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Bird Ingestion into Large Turbofan Engines

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Interim Report

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16. Abstract The Federal Aviation Administration (FAA) is conducting a study of bird ingestion into certain modern, large high bypass turbofan engines. The engines under consideration were certificated to current FAA standards and are installed in A300, A310, A320, B747, B757, B767, DC10, and MD11 aircraft in commercial service worldwide. Data were collected during 1989-1991 by the principal manufacturers of such engines. This interim report provides some analysis of the initial 381 aircraft ingestion events, with emphasis on the kinds and numbers of ingested birds and the adverse effects of bird ingestion on aircraft engines and flights.			
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EXECUTIVE SUMMARY

During 1981-83, the Federal Aviation Administration (FAA) conducted a study of bird ingestions into large high bypass ratio (HBPR) turbofan engines [1]. The majority of such engines in service at that time were certificated under airworthiness standards for bird ingestion pre-dating Change 1 (October 1974) to Part 33 of the Federal Aviation Regulations. Over the past decade many newer HBPR engines, that were designed and certificated to more stringent standards, have come into wide-spread service. The current study grew out of a need to ascertain any changes that have occurred in the bird threat and to assess the effects of bird ingestions on these newer engines.

The data in this interim report, which represent approximately 65 percent of the total amount expected for the study, were generated from over 2 million operations flown by a fleet of more than 1100 aircraft during the period January 1989 to September 1990. Aircraft models include the A300, A310, A320, B747, B757, B767, and DC10.

A total of 381 aircraft ingestions was reported, yielding a worldwide ingestion rate of 1.85 ingestions per 10,000 aircraft operations. This is approximately 80 percent of the rate in the 1981-83 FAA study. The foreign aircraft ingestion rate is currently more than four times the United States rate, compared with two and one-half times in the previous study.

Aircraft ingestion events were reported to have occurred at 120 different airports worldwide. One airport had 10 events and two others had 7 each. All three of these airports are outside the United States. The largest number of events at any United States airport was 4.

There were 16 multiple engine events, yielding a rate slightly under 8 per million operations. Each involved two engines of the aircraft. Thirty-five (35) of the 397 engine ingestions are known to have involved multiple birds.

The species of ingested birds are consistent with the 1981-83 study. The herring gull, common lapwing, black-headed gull, and common rock dove were the most frequently identified ingested bird species. The first three were also the most frequently encountered birds during multiple engine or multiple bird ingestions.

Bird weights, both United States and foreign, are markedly similar to those in the previous study. This is true not only in terms of summary statistics (median, mode, mean, etc.) but also in terms of the distribution functions for the weights. As before, birds ingested in the United States tend to be heavier than foreign birds.

Forty-seven (47) percent of engines that ingested birds had some reported damage, compared to 62 percent in previous study. Fifty-four (54) percent of current engine damage was classified as "minor," which typically consisted of leading edge distortions or at most three bent, dented, or torn fan blades.

The aircraft ingestion events were fairly evenly split between the departure (takeoff or climb) and arrival (descent, approach or landing) phases of flight. However, engines ingesting birds during departures sustained damage at about twice the rate as in arrivals.

An unscheduled crew action (aborted takeoff, air turnback, etc.) was performed in 14 percent of the aircraft events, which is half the rate in the previous study. There were 11 in-flight engine shutdowns (IFSD's), representing less than 3 percent of all engine events. In the previous study, nearly 13 percent of engine events resulted in an IFSD.

Following is a summary of some data from the current and previous FAA studies. Except where noted, all numbers represent worldwide data.

DATA SUMMARY

	<u>Current Study</u>	<u>1981-83 Study</u>
# aircraft	1162 (5/90)	1513 (6/84)
# operations	2,056,676	2,738,320
# aircraft ingestions *	34/333/381	97/484/638
ingestion rate ($\times 10^{-4}$) *	0.54/2.34/1.85	0.99/2.80/2.33
# multiple engine events	16	25
multiple engine ingestion rate ($\times 10^{-6}$)	7.78	9.86
# engine ingestions	397	666
# multiple bird engine ingestions	35	65
% multiple bird ingestions	8.8	9.8
# damaging engine ingestions	185	416
% damaging engine ingestions	47	62
median bird weight (oz.) *	28/14/14	32/18/19
modal bird weight (oz.) *	40/14/40	40/24/40
mean bird weight (oz.) *	30/22/23	30/27/27
# crew action a/c evts.	53	129
% crew actions	13.9	28.2
# IFSD eng. evts.	11	85
% IFSD's	2.8	12.8

* US/FOREIGN/WORLDWIDE

1. INTRODUCTION.

1.1 BACKGROUND.

The Federal Aviation Administration (FAA) conducted a study during 1981-83 to determine the numbers, weights and species of birds being ingested into all large high bypass ratio (HBPR) turbofan engines in service worldwide and to document any resultant damage. The purpose of that effort was to provide data in support of possible changes to the airworthiness certification standards for bird ingestion, so they might better reflect actual service experience. The data were collected by the three principal large engine manufacturers, General Electric (GE), Pratt and Whitney (PW), and Rolls Royce (RR), under contract to the FAA. Results from that study were reported in reference 1.

The majority of large HBPR engines in service at that time were certificated under bird ingestion standards pre-dating 1974. Over the past decade, many newer large HBPR engines that were designed and certificated to more stringent standards have come into wide-spread service. The current study grew out of a need to ascertain any changes that have occurred in the bird threat and to assess the effects of bird ingestions on these newer engines.

The abovementioned three engine manufacturers were again contracted by the FAA to provide as much pertinent data as possible on all known bird ingestions into engines that were certificated under standards of 1974 or later. Unfortunately, because of complexities in contractual startups, it was not possible to synchronize the initiation of data collection between all three manufacturers. The RR and PW data reporting started in January 1989, while GE data collection began in July 1989. It is anticipated that each data collection period will last for 26 months. This interim report is based on initial data collected by RR and GE through September 1990 and by PW through August 1990. All International Aero Engine (IAE) and CFM International (CFMI) data are being collected for this study by PW and GE, respectively, and correspond to their reporting periods.

Two additional FAA bird ingestion studies, for medium and small turbine engines, were conducted in recent years. They were reported on in references 2 and 3.

1.2 OBJECTIVE.

The objective of this study is to determine the numbers, species, and weights of birds being ingested into certain modern large HBPR turbine engines during worldwide service and to assess the impact of these ingestions on engines and aircraft operations.

1.3 ORGANIZATION OF REPORT.

The main body of the report is contained in Sections 2 through 5. These sections are ordered so as to deal with relevant topics according to increasing dependency and complexity. The aircraft fleet under study and operations flown by it are discussed in Section 2. Section 3 deals with various kinds of ingestion events and their rates of occurrence. Airports are also discussed. The population of ingested birds is analyzed in Section 4, while Section 5 examines the adverse effects of bird ingestions on aircraft flights and engines. Section 6 contains a summary of results and presents some conclusions.

2. ENGINES, AIRCRAFT, AND OPERATIONS.

The current study involves all aircraft containing certain large high bypass ratio engines that were certificated under the most recent and most stringent airworthiness standards, i.e., those of Change 1 of October 31, 1974, or Change 5 of March 26, 1984, to Part 33 of the Federal Aviation Regulations. Both of these contain a requirement that an engine having inlet area greater than 3900 square inches continue to operate with 75 percent power and under specified conditions of safety upon the ingestion of a flock of eight 1.5 pound birds. Consideration has been given in recent years to include birds heavier than 1.5 pounds in this "medium bird" certification test. All the applicable portions of the current (March 1984) standard relating to bird ingestion are summarized in appendix A.

Table 2.1 lists each of the engine models covered in this study, along with its manufacturer, takeoff thrust(s), bypass ratio(s), fan tip diameter, inlet area and year(s) in which it was certified. All engines except the V2500 and CFM56 have inlet areas larger than 3900 square inches and, thus, require an eight-bird "medium bird" certification test. The CFM56-5 was certified with seven 1.5-pound birds and the V2500-A1 with six.

The above engine models have been installed in the following types of aircraft: B747, B757, B767, DC10, MD11, A300, A310, and A320. The B747 has four engines while the DC10 and MD11 each have three engines. The rest are all two-engine aircraft. All engines are wing-mounted with the exception of a single tail-mounted engine on the DC10 and MD11. Table 2.2 indicates the approximate number of aircraft in service for each aircraft type included in this study, broken down according to engine model. The numbers represent the worldwide aircraft fleet, which is growing steadily, as of May 1990. The total of 1162 aircraft is roughly 75 percent of the fleet size in the 1981-1983 FAA study, reference 1. Note that a relatively small number of DC10's (those equipped with JT9-59A engines) are represented in this study. The MD11, which entered commercial service in December 1990, will be included in the final report for this study.

An "aircraft operation" is simply one complete flight cycle of an airplane. (See Glossary for formal definition.) It was not possible to utilize Official Airline Guide computer tapes to derive operational data as in previous studies [1 and 2] because these tapes do not distinguish between B747, A300 and DC10 aircraft having older engines and those with the newer engine models included in this study. All operational data, including estimates of United States (50 states) and foreign (non-United States) operations, were obtained from the engine manufacturers.

Figure 2.1 charts the number of monthly worldwide aircraft operations for the entire fleet of aircraft under consideration. These numbers correspond to the data contributed for this report by each engine manufacturer, i.e., there are no operational data from GE for the period January 1 through June 30, 1989 (months 1 through 6) or from PW for September 1990 (month 21). These facts, along with a steady growth in the aircraft fleet over the reporting period, account for the large variation in monthly totals. In the figure, the number of operations for any given month is cumulative. For example, RR reported approximately 20,000 operations with aircraft included in this study during month 16 (April, 1990) while PW and GE each had about 50,000 operations.

TABLE 2.1. ENGINE MODELS

ENGINE MODEL	MANUF.	TAKEOFF THRUST (1000 LB)	BYPASS RATIO	FAN DIAM (IN.)	INLET DIAM (IN.)	YEAR(S) CERTIFIED
JT9D-7Q	PW	53-56	5.2	97.0	83.1	1979
JT9D-59A		53	4.9	97.0	83.6	1974
JT9D-70A		53	4.9	97.0	83.6	1974
JT9D-7R4		48-56	4.8-5	97.0	83.1	1980-82
PW2000		37-41	6.0	78.5	74.5	1983
PW4000		52-60	4.9	93.4	84.0	1986
CF6-80A	GE	48	4.7	86.4	82.8	1981
CF6-80C2		52-60	5.1	93.1	86.2	1985
RB211-535C	RR	37.4	4.4	73.2	73.9	1982
RB211-535E4		40-43	4.1	74.1	74.5	1983
RB211-524G		58	4.3	86.3	86.3	1988
RB211-524H		60.6	4.1	86.3	86.3	1989
V2500-A1	IAE	25	5.4	63.0	59.4	1988
CFM56-5	CFMI	25	6.0	68.3	62.6	1987

TABLE 2.2. AIRCRAFT FLEET

MANUF.	ENG. MODEL	A300	A310	A320	B747	B757	B767	DC10	MD11	TOTALS
PW	JT9D-7Q				86					86
	JT9D-59A	24						17		41
	JT9D-70A				12					12
	JT9D-7R4	19	38		64		92			213
	PW2000					126				126
	PW4000	9	20		21		23		0	73
GE	CF6-80A		47				110			157
	CF6-80C2	48	66		34		74		0	222
RR	RB211-535C					38				38
	RB211-535E4					76				76
	RB211-524G				24					24
	RB211-524H						6			6
IAE	V2500-A1			24						24
CFMI	CFM56-5			64						64
	TOTALS	100	171	88	241	240	305	17	0	1162

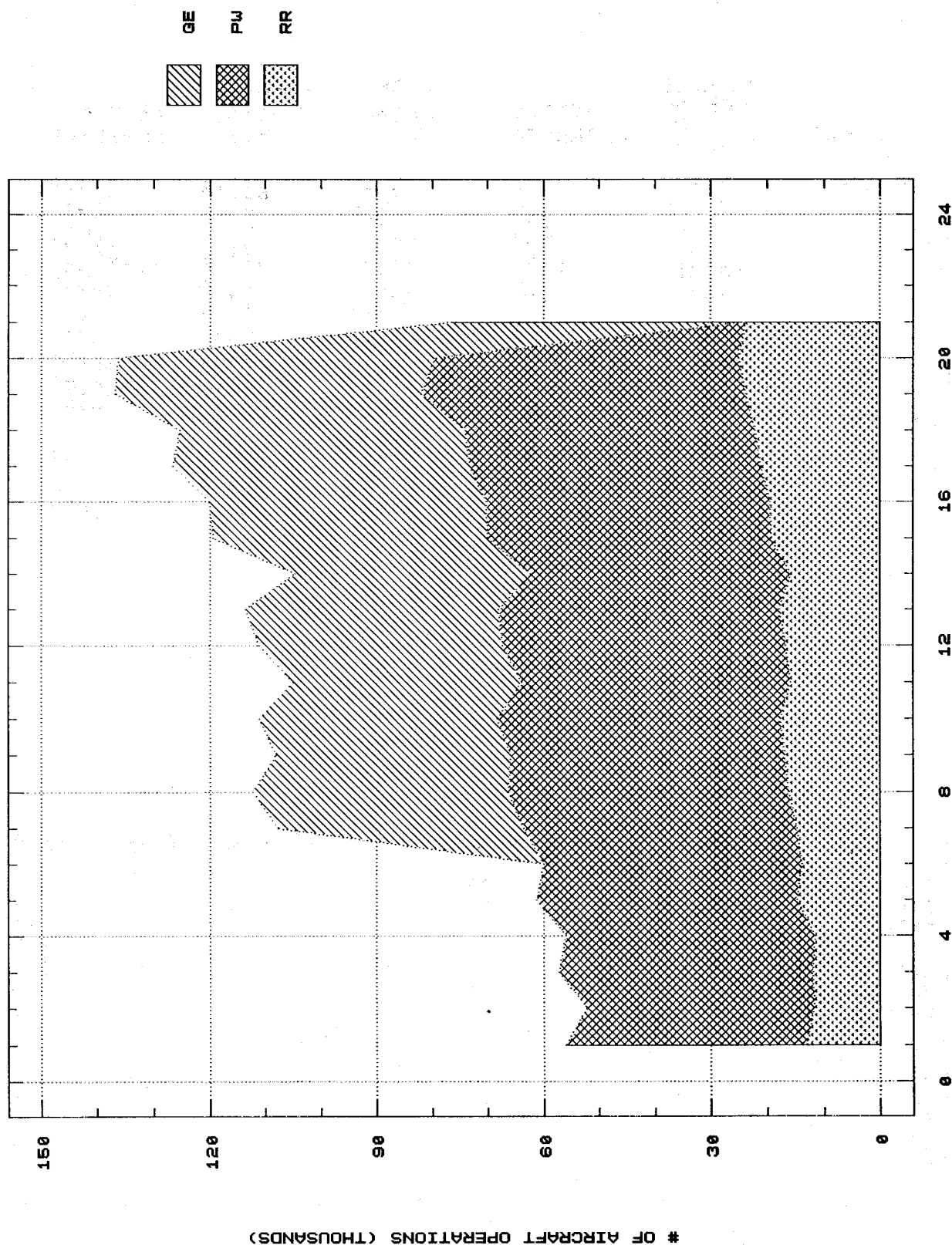


FIGURE 2.1. MONTHLY AIRCRAFT OPERATIONS BY ENGINE MANUFACTURER
JAN 1989 THROUGH SEPT 1990

As noted in the Introduction, the IAE and CFMI operational data were collected by PW and GE, respectively, and correspond to their reporting periods.

Figure 2.2 indicates the total number of worldwide aircraft operations for each aircraft type, broken down by United States and foreign categories. As in the previous figure, these numbers correspond to the reporting periods of each engine manufacturer. The B757 and B767 flew the largest number of both domestic and worldwide operations. The five remaining aircraft types operated in a predominantly foreign environment. Overall, about 70 percent of the total fleet's operations were foreign. The precise numbers used to generate figure 2.2 can be found in table 3.1. Although worldwide operational data are believed to be fairly accurate, the breakdowns according to United States and foreign stemmed, in some cases, from educated guesses by the engine manufacturers and should be viewed as approximations.

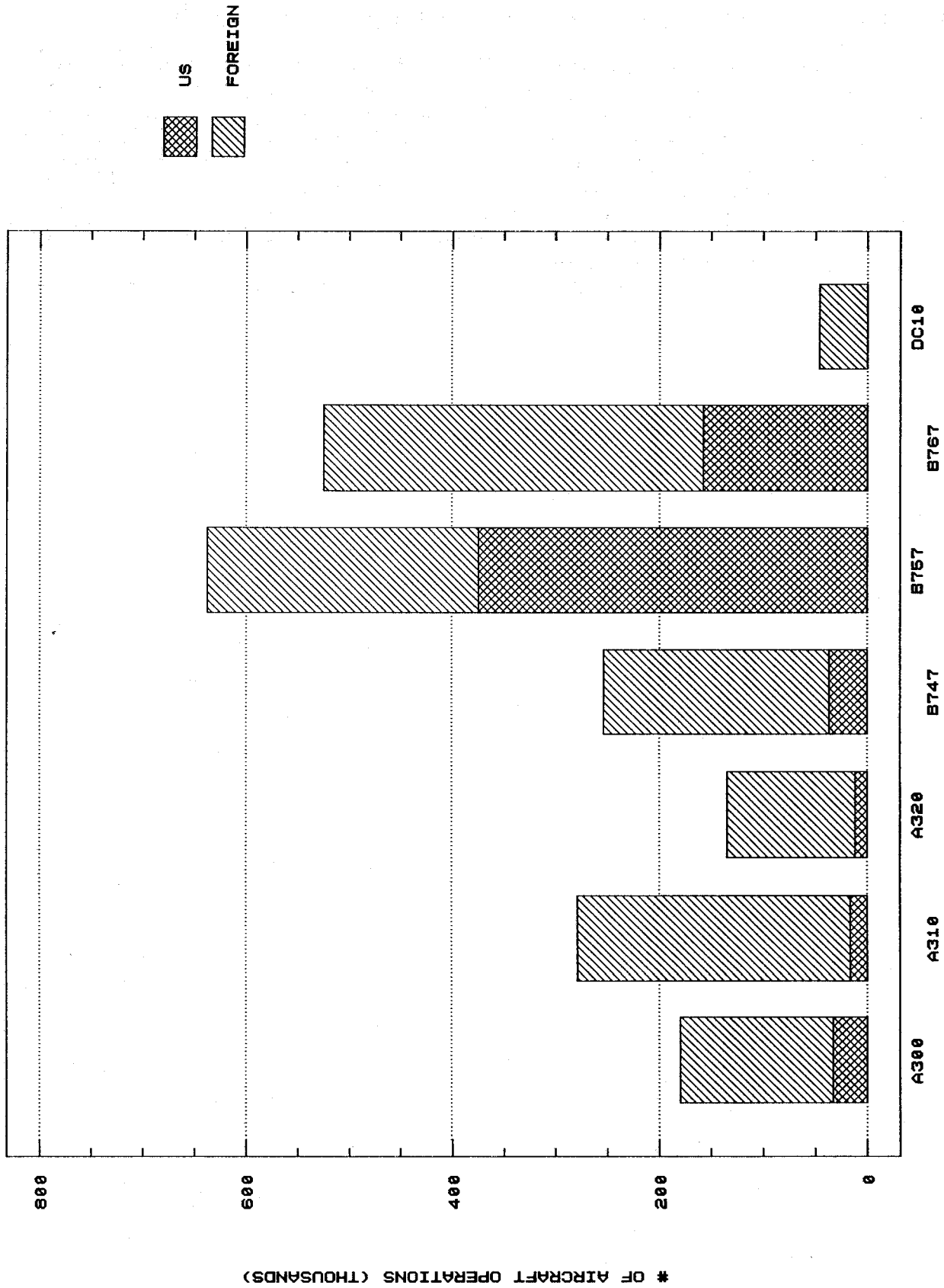


FIGURE 2.2. AIRCRAFT OPERATIONS BY AIRCRAFT TYPE, US/FOREIGN

3. INGESTION EVENTS AND RATES.

In this section various types of bird ingestion events are defined and their frequencies of occurrence are discussed. Although the current study attempts to document all incidents of bird ingestions into the requisite engines, it is likely that many such occurrences remain undiscovered or go unreported. It should be emphasized that only "reported" bird ingestions can be discussed here.

An "aircraft ingestion event" (usually abbreviated as "aircraft ingestion" or "aircraft event") occurs when one or more birds are simultaneously ingested into one or more engines of an aircraft during an aircraft operation. (See Glossary for formal definition.)

Three hundred and eighty-one (381) aircraft events are reported on herein. One of these was a foreign event in which the aircraft type is unknown. Figure 3.1 depicts the aircraft type for the remaining 380 events and indicates whether they occurred inside or outside the United States. This latter information is unknown for 14 of the events. Of those remaining, only 34 occurred in the United States while 333 were foreign. There were no reported United States ingestions for the A300 aircraft and only one for the A310. (The DC10 also had no United States ingestions since it flew no United States operations configured with JT9D-59A engines.) There appears to be a disproportionately small number of United States ingestion events.

It is more meaningful, however, to consider the number of ingestions relative to the frequency of exposure. An "ingestion rate" is obtained by dividing a quantity of ingestion events by the corresponding number of operations. Figure 3.2 is a histogram of reported aircraft ingestion rates for each aircraft type, broken down by United States, foreign, and worldwide categories. As is customary, these rates are expressed in units of ingestions per 10,000 aircraft operations. Only the A320 and B747 had reported United States ingestion rates greater than two, with the latter's actually being more than its foreign counterpart. The A300, A310, B757, and B767 all had substantially higher foreign ingestion rates than domestic. Surprisingly, the only four-engine aircraft (B747) had a lower worldwide ingestion rate than four other aircraft types.

Table 3.1 summarizes aircraft ingestions, operations, and ingestion rates according to aircraft type and United States/foreign/worldwide. The numbers therein were used to generate figures 2.2, 3.1, and 3.2. The reported worldwide ingestion rate for the entire fleet is currently 1.85 (per 10,000 operations), compared to 2.33 in 1981-83 [1]. The current foreign rate, 2.34, is more than four times the domestic rate of 0.54. In the 1981-83 study [1], the foreign rate was approximately 2.5 times the domestic rate. Two possible explanations for this disparity are that (1) bird control measures have been relatively more effective over the past decade at domestic airports than at airports outside the United States, and (2) foreign carriers are presently more diligent than domestic carriers in reporting bird ingestions. It is conceivable that the spate of mergers and bankruptcies among domestic carriers has been a contributing factor to the low United States ingestion rate. For example, one bankrupt major domestic carrier, which has since ceased flying altogether, reported no bird ingestions although it flew a considerable number of operations during the reporting period with aircraft included in this study.

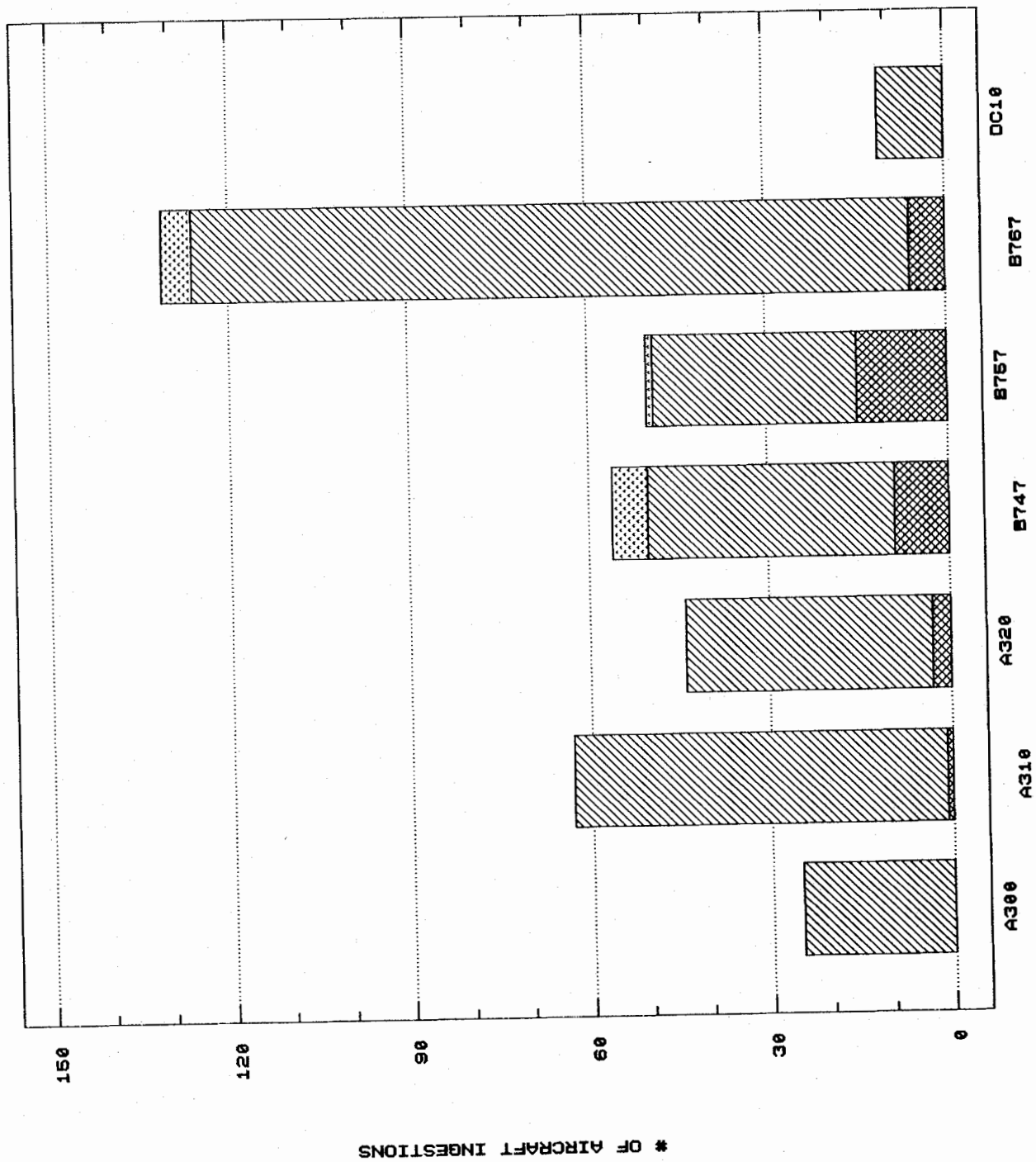


FIGURE 3.1.1. AIRCRAFT INGESTIONS BY AIRCRAFT TYPE, US/FOREIGN

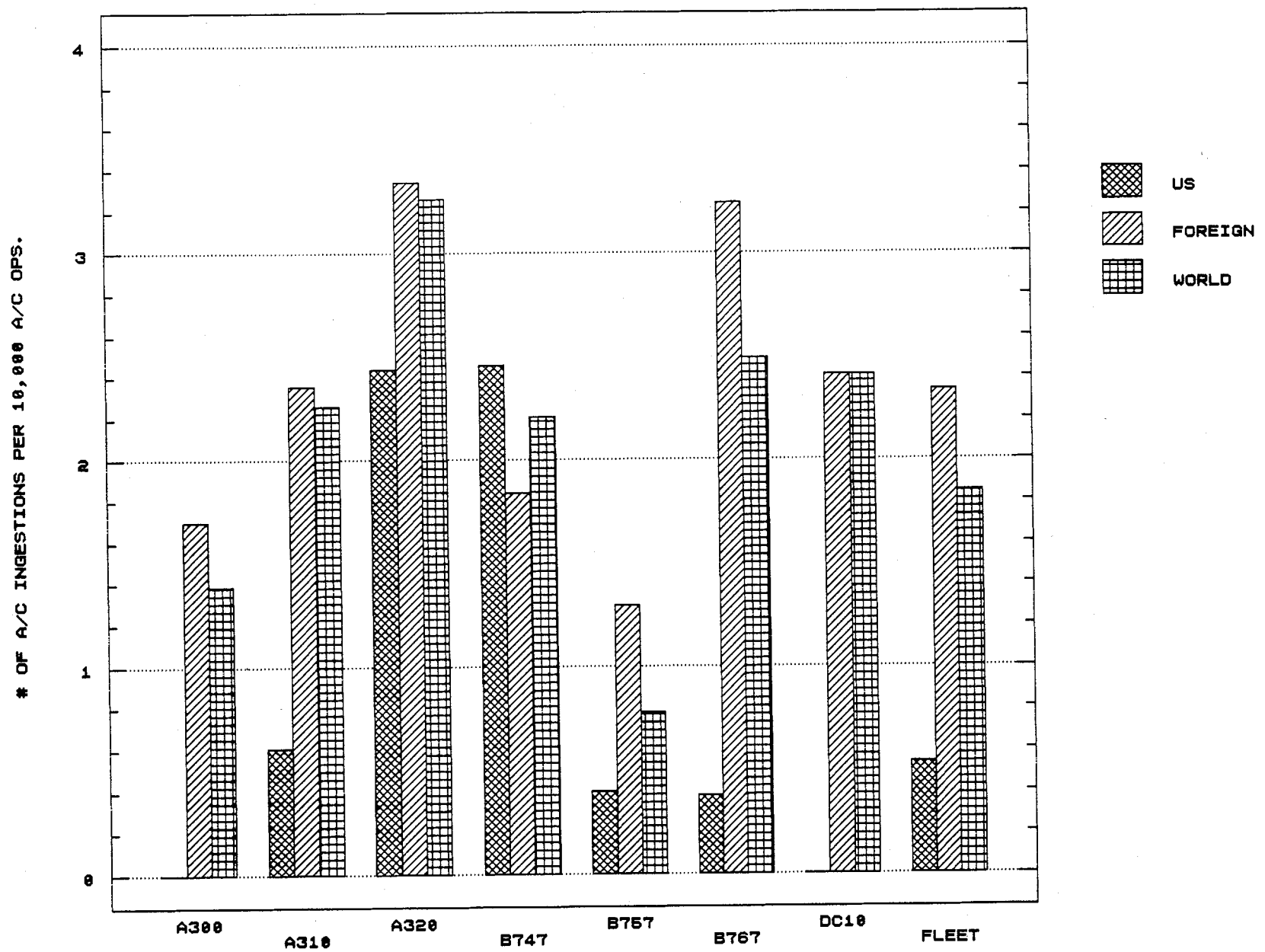


FIGURE 3.2. INGESTION RATES BY AIRCRAFT TYPE, US/FOREIGN/WORLDWIDE

TABLE 3.1. OPERATIONS, INGESTIONS AND INGESTION RATES BY AIRCRAFT TYPE

	AIRCRAFT INGESTIONS				US	AIRCRAFT OPERATIONS			INGESTION RATES (PER 10,000 OPS.)		
	US	FOR	UNK	WW		FOR	WW	US	FOR	WW	
A300	0	25	0	25	32,824	147,064	179,888	0.00	1.70	1.39	
A310	1	62	0	63	16,333	262,678	279,012	0.61	2.36	2.26	
A320	3	41	0	44	12,276	122,633	134,909	2.44	3.34	3.26	
B747	9	40	7	56	36,624	217,121	253,745	2.46	1.84	2.21	
B757	15	34	1	50	375,117	262,689	637,806	0.40	1.29	0.78	
B767	6	119	6	131	158,279	367,366	525,645	0.38	3.24	2.49	
DC10	0	11	0	11	0	45,671	45,671	-	2.41	2.41	
unk a/c	0	1	0	1							
TOTALS	34	333	14	381	631,453	1,425,222	2,056,676	0.54	2.34	1.85	

Because of the staggered start of data collection, any attempt to derive seasonal effects on the bird ingestion phenomenon by simply counting monthly aircraft ingestions could prove misleading. Again, it makes more sense to look at ingestion rates. Figure 3.3 plots reported worldwide ingestion rates by month and year for each of the 21 months of data. In general, the rates are highest from June to October and lowest in December and January. Strictly speaking, this does not show seasonal effects since aircraft operations could not be broken down according to hemisphere. However, only 27 of the 381 aircraft events are known to have occurred in the Southern Hemisphere and the preponderance of aircraft operations were in the Northern Hemisphere.

Some indication of the phase of flight during which an ingestion took place was given for 225 of the 381 aircraft events. Figure 3.4 summarizes these data as reported by the engine manufacturers. All but one event (a cruise) involved a flight phase near an airport. The aircraft ingestions are fairly equally divided between departure (102) and arrival (118) phases. Sixty-two (62) of the former events and 55 of the latter took place on the runway.

In 16 aircraft events, more than one engine of the aircraft ingested a bird, i.e., there were 16 "multiple engine events." All of these involved two engines of the aircraft. Figure 3.5 illustrates, according to aircraft type, both the frequencies and rates of multiple engine ingestion events, worldwide. The rates are given in units of ingestions per million aircraft operations. The aircraft in four of the multiple engine events were B747's while the remaining 12 events involved both engines of two-engine aircraft. The B747 multiple engine ingestion rate is slightly over twice the composite rate for all two-engine aircraft. The current overall fleet multiple ingestion rate of 7.82 is roughly 80 percent of the 9.86 rate in the previous study [1]. Multiple engine ingestion events are of particular interest because they are a prerequisite for the loss of an aircraft due to bird ingestion. They are summarized, along with other types of events to be discussed later in this section, in table 3.2.

Since 397 different engines ingested one or more birds, a total of 397 "engine ingestion events" (usually abbreviated as "engine events" or "engine ingestions") occurred during the reporting period. (See Glossary for formal definition.)

When more than one bird is ingested into an engine, the corresponding aircraft and engine ingestion events are called "multiple bird aircraft events" and "multiple bird engine events," respectively. There were 35 multiple bird engine events. Specific numbers of birds that were ingested in these events are discussed in Section 4. In 29 aircraft events, at least one engine of the aircraft ingested more than one bird; i.e., there were 29 multiple bird aircraft events. Of these, eight were also multiple engine events.

Each multiple engine or multiple bird aircraft event falls into precisely one of the following categories: single engine-multiple bird (SEMB), multiple engine-multiple bird (MEMB), and multiple engine-single bird (MESB). These are all considered to be "significant events." Other events defined to be "significant" in this study are involuntary power loss, transverse fracture of a fan blade, and airworthiness effects. The last category encompasses any flight safety-related incident not covered by the previous categories.

Table 3.2 summarizes, in chronological order, the 42 significant events that were reported. The 16 multiple engine events are seen to be evenly split between

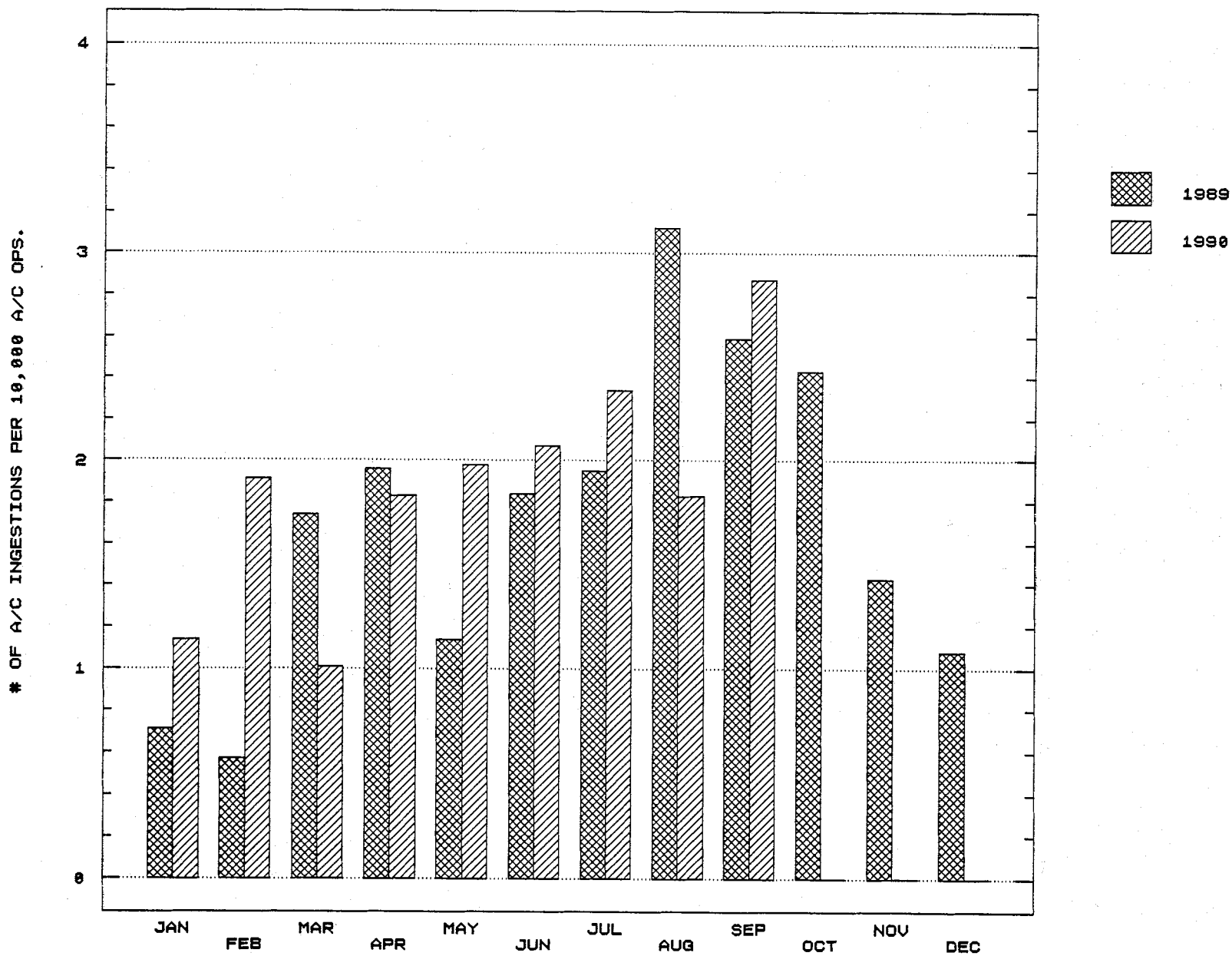


FIGURE 3.3 WORLDWIDE INGESTION RATES BY MONTH AND YEAR

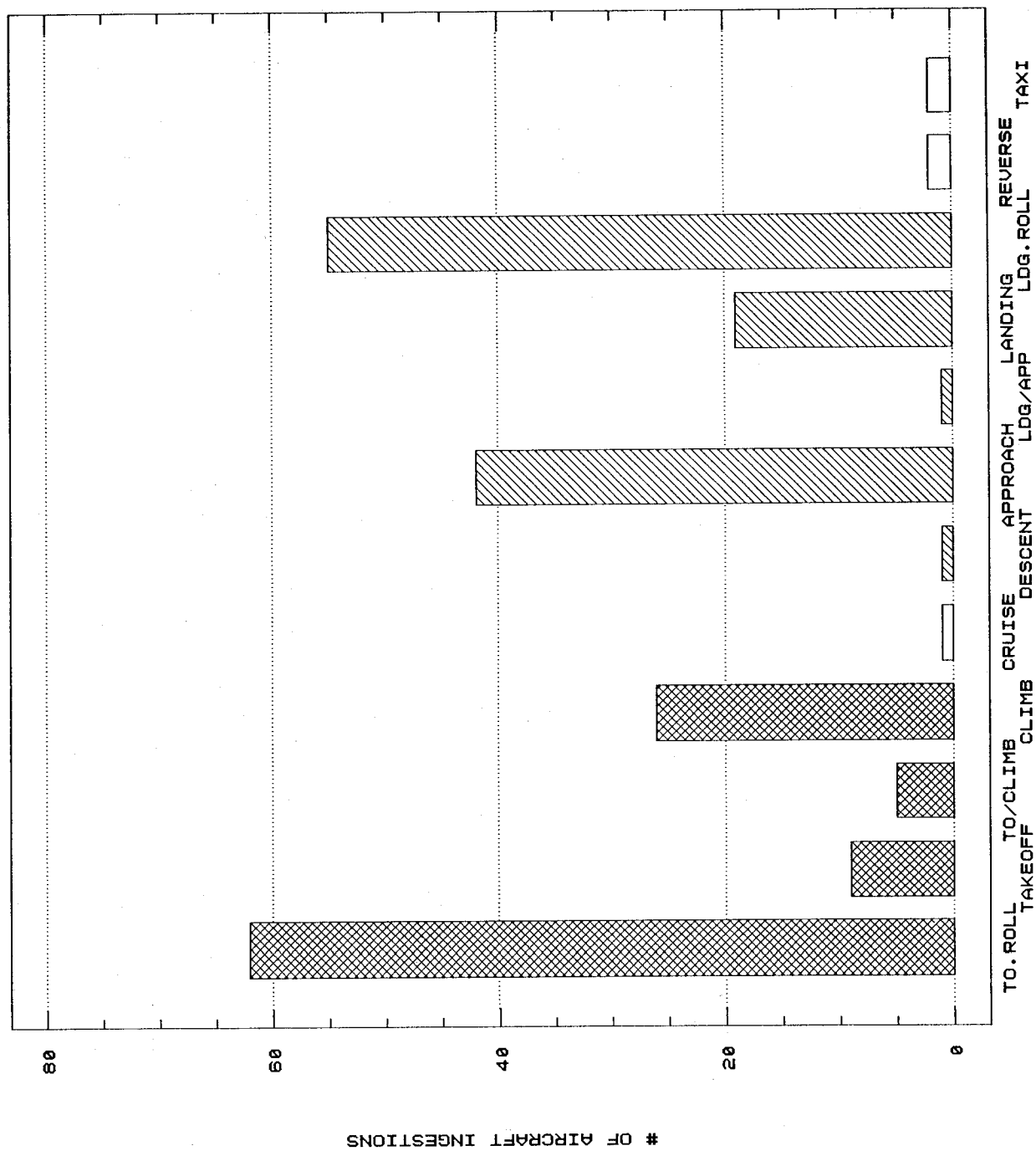


FIGURE 3.4. AIRCRAFT INGESTIONS BY PHASE OF FLIGHT

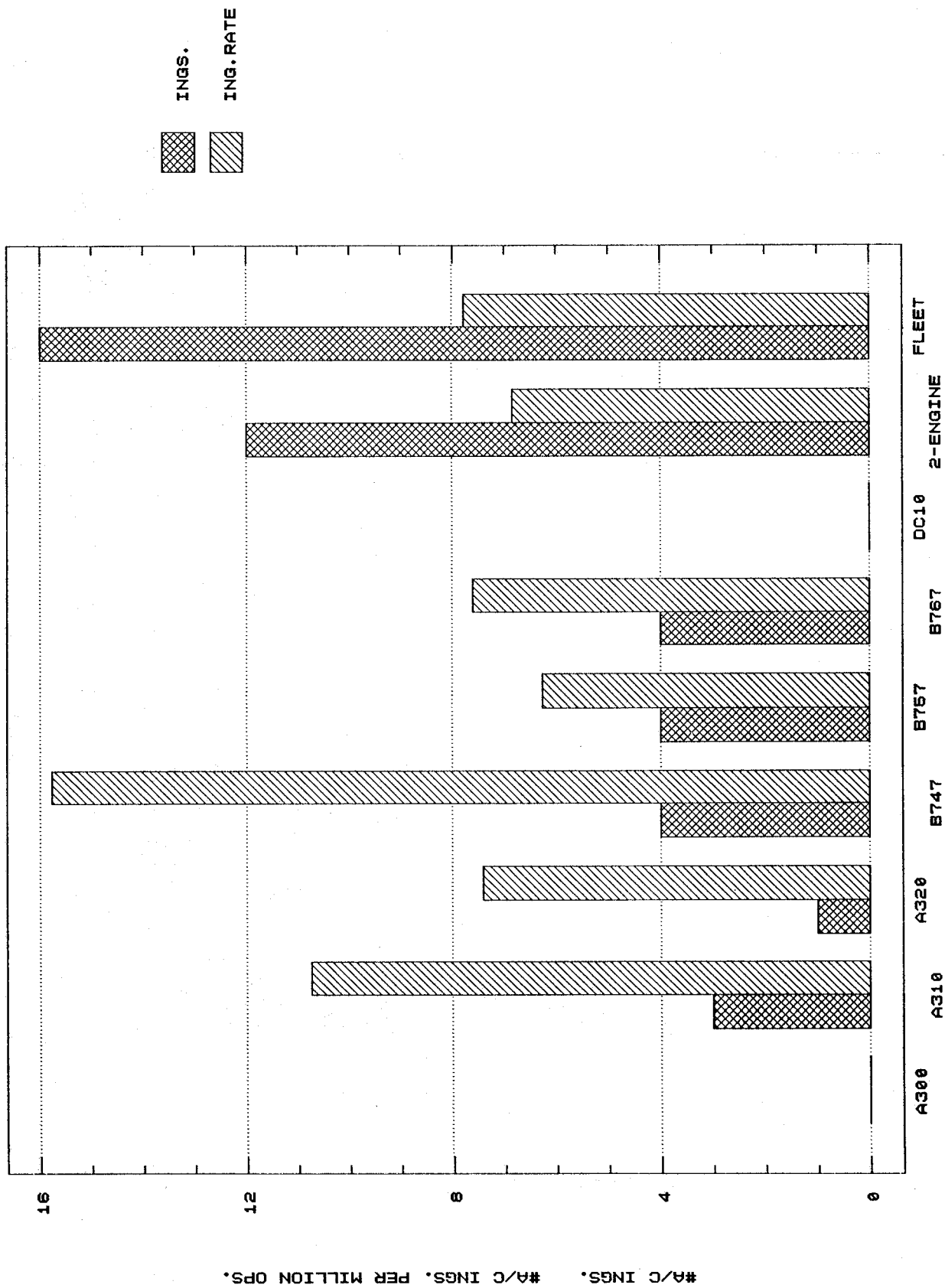


FIGURE 3.5. MULTIPLE ENGINE INGESTIONS AND INGESTION RATES BY AIRCRAFT TYPE

TABLE 3.2. SIGNIFICANT EVENTS

EVT#	DATE	A/C	ENGINE	SIGNIFICANT EVENT	US/FOR	POF
1	01/24/89	B757	RB211 535C	MESB	FOR	TR
16	03/12/89	B747	JT9D 70A	AIRWORTHY	FOR	CL
17	03/13/89	A310	4000 4152	SEMB	FOR	AP
24	04/18/89	B767	JT9D 7R4D	MESB	FOR	
168	05/02/89	B747	JT9D 7R4G2	SEMB		
31	05/04/89	B767	JT9D 7R4D	SEMB	FOR	TR
32	05/10/89	A300	JT9D 59A	SEMB, INVOLUNTARY POWER LOSS	FOR	TR
39	06/18/89	B747	JT9D 7R4G2	AIRWORTHY	FOR	CL
72	07/19/89	B767	CF6 80C2	SEMB	FOR	TR
140	07/25/89	A320	V2500 A1	SEMB	FOR	TR
74	08/13/89	A310	CF6 80C2	SEMB	FOR	TR
75	08/14/89	B767	CF6 80C2	TRANSVERSE FRACTURE	FOR	CL
171	08/31/89	B747	4000 4056	MEMB	US	LR
138	09/12/89	B747	JT9D 7Q	MEMB, TRANSVERSE FRACTURE	US	TR
151	10/04/89	B767	4000 4060	SEMB		
112	10/07/89	B757	RB211 535C	MESB	FOR	LD
150	10/07/89	B767	4000 4060	SEMB	FOR	
152	10/12/89	B767	JT9D 7R4D	MEMB	FOR	TR
155	10/19/89	B767	4000 4060	SEMB	FOR	LR
102	10/21/89	B747	CF6 80C2	MESB	FOR	CL
103	10/23/89	A310	CF6 80C2	SEMB, TRANSVERSE FRACTURE	FOR	TR
158	11/02/89	B767	JT9D 7R4D	SEMB	FOR	AP
115	11/18/89	B757	RB211 535C	SEMB	FOR	LR
85	11/21/89	A320	CFM56 5	MESB	FOR	
97	12/14/89	A310	CF6 80A	MEMB	FOR	LR
116	12/28/89	B757	RB211 535C	SEMB	FOR	TO
184	01/14/90	B767	CF6 80A	SEMB	FOR	LR
219	01/15/90	B767	JT9D 7R4	SEMB	FOR	AP
193	01/16/90	A310	CF6 80C2	MESB	FOR	
244	02/09/90	A310	JT9D 7R4E	MESB	FOR	
226	02/11/90	B747	4000 4056	SEMB		
201	02/21/90	B767	CF6 80C2	MESB	FOR	TR
225	02/21/90	B767	JT9D 7R4D	MEMB	FOR	AP
265	04/06/90	A320	CFM56 5	SEMB	FOR	
292	04/06/90	B767	CF6 80C2	SEMB	FOR	LD
268	05/23/90	A320	CFM56 5	SEMB	FOR	TR
247	05/31/90	A300	JT9D 59A	INVOLUNTARY POWER LOSS	FOR	TR
273	06/14/90	A320	CFM56 5	SEMB	FOR	
214	06/17/90	B757	RB211 535E4	MEMB	US	LD
257	07/30/90	B757	2000 2037	TRANSVERSE FRACTURE	US	CL
323	08/14/90	B757	2000 2037	MEMB	US	TO
382	09/04/90	B747	CF6 80C2	MEMB	FOR	LR

departure and arrival phases of flight. (The acronyms used for phases of flight are defined in appendix C.) Six (6) events are known to have resulted in an involuntary power loss, four of which involved the transverse fracture of a fan blade. All six occurred during departure. In addition there were two "airworthiness" events--one involving extensive cowl damage (event 16) and the other (event 39) resulting in a reduction from the planned flight altitude. Significant events warrant close scrutiny because of their bearing on flight safety and are discussed in further detail in the ensuing sections.

The airport near which the ingestion occurred was able to be identified in 226 (60 percent) of the aircraft events. All told, aircraft ingestions are known to have taken place in the vicinity of 11 domestic and 109 foreign airports during the reporting period. Of the 155 aircraft events in which the associated airport could not be determined, it is known that 14 occurred in the United States and 129 were foreign. Table 3.3 lists all airports at which aircraft ingestions are known to have occurred and tallies the aircraft types involved at each airport. Thirteen of the airports, two of which are in the United States, experienced four or more aircraft ingestions. One of these airports had ten known events and two others each had seven. The airports are organized into eight geographical regions: North America, South America, Europe, Africa, Asia, Australia-New Zealand, Pacific, and Middle East. For this purpose, Japan and Thailand are considered to be in the Pacific region, Korea in Asia, and Cyprus in the Middle East. All remaining airport locations seem to fall naturally into a unique region. XUS (resp. XFO) designates an unknown location known to be in (resp. outside) the United States. XXX indicates a location not known specifically to be domestic or foreign. In two cases, airports designated XXX are known to be in North America.

TABLE 3.3. AIRCRAFT INGESTIONS BY AIRPORT AND AIRCRAFT TYPE

N.AMERICA

AIRPORT	LOCALE	AIRCRAFT							AIRPORT TOTALS
		A	A	A	B	B	B	D	
		3	3	3	7	7	7	C	
		0	1	2	4	5	6	1	
		0	0	0	7	7	7	0	
ANC	ANCHORAGE, ALASKA				1				1
BOS	BOSTON, MASS.					1			1
DCA	WASHINGTON-NATIONAL, DC					1			1
JFK	NEW YORK-JFK, NY				2	1	1		4
LAX	LOS ANGELES, CAL.				1	1	1		3
MCO	ORLANDO, FLORIDA					1			1
MEM	MEMPHIS, TENN.					1			1
ORD	CHICAGO, ILLINOIS				1	1			2
PAE	EVERETT, WASHINGTON				4				4
PIE	ST. PETERSBURGH, FLA.					1			1
SFO	SAN FRANCISCO, CAL.						1		1
XFO	UNKNOWN, CANADA						1		1
XUS	UNKNOWN, US	1	3			7	3		14
XXX	UNKNOWN, N.AMERICA					1	1		2
YUL	MONTREAL, CANADA			1					1
YVR	VANCOUVER, CANADA	1							1
YYZ	TORONTO, CANADA						2		2
REGION TOTALS		0	2	4	9	16	10	0	41

S.AMERICA

AIRPORT	LOCALE	AIRCRAFT							AIRPORT TOTALS
		A	A	A	B	B	B	D	
		3	3	3	7	7	7	C	
		0	1	2	4	5	6	1	
		0	0	0	7	7	7	0	
BUE	BUENOS AIRES, ARGENTINA				1				1
GRU	SAO PAULO, BRAZIL						1		1
IGU	IGUASSA FALLS, BRAZIL						1		1
LIM	LIMA, PERU						1		1
MAO	MANUS, BRAZIL						1		1
REGION TOTALS		0	0	0	1	0	4	0	5

TABLE 3.3. AIRCRAFT INGESTIONS BY AIRