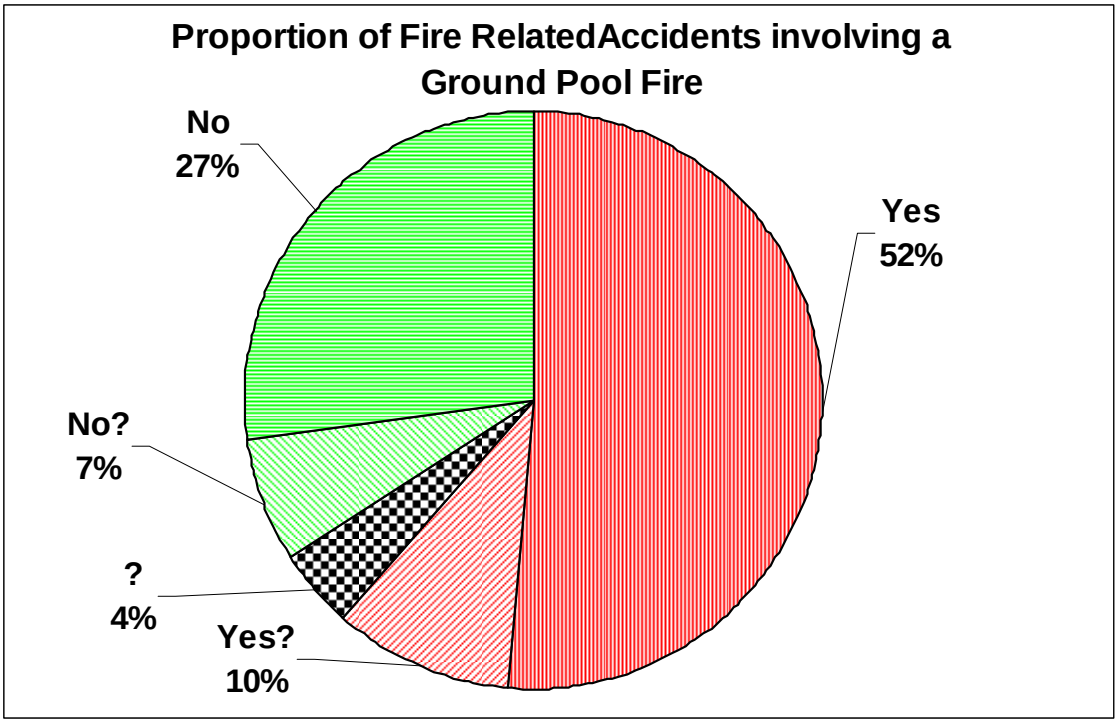

Figure 2. Pictorial Representation of the Proportion of Fire Related Accidents Involving a Ground Pool Fire

The 36 accidents confirmed as involving a Ground Pool Fire are listed in table 2, and the 7 accidents that were thought likely to involve a Ground Pool Fire are listed in table 3.

Table 2. List of Accidents Involving a Ground Pool Fire—Confirmed

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION
05-Mar-67	DC8-33	PP-PEA	NR. MONROVIA, LIBERIA, AFRICA
06-Nov-67	B707-131	N742TW	CINCINNATI, U.S.A.
08-Apr-68	B707-465	G-ARWE	LONDON (HEATHROW), U.K.
27-Nov-70	DC8-63F	N4909C	ANCHORAGE, ALASKA, U.S.A.
18-Apr-72	VC10	5X-UVA	ADDIS ABABA, ETHIOPIA
18-May-72	DC9-31	N8961E	FORT LAUDERDALE, FLORIDA, U.S.A.
08-Dec-72	B737-222	N9031U	NR. MIDWAY AIRPORT, CHICAGO, U.S.A.
20-Dec-72	DC9-31	N954N	CHICAGO, U.S.A.
22-Jan-73	B707-3D3C	JY-ADO	KANO AIRPORT, NIGERIA
26-Jan-74	F28-1000	TC-JAO	COMAOVASI, TURKEY
30-Jan-74	B707-321B	N454PA	PAGO PAGO, AMERICAN SAMOA
15-Mar-74	CARAVELLE	OY-STK	TEHERAN, IRAN
11-Sep-74	DC9-31	N8984E	CHARLOTTE, N.CAROLINA, U.S.A.
20-Nov-74	B747-130	D-ABYB	NAIROBI, KENYA
24-Jun-75	B727-225	N8845E	KENNEDY AIRPORT, NEW YORK, U.S.A.
05-Apr-76	B727-81	N124AS	KETCHIKAN, ALASKA, U.S.A.
27-Apr-76	B727-95	N1963	ST. THOMAS, VIRGIN ISLAND
27-Mar-77	B747	N736PA	TENERIFE AIRPORT, CANARY ISLANDS
11-Feb-78	B737-275	C-FPWC	CRANBROOK B.C., CANADA
01-Mar-78	DC10-10	N68045	LOS ANGELES, CALIFORNIA, U.S.A.
17-Dec-78	B737-200	VT-EAL	HYDERABAD, INDIA
07-Oct-79	DC8-62	HB-IDE	ATHENS, GREECE
21-Nov-80	B727-92C	N18479	YAP ISLAND, MICRONESIA
17-Feb-81	B737-293	N468AC	SANTA ANA, CALIFORNIA, U.S.A.
13-Sep-82	DC10	EC-DEG	MALAGA, SPAIN
07-Dec-83	B727-200	EC-CFJ	MADRID, SPAIN
22-Aug-85	B737-236 Sr1	G-BGJL	MANCHESTER AP., U.K.
26-Jun-88	A320-100	F-GKFC	HABSHEIM, FRANCE
31-Aug-88	B727-232	N473DA	DALLAS FORT WORTH, U.S.A.
14-Feb-90	A320-231	VT-EPN	BANGALORE, INDIA
30-Jul-92	L1011-385-1	N11002	NEW YORK JFK, U.S.A.
21-Dec-92	DC10-30CF	PH-MBN	FARO, PORTUGAL
14-Sep-93	A320-211	D-AIPN	WARSAW, POLAND
26-Apr-94	A300B4-622R	B-1816	NAGOYA, JAPAN
01-Jun-99	MD82	N215AA	LITTLE ROCK, ARKANSAS, U.S.A.
31-Oct-00	B747-412B	9V-SPK	CHIANG KAI-SHEK AP, TAIWAN

Table 3. List of Accidents Involving a Ground Pool Fire—Probable

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION
20-Nov-67	CV880	N821TW	CONSTANCE, KENTUCKY, U.S.A.
10-Mar-89	F28-1000	C-FONF	DRYDEN, ONTARIO, CANADA
02-Jul-94	DC9-31	N954VJ	CHARLOTTE, NORTH CAROLINA
10-Aug-94	A300B4	HL-7296	CHEJU ISLAND AIRPORT, KOREA
13-Jun-96	DC10-30	PK-GIE	FUKUOKA AIRPORT, JAPAN
06-Aug-97	B747-3B5B	HL-7468	NIMITZ HILL, NR AGANA, GUAM
17-Jul-00	B737-200	VT-EGD	NEAR PATNA AP, INDIA

4. TIME TO INITIATE EVACUATION.

4.1 DATA DEFINITION.

The 'Time to Initiate an Evacuation' was measured from the time the aircraft came to rest to the time that the evacuation started.

4.2 DATA USED FOR DISTRIBUTION.

Table 4 gives the results of the data extraction for 'Time to Initiate an Evacuation'. Accidents in appendix A were analyzed for those featuring an intense fire threat[3]. Of those accidents selected as featuring an intense fire threat, only 7 provided sufficient information to obtain the time to initiate an evacuation, as shown in table 4.

Table 4. List of Accidents—Time to Initiate an Evacuation

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION	TIME (SECONDS)
31-Aug-88	B727-232	N473DA	DALLAS FORT WORTH, U.S.A.	15
22-Aug-85	B737-236	G-BGJL	MANCHESTER AP., U.K.	25
18-Dec-83	A300B4	OY-KAA	KUALA LUMPUR, MALAYSIA	40
02-Jun-83	DC9-32	C-FTLU	CINCINNATI AIRPORT U.S.A.	30
13-Sep-82	DC10	EC-DEG	MALAGA, SPAIN	15
17-Feb-81	B737-293	N468AC	SANTA ANA, CALIFORNIA, U.S.A	8
27-Mar-77	B747	N736PA	TENERIFE, CANARY ISLANDS	20

[3] Accidents involving intense ground fires, other than Ground Pool Fires, were included in the data set since the urgency of commencing the evacuation is likely to be similar in both cases.

4.3 DISTRIBUTION OF EVACUATION INITIATION TIMES.

The data for evacuation initiation times are presented as a cumulative probability distribution, as shown in figure 3. The "Curve of Best Fit" is derived assuming that the data may be represented by a Weibull Distribution. The data suggests that 50% of evacuations are initiated within 20 seconds and 90% within 40 seconds.

Since there are only seven data points, confidence in the distribution must be somewhat limited. However the Weibull curve depicted in figure 3 fits the data points well.

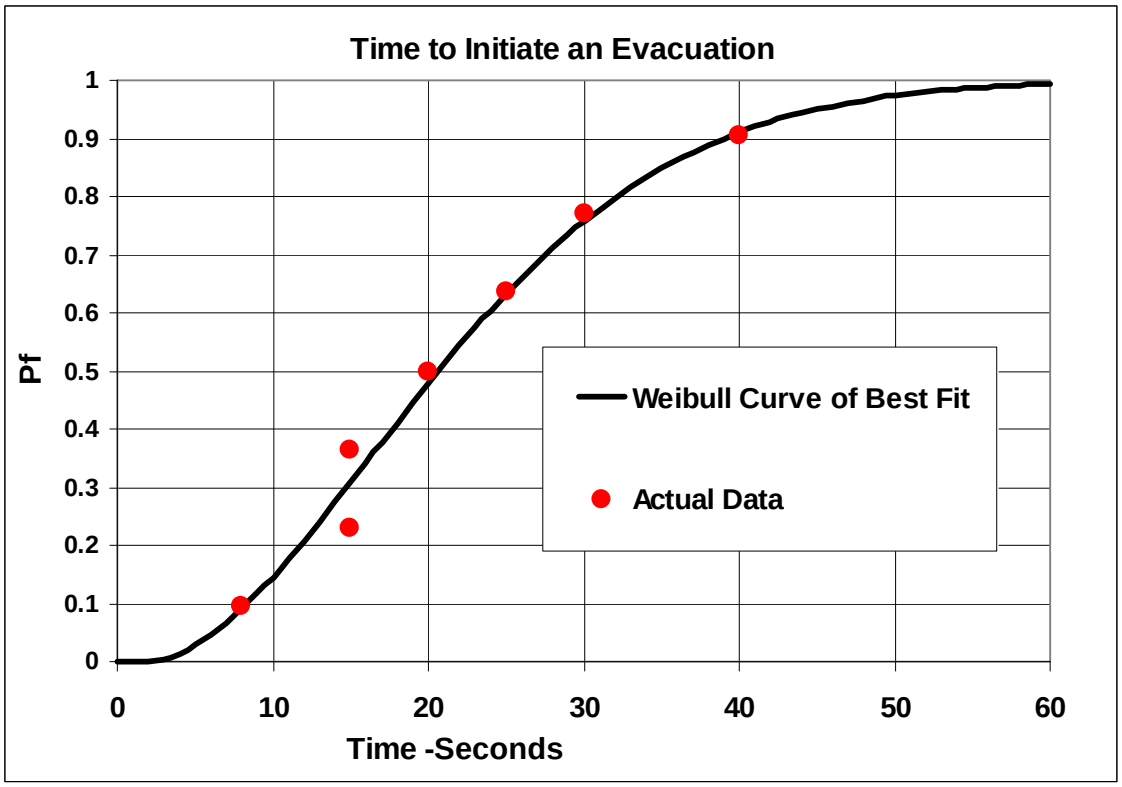

Figure 3. Distribution of Time to Initiate an Evacuation

5. TIME TO COMPLETE AN EVACUATION.

5.1 DATA DEFINITION.

Evacuation Completion Times have been derived from the commencement of the evacuation to the time the last occupant exited the aircraft. The times relate to mobile occupants that were able to self-evacuate.

5.2 DATA USED FOR DISTRIBUTION.

Table 5 gives the results of the data extraction for Evacuation Completion Times. Only accidents in table 1 and table 2 were analyzed (i.e. those involving, or considered likely to

involve a Ground Pool Fire). Of the 43 accidents reviewed, 24 provided sufficient information for the determination of Evacuation Completion Times as shown in table 5.

The time associated with the accident that occurred to the Boeing 727 in November 1980 was measured by a flight attendant using a stopwatch.

Table 5. List of Accidents—Time to Complete an Evacuation

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION	TIME (SECONDS)	NUMBER OF EVACUEES
13-Jun-96	DC10-30	PK-GIE	FUKUOKA AIRPORT, JAPAN	120	272
21-Dec-92	DC10-30CF	PH-MBN	FARO, PORTUGAL	240	284
30-Jul-92	L1011-385	N11002	NEW YORK JFK, U.S.A.	120	292
31-Aug-88	B727-232	N473DA	DALLAS FORT WORTH, U.S.A.	260	94
22-Aug-85	B737-236	G-BGJL	MANCHESTER AP., U.K.	210	82
13-Sep-82	DC10	EC-DEG	MALAGA, SPAIN	360	344
17-Feb-81	B737-293	N468AC	SANTA ANA, CALIFORNIA, U.S.A.	90	110
21-Nov-80	B727-92C	N18479	YAP ISLAND, MICRONESIA	54.48	73
07-Oct-79	DC8-62	HB-IDE	ATHENS, GREECE	240	140
01-Mar-78	DC10-10	N68045	LOS ANGELES, CALIFORNIA, U.S.A.	300	198
27-Mar-77	B747	N736PA	TENERIFE AIRPORT, CANARY ISLANDS	60	61
27-Apr-76	B727-95	N1963	ST. THOMAS, VIRGIN ISLAND	90	41
20-Nov-74	B747-130	D-ABYB	NAIROBI, KENYA	300	97
11-Sep-74	DC9-31	N8984E	CHARLOTTE, N.CAROLINA, U.S.A.	60	10
15-Mar-74	CARAVELLE	OY-STK	TEHERAN, IRAN	120	81
26-Jan-74	F28-1000	TC-JAO	COMAOVASI, TURKEY	240	7
22-Jan-73	B707-3D3C	JY-ADO	KANO AIRPORT, NIGERIA	60	26

Table 5. List of Accidents—Time to Complete an Evacuation (Continued)

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION	TIME (SECONDS)	NUMBER OF EVACUEES
20-Dec-72	DC9-31	N954N	CHICAGO, U.S.A.	120	35
18-May-72	DC9-31	N8961E	FORT LAUDERDALE, FLORIDA, U.S.A.	30	10
18-Apr-72	VC10	5X-UVA	ADDIS ABABA, ETHIOPIA	180	64
27-Nov-70	DC8-63F	N4909C	ANCHORAGE, ALASKA, U.S.A.	165	182
08-Apr-68	B707-465	G-ARWE	LONDON U.K.	180	122
20-Nov-67	CV880	N821TW	CONSTANCE, KENTUCKY, U.S.A.	60	12
05-Mar-67	DC8-33	PP-PEA	NR. MONROVIA, LIBERIA, AFRICA	60	39

5.3 DISTRIBUTION OF EVACUATION COMPLETION TIMES.

The data for Evacuation Completion Times are presented as a cumulative probability distribution as shown in figure 4. The "Curve of Best Fit" is derived assuming that the data may be represented by a Weibull Distribution. The data suggests that 50% of evacuations are completed within 130 seconds and 90% within 325 seconds.

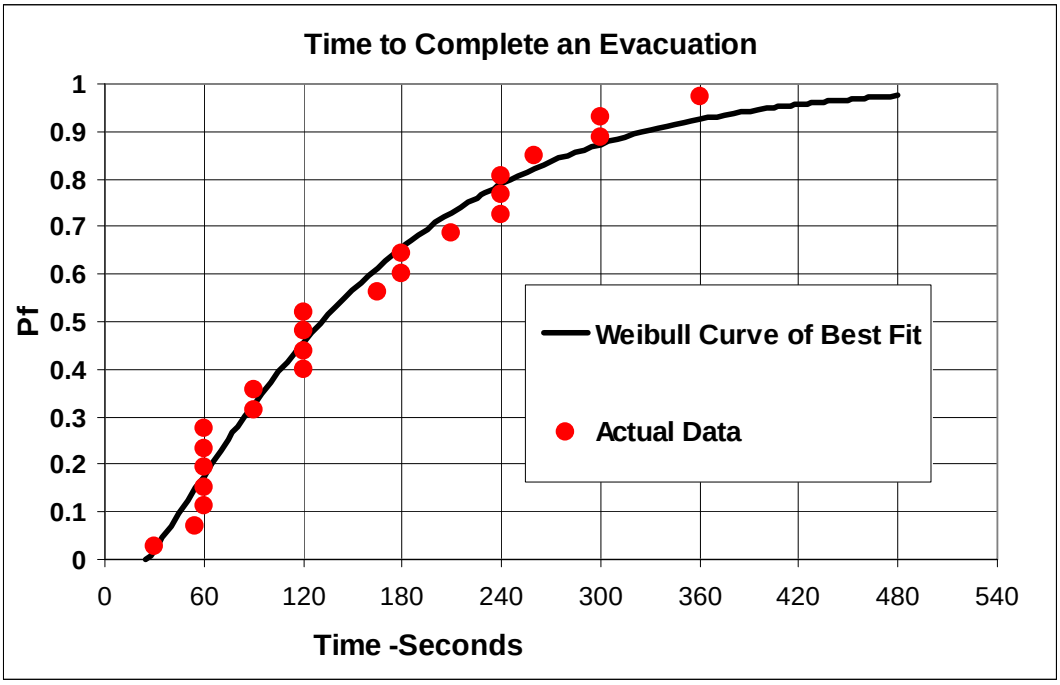

Figure 4. Distribution of Time to Complete an Evacuation

6. TIME TO ARRIVAL OF FIRE-FIGHTERS.

6.1 DEFINITION.

The 'Time to Arrival of Fire-Fighters' has been measured from the time the aircraft stopped to the time that the fire-fighters were in a position to start fire-fighting activities.

There are occasions when fire-fighters are given prior notification of an impending accident. In these cases the fire-fighting apparatus is often at the accident site prior to its occurrence, and hence the "Time to Arrival of Fire-Fighters" is taken as zero.

6.2 DATA USED FOR DISTRIBUTION.

Table 6 gives the results of the data extraction for "Time to Arrival of Fire-Fighters". All 147 accidents in appendix A were used including those where there was no fire for two reasons:

1. Fire-fighters' response is not considered likely to be dependent on whether there was a fire.

2. The greater sample size results in a more representative distribution.

Of the 147 accidents reviewed, 54 accidents provided sufficient information for the determination of 'Time to Arrival of Fire-Fighters', as shown in table 6.

Table 6. List of Accidents—Time to Arrival of Fire-Fighters

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION	TIME (SECONDS)
31-Oct-00	B747-412B	9V-SPK	CHIANG KAI-SHEK AP, TAIWAN	189
25-Jul-00	CONCORDE	F-BTSC	GONESSE, FRANCE	480
14-Sep-99	B757-204	G-BYAG	GIRONA AIRPORT, SPAIN	1200
01-Jun-99	MD82	N215AA	NATIONAL AIRPORT, LITTLE ROCK, ARKANSAS, U.S.A.	1032
08-Jun-95	DC9-32	N908VJ	WILLIAM B. HARTSFIELD INTL. AIRPORT, ATLANTA	180
26-Apr-94	A300B4-622R	B-1816	NAGOYA/KOMAKI AIRPORT, NAGOYA, JAPAN	195
14-Sep-93	A320-211	D-AIPN	WARSAW, POLAND	180

Table 6. List of Accidents—Time to Arrival of Fire-Fighters (Continued)

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION	TIME (SECONDS)
21-Dec-92	DC10-30CF	PH-MBN	FARO, PORTUGAL	30
30-Jul-92	L1011-385-1	N11002	NEW YORK JFK, U.S.A.	120
22-Mar-92	F28-4000 a	N485US	LA GUARDIA, NEW YORK, U.S.A.	240
01-Feb-91	B737-300	N388US	LOS ANGELES, CALIFORNIA, U.S.A.	60
03-Dec-90	DC9-14	N3313L	ROMULUS, DETROIT, U.S.A.	360
14-Feb-90	A320-231	VT-EPN	BANGALORE, INDIA	330
19-Jul-89	DC10-10	N1819U	SIOUX CITY, U.S.A.	30
08-Jan-89	B737-400	G-OBME	KEGWORTH, EAST MIDLANDS AIRPORT, U.K.	497
31-Aug-88	B727-232	N473DA	DALLAS FORT WORTH, U.S.A.	260
31-Aug-88	TRIDENT 2E	B-2218	HONG KONG	60
16-Aug-87	MD82	N312RC	DETROIT, U.S.A.	180
31-Aug-86	DC9-32	XA-JED	CERRITOS, CALIFORNIA, U.S.A.	300
12-Dec-85	DC8-63	N950JW	GANDER, NEWFOUNDLAND, CANADA	600
06-Sep-85	DC9-14	N100ME	MILWAUKEE, WISCONSIN, U.S.A.	120
22-Aug-85	B737-236 Sr1	G-BGJL	MANCHESTER AP., U.K.	25
02-Aug-85	L1011-385-1	N726DA	DALLAS FORT WORTH, U.S.A.	60
18-Dec-83	A300B4-120	OY-KAA	KUALA LUMPUR, MALAYSIA	600
02-Jun-83	DC9-32	C-FTLU	CINCINNATI INTERNATIONAL AIRPORT, U.S.A.	0
13-Sep-82	DC10	EC-DEG	MALAGA, SPAIN	270

Table 6. List of Accidents—Time to Arrival of Fire-Fighters (Continued)

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION	TIME (SECONDS)
23-Jan-82	DC10-30CF	N113WA	LOGAN INT. AIRPORT BOSTON, U.S.A.	240
13-Jan-82	B737-222	N62AF	POTOMAC RIVER, WASHINGTON D.C., U.S.A.	600
17-Feb-81	B737-293	N468AC	JOHN WAYNE AIRPORT, SANTA ANA, CALIFORNIA, U.S.A.	5
22-Dec-80	L1011	HZ-AHJ	NR. STATE OF QATAR	0
07-Oct-79	DC8-62	HB-IDE	ATHENS, GREECE	150
17-Dec-78	B737-200	VT-EAL	HYDERABAD, INDIA	480
01-Mar-78	DC10-10	N68045	LOS ANGELES, CALIFORNIA, U.S.A.	90
11-Feb-78	B737-275	C-FPWC	CRANBROOK B.C., CANADA	300
27-Mar-77	B747-206B	PH-BUF	TENERIFE AIRPORT, CANARY ISLANDS	300
27-Mar-77	B747	N736PA	TENERIFE AIRPORT, CANARY ISLANDS	600
10-Sep-76	DC9-32	YU-AJR	VROBEC, YUGOSLAVIA	480
27-Apr-76	B727-95	N1963	ST. THOMAS, VIRGIN ISLAND	120
24-Jun-75	B727-225	N8845E	KENNEDY AIRPORT, NEW YORK, U.S.A.	180
20-Nov-74	B747-130	D-ABYB	NAIROBI, KENYA	660
11-Sep-74	DC9-31	N8984E	DOUGLAS AIRPORT, CHARLOTTE, N.CAROLINA, U.S.A.	360
30-Jan-74	B707-321B	N454PA	PAGO PAGO, AMERICAN SAMOA	960
16-Jan-74	B707-131B	N757TW	LOS ANGELES INTL AIRPORT, CALIFORNIA, U.S.A.	360

Table 6. List of Accidents—Time to Arrival of Fire-Fighters (Continued)

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION	TIME (SECONDS)
31-Jul-73	DC9-31	N975NE	LOGAN INTERNATIONAL AIRPORT, BOSTON, MASSACHUSETTS	600
20-Dec-72	DC9-31	N954N	CHICAGO, U.S.A.	180
08-Dec-72	B737-222	N9031U	NR. MIDWAY AIRPORT, CHICAGO, U.S.A.	240
18-May-72	DC9-31	N8961E	FORT LAUDERDALE, FLORIDA, U.S.A.	40
18-Apr-72	VC10	5X-UVA	ADDIS ABABA, ETHIOPIA	120
02-Jan-71	COMET 4C	SU-ALC	TRIPOLI AP., LIBYA	540
28-Dec-70	B727-200	N8790R	ST.THOMAS, VIRGIN ISLANDS	75
27-Nov-70	DC8-63F	N4909C	ANCHORAGE, ALASKA, U.S.A.	165
08-Apr-68	B707-465	G-ARWE	LONDON (HEATHROW), U.K.	60
04-Nov-67	CARAVELLE 10BIR	EC-BDD	BLACK DOWN HILL, SUSSEX, U.K.	1140
05-Mar-67	DC8-33	PP-PEA	NR. MONROVIA, LIBERIA, AFRICA	460

6.3 DISTRIBUTION OF TIME TO ARRIVAL OF FIRE-FIGHTERS.

The data for Time to Arrival of Fire-Fighters are presented as a cumulative probability distribution as shown in figure 5. The “Curve of Best Fit” is derived assuming that the data may be represented by a Weibull Distribution. The data suggests that, on 50% of occasions, the fire-fighters arrive within four minutes (240 seconds) and 90% of occasions within twelve minutes (720 seconds).

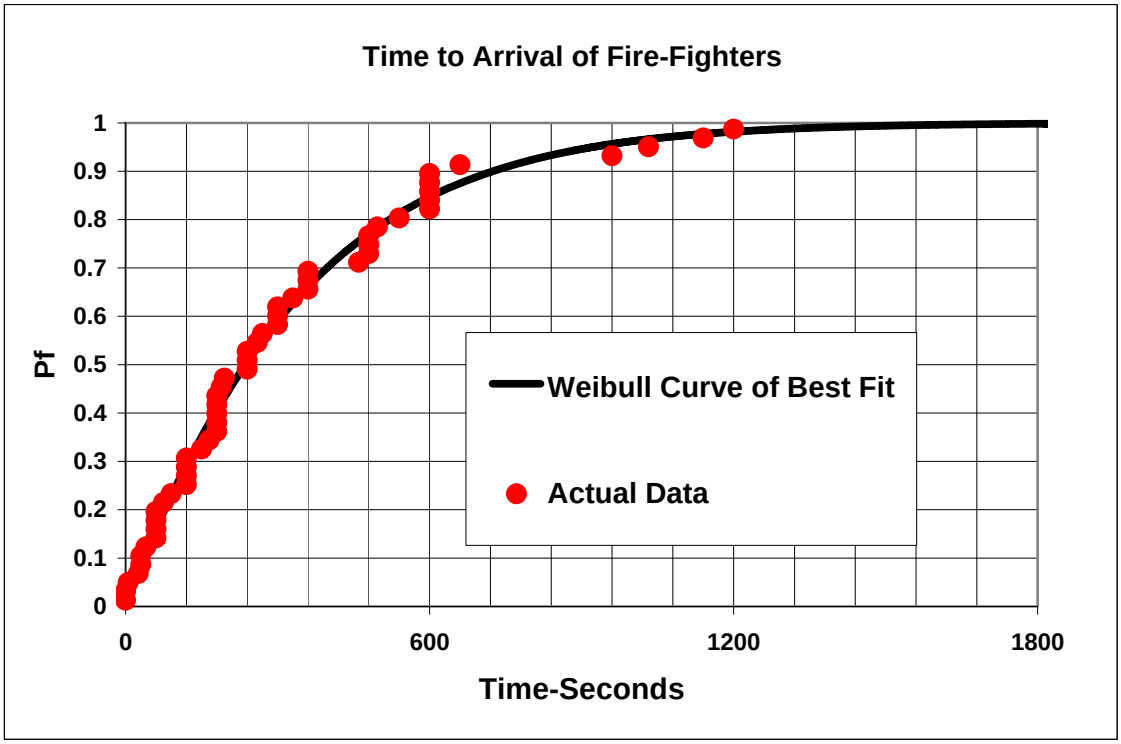

Figure 5. Distribution of Time to Arrival of Fire-Fighters

7. TIME FOR FIRE-FIGHTERS TO ESTABLISH CONTROL.

7.1 DEFINITION.

The 'Time for Fire-Fighters to Establish Control' of a Ground Pool Fire is measured from the time of arrival of fire-fighters to the time that they established control of the fire.

7.2 DATA USED FOR DISTRIBUTION.

Table 7 gives the results of the data extraction for 'Time for Fire-Fighters to Establish Control'. Only accidents in table 1 and table 2 were analyzed (i.e. those involving, or considered likely to involve a Ground Pool Fire).

Of the 43 accidents reviewed, 12 accidents provided sufficient information for the determination of the 'Time for Fire-Fighters to Establish Control' as shown in table 7.

Table 7. List of Accidents—Time for Fire-Fighters to Establish Control

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION	TIME (SECONDS)
31-Oct-00	B747-412B	9V-SPK	CHIANG KAI-SHEK AP, TAIWAN	720
01-Jun-99	MD82	N215AA	NATIONAL AIRPORT, LITTLE ROCK, ARKANSAS, U.S.A.	60
30-Jul-92	L1011-385-1	N11002	NEW YORK JFK, U.S.A.	330
31-Aug-88	B727-232	N473DA	DALLAS FORT WORTH, U.S.A.	60
22-Aug-85	B737-236 Sr1	G-BGJL	MANCHESTER AP., U.K.	755
07-Oct-79	DC8-62	HB-IDE	ATHENS, GREECE	1890
17-Dec-78	B737-200	VT-EAL	HYDERABAD, INDIA	4200
24-Jun-75	B727-225	N8845E	KENNEDY AIRPORT, NEW YORK, U.S.A.	120
20-Nov-74	B747-130	D-ABYB	NAIROBI, KENYA	600
30-Jan-74	B707-321B	N454PA	PAGO PAGO, AMERICAN SAMOA	480
20-Dec-72	DC9-31	N954N	CHICAGO, U.S.A.	960
08-Dec-72	B737-222	N9031U	NR. MIDWAY AIRPORT, CHICAGO, U.S.A.	1500

7.3 DISTRIBUTION OF TIME FOR FIRE-FIGHTERS TO ESTABLISH CONTROL.

The data for Time for Fire-Fighters to Establish Control are presented as a cumulative probability distribution as shown in figure 6. The “Curve of Best Fit” is derived assuming that the data may be represented by a Weibull Distribution. The data suggests that, on 50% of occasions, the fire-fighters establish control within ten minutes (600 seconds) and 90% of occasions within forty-two minutes (2520 seconds).

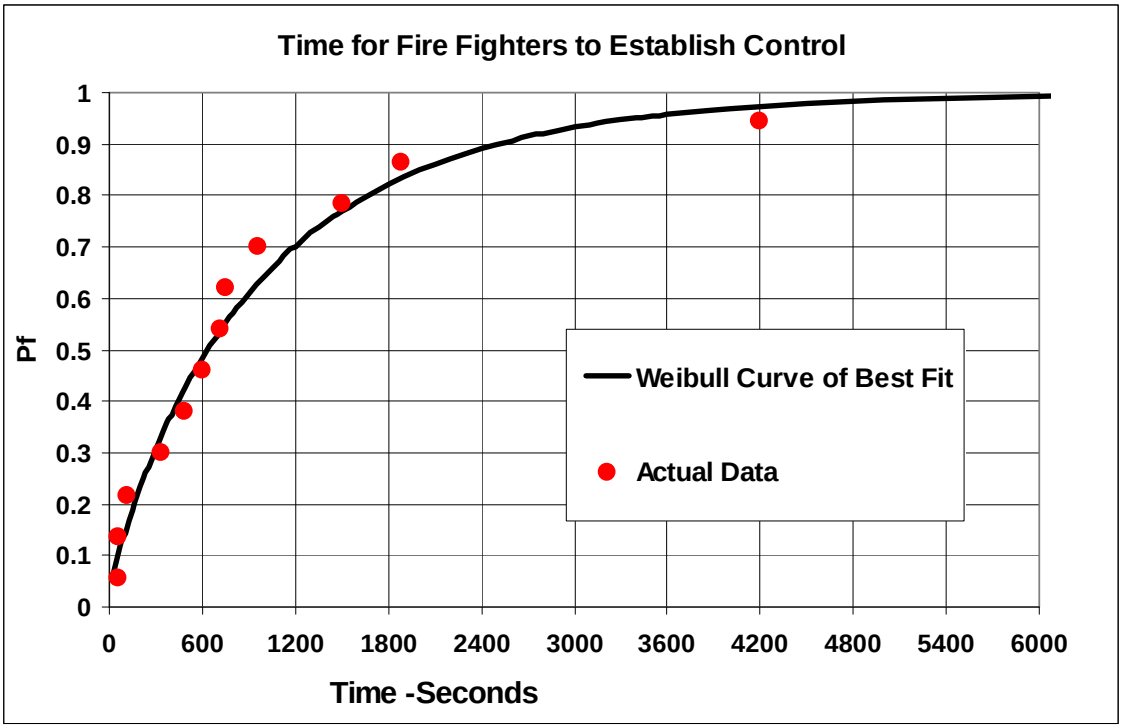

Figure 6. Distribution of Time for Fire-Fighters to Establish Control

8. REFERENCES.

1. Cabin Safety Research Technical Group Accident Database Version 24

2. Boeing Statistical Summary of Commercial Jet Airplane Accidents www.boeing.com/news/techissues May 2004

APPENDIX A—ACCIDENTS RESULTING IN FATALITIES OR THE AIRCRAFT BEING DESTROYED FOR WHICH THERE ARE FULL SCREEN 3* DATA

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION
05-MAR-1967	DC8-33	PP-PEA	NR. MONROVIA, LIBERIA, AFRICA
09-MAR-1967	DC9-15	N1063T	NR. URBANA, OHIO, U.S.A.
23-JUN-1967	BAC1-11-204AF	N1116J	NR. BLOSSBURG, PENNSYLVANIA, U.S.A.
19-JUL-1967	B727-22	N68650	HENDERSONVILLE, NORTH CAROLINA, U.S.A.
04-NOV-1967	CARAVELLE 10BIR	EC-BDD	BLACK DOWN HILL, SUSSEX, U.K.
06-NOV-1967	B707-131	N742TW	CINCINNATI, U.S.A.
20-NOV-1967	CV880	N821TW	CONSTANCE, KENTUCKY, U.S.A.
06-MAR-1968	B707-328C	F-BLCJ	POINTE A PITRE, GUADELOUPE
08-APR-1968	B707-465	G-ARWE	LONDON (HEATHROW), U.K.
27-DEC-1968	DC9-15	N974Z	SIOUX CITY AIRPORT, IOWA, U.S.A.
13-JAN-1969	DC8-62	LN-MOO	SANTA MONICA BAY, CALIFORNIA, U.S.A.
18-JAN-1969	B727-22C	N7434U	SANTA MONICA BAY, LOS ANGELES, CALIFORNIA, U.S.A.
09-SEP-1969	DC9-30	N988VJ	NR. FAIRLAND, INDIANA, U.S.A.
20-NOV-1969	VC10-1101	5N-ABD	LAGOS, NIGERIA
02-MAY-1970	DC9-33F	N935F	ST.CROIX, VIRGIN ISLANDS
03-JUL-1970	COMET 4	G-APDN	SIERRA DEL MONTENSY, GERONA, SPAIN
05-JUL-1970	DC8-63	C-FTIW	TORONTO, CANADA
15-SEP-1970	DC8-62	I-DIWZ	J.F.K. AIRPORT, NEW YORK, U.S.A.
14-NOV-1970	DC9-31	N97S	TRI-STATE AP., HUNTINGTON, WEST VIRGINIA, U.S.A.
27-NOV-1970	DC8-63F	N4909C	ANCHORAGE, ALASKA, U.S.A.

* "Screen 3" information is textual data contained in the CSRTG Accident Database that is extracted from Accident Reports produced by the Investigating Authority. Further analysis of selected accidents was supported by the library of Accident Reports and Data held by RGW Cherry & Associates Limited.

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION
28-DEC-1970	B727-200	N8790R	ST.THOMAS, VIRGIN ISLANDS
02-JAN-1971	COMET 4C	SU-ALC	TRIPOLI AP., LIBYA
06-JUN-1971	DC9-31	N9345	NEAR DUARTE, CALIFORNIA, U.S.A.
04-SEP-1971	B727-193	N2969G	NEAR JUNEAU, ALASKA, U.S.A.
06-SEP-1971	BAC1-11-500/515	D-ALAR	NR. HASLOH, GERMANY
18-APR-1972	VC10	5X-UVA	ADDIS ABABA, ETHIOPIA
18-MAY-1972	DC9-31	N8961E	FORT LAUDERDALE, FLORIDA, U.S.A.
18-JUN-1972	TRIDENT 1C	G-ARPI	STAINES, HEATHROW, U.K.
19-JUL-1972	BAC1-11	G-AWYS	CORFU, GREECE
08-DEC-1972	B737-222	N9031U	NR. MIDWAY AIRPORT, CHICAGO, U.S.A.
20-DEC-1972	DC9-31	N954N	CHICAGO, U.S.A.
29-DEC-1972	L1011	N310EA	NR. MIAMI INTERNATIONAL AIRPORT, FLORIDA, U.S.A.
22-JAN-1973	B707-3D3C	JY-ADO	KANO AIRPORT, NIGERIA
11-JUL-1973	B707-321C	PP-VJZ	ORLY, NR. PARIS, FRANCE
31-JUL-1973	DC9-31	N975NE	LOGAN INTERNATIONAL AIRPORT, BOSTON, MASSACHUSETTS
28-AUG-1973	B707-331B	N8705T	NR. LOS ANGELES, CALIFORNIA, U.S.A.
03-NOV-1973	DC10-10	N60NA	NR. SOCORRO & ALBUQUERQUE, NEW MEXICO
27-NOV-1973	DC9-32	N3323L	CHATTANOOGA MUNICIPAL AIRPORT, TENNESSEE, U.S.A.
27-NOV-1973	DC9-31	N8967E	AKRON-CANTON AIRPORT, OHIO, U.S.A.
01-JAN-1974	F28-1000	I-TIDE	NR. TURIN, ITALY
16-JAN-1974	B707-131B	N757TW	LOS ANGELES INTL AIRPORT, CALIFORNIA, U.S.A.
26-JAN-1974	F28-1000	TC-JAO	COMAOVASI, TURKEY
30-JAN-1974	B707-321B	N454PA	PAGO PAGO, AMERICAN SAMOA
03-MAR-1974	DC10-10	TC-JAV	ERMENONVILLE FOREST, NR. PARIS, FRANCE

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION
15-MAR-1974	CARAVELLE 10B3	OY-STK	TEHERAN, IRAN
22-APR-1974	B707-321C	N446PA	DENPASAR, BALI, INDONESIA
11-SEP-1974	DC9-31	N8984E	DOUGLAS AIRPORT, CHARLOTTE, N.CAROLINA, U.S.A.
20-NOV-1974	B747-130	D-ABYB	NAIROBI, KENYA
01-DEC-1974	B727-231	N54328	BERRYVILLE, VIRGINIA, U.S.A.
04-DEC-1974	DC8-55F	PH-MBH	ANJIMALAI MOUNTAIN, SRI LANKA
24-JUN-1975	B727-225	N8845E	KENNEDY AIRPORT, NEW YORK, U.S.A.
05-APR-1976	B727-81	N124AS	KETCHIKAN, ALASKA, U.S.A.
27-APR-1976	B727-95	N1963	ST. THOMAS, VIRGIN ISLAND
23-JUN-1976	DC9-31	N994VJ	PHILADELPHIA INTERNATIONAL AIRPORT
10-SEP-1976	TRIDENT 3B	G-AWZT	VROBEC, YUGOSLAVIA
10-SEP-1976	DC9-32	YU-AJR	VROBEC, YUGOSLAVIA
27-MAR-1977	B747	N736PA	TENERIFE AIRPORT, CANARY ISLANDS
27-MAR-1977	B747-206B	PH-BUF	TENERIFE AIRPORT, CANARY ISLANDS
04-APR-1977	DC9-31	N1335U	NEW HOPE GEORGIA, U.S.A.
18-DEC-1977	CARAVELLE 10B1R	HB-ICK	NR. FUNCHAL, MADEIRA, PORTUGAL
11-FEB-1978	B737-275	C-FPWC	CRANBROOK B.C., CANADA
01-MAR-1978	DC10-10	N68045	LOS ANGELES, CALIFORNIA, U.S.A.
08-MAY-1978	B727-235	N4744NA	NR. PENSACOLA, FLORIDA, U.S.A.
26-JUN-1978	DC9-32	C-FTLV	TORONTO INTERNATIONAL AIRPORT, CANADA
25-SEP-1978	B727-214	N533PS	SAN DIEGO, CALIFORNIA, U.S.A.
17-DEC-1978	B737-200	VT-EAL	HYDERABAD, INDIA
28-DEC-1978	DC8-61	N8082U	PORTLAND, OREGON, U.S.A.
25-MAY-1979	DC10-10	N110AA	CHICAGO-O'HARE AP., ILLINOIS, U.S.A.

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION
07-OCT-1979	DC8-62	HB-IDE	ATHENS, GREECE
31-OCT-1979	DC10-10	N903WA	MEXICO CITY, MEXICO
28-NOV-1979	DC10-30	ZK-NZP	MT. EREBUS, ANTARCTICA
25-APR-1980	B727-64	G-BDAN	NR. TENERIFE NORTE AP., CANARY ISLANDS
19-AUG-1980	L1011	HZ-AHK	NR. RIYADH, SAUDI ARABIA
19-NOV-1980	B747-100	HL-7445	SEOUL, KOREA
21-NOV-1980	B727-92C	N18479	YAP ISLAND, WESTERN CAROLINE ISLANDS, MICRONESIA
22-DEC-1980	L1011	HZ-AHJ	NR. STATE OF QATAR
17-FEB-1981	B737-293	N468AC	JOHN WAYNE AIRPORT, SANTA ANA, CALIFORNIA, U.S.A.
20-SEP-1981	DC10-30CF	N112WA	OVER NORTH ATLANTIC OCEAN
13-JAN-1982	B737-222	N62AF	POTOMAC RIVER, WASHINGTON D.C., U.S.A.
23-JAN-1982	DC10-30CF	N113WA	LOGAN INT. AIRPORT BOSTON, U.S.A.
09-FEB-1982	DC8-61	JA-8061	HANEDA AIRPORT, TOKYO, JAPAN
09-JUL-1982	B727-235	N4737	KENNER, LOUISIANA, U.S.A.
13-SEP-1982	DC10	EC-DEG	MALAGA, SPAIN
02-JUN-1983	DC9-32	C-FTLU	CINCINNATI INTERNATIONAL AIRPORT, U.S.A.
07-DEC-1983	B727-200	EC-CFJ	MADRID, SPAIN
07-DEC-1983	DC9-32	EC-CGS	MADRID, SPAIN
18-DEC-1983	A300B4-120	OY-KAA	KUALA LUMPUR, MALAYSIA
02-AUG-1985	L1011-385-1	N726DA	DALLAS FORT WORTH, U.S.A.
12-AUG-1985	B747-SR-100	JA-8119	MOUNT OSUTAKA, GUMMA, JAPAN
22-AUG-1985	B737-236 Sr1	G-BGJL	MANCHESTER AP., U.K.
06-SEP-1985	DC9-14	N100ME	MILWAUKEE, WISCONSIN, U.S.A.
12-DEC-1985	DC8-63	N950JW	GANDER, NEWFOUNDLAND, CANADA

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION
31-AUG-1986	DC9-32	XA-JED	CERRITOS, CALIFORNIA, U.S.A.
25-OCT-1986	B737-222	N752N	CHARLOTTE, NORTH CAROLINA, U.S.A.
16-AUG-1987	MD82	N312RC	DETROIT, U.S.A.
31-AUG-1987	B737-200	HS-TBC	NR. PHUKET AP., THAILAND
15-NOV-1987	DC9-14	N626TX	DENVER COLORADO U.S.A.
28-APR-1988	B737-200	N73711	NR. MAUI, HAWAII
26-JUN-1988	A320-100	F-GKFC	HABSHEIM, FRANCE
31-AUG-1988	TRIDENT 2E	B-2218	HONG KONG
31-AUG-1988	B727-232	N473DA	DALLAS FORT WORTH, U.S.A.
08-JAN-1989	B737-400	G-OBME	KEGWORTH, EAST MIDLANDS AIRPORT, U.K.
24-FEB-1989	B747-122	N4713U	EN-ROUTE OVER PACIFIC OCEAN
10-MAR-1989	F28-1000	C-FONF	DRYDEN, ONTARIO, CANADA
19-JUL-1989	DC10-10	N1819U	SIOUX CITY, U.S.A.
20-SEP-1989	B737-400	N416US	NEW YORK LA GUARDIA, U.S.A.
25-JAN-1990	B707-321B	HK-2016	COVE NECK, LONG ISLAND, NEW YORK, U.S.A.
14-FEB-1990	A320-231	VT-EPN	BANGALORE, INDIA
02-JUN-1990	B737-2X6C	N670MA	ALASKALEET, ALASKA, U.S.A.
03-DEC-1990	DC9-14	N3313L	ROMULUS, DETROIT, U.S.A.
01-FEB-1991	B737-300	N388US	LOS ANGELES, CALIFORNIA, U.S.A.
03-MAR-1991	B737-291	N999UA	COLORADO SPRINGS, COLORADO, U.S.A.
26-MAY-1991	B767-3Z9ER	OE-LAV	PHU TOEY VILLAGE , THAILAND
11-JUL-1991	DC8-61	C-GMXQ	KING ABDULAZIZ INT. AP., JEDDAH, SAUDI ARABIA
20-JAN-1992	A320-100	F-GGED	NR STRASBOURG, FRANCE
22-MAR-1992	F28-4000 a	N485US	LA GUARDIA, NEW YORK, U.S.A.

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION
30-JUL-1992	L1011-385-1	N11002	NEW YORK JFK, U.S.A.
21-DEC-1992	DC10-30CF	PH-MBN	FARO, PORTUGAL
06-APR-1993	MD11	B-2171	NR. SHEMYA, ALASKA, U.S.A.
14-APR-1993	DC10-30	N139AA	DALLAS/FORT WORTH AIRPORT, DALLAS, TEXAS, U.S.A.
14-SEP-1993	A320-211	D-AIPN	WARSAW, POLAND
24-NOV-1993	MD87	SE-DIB	COPENHAGEN AIRPORT KASTRUP, DENMARK
26-APR-1994	A300B4-622R	B-1816	NAGOYA/KOMAKI AIRPORT, NAGOYA, JAPAN
02-JUL-1994	DC9-31	N954VJ	CHARLOTTE AIRPORT, CHARLOTTE, NORTH CAROLINA
10-AUG-1994	A300B4-622R	HL-7296	CHEJU ISLAND AIRPORT, KOREA
08-SEP-1994	B737-300	N513AU	NR. ALIQUIPPA, PENNSYLVANIA, U.S.A.
08-JUN-1995	DC9-32	N908VJ	WILLIAM B. HARTSFIELD INTL. AIRPORT, ATLANTA
20-DEC-1995	B757-223	N651AA	BUGA, NR. CALI, COLOMBIA
06-FEB-1996	B757-225	TC-GEN	PUERTO PLATA, DOMINICAN REPUBLIC
11-MAY-1996	DC9-32	N904VJ	EVERGLADES, FLORIDA, U.S.A.
13-JUN-1996	DC10-30	PK-GIE	FUKUOKA AIRPORT, JAPAN
06-JUL-1996	MD88	N927DA	PENSACOLA REGIONAL AIRPORT, FLORIDA, U.S.A.
17-JUL-1996	B747-131	N93119	OFF LONG ISLAND, U.S.A.
06-AUG-1997	B747-3B5B	HL-7468	NIMITZ HILL, NR AGANA, GUAM
16-DEC-1997	CL600-2B19	C-FSKI	FREDERICTON AP., NEW BRUNSWICK, CANADA
19-DEC-1997	B737-300	9V-TRF	PALEMBANG, INDONESIA
09-FEB-1998	B727-223	N845AA	O'HARE INTL AIRPORT, CHICAGO, ILLINOIS, U.S.A.
02-SEP-1998	MD11	HB-IFW	IN SEA, NR. PEGGY'S COVE, NOVA SCOTIA, CANADA
01-JUN-1999	MD82	N215AA	NATIONAL AIRPORT, LITTLE ROCK, ARKANSAS, U.S.A.
14-SEP-1999	B757-204	G-BYAG	GIRONA AIRPORT, SPAIN

DATE	AIRCRAFT TYPE	REGISTRATION	LOCATION
31-OCT-1999	B767-366ER	SU-GAP	NANTUCKET ISLAND, MA, U.S.A.
31-JAN-2000	MD83	N963AS	ANACAPA ISLAND, CA, U.S.A.
05-MAR-2000	B737-300	N668SW	BURBANK, CA, U.S.A.
17-JUL-2000	B737-200	VT-EGD	NEAR PATNA AP, INDIA
25-JUL-2000	CONCORDE	F-BTSC	GONESSE, FRANCE
23-AUG-2000	A320	A40-EK	NEAR BAHRAIN AP, BAHRAIN
31-OCT-2000	B747-412B	9V-SPK	CHIANG KAI-SHEK AP, TAIWAN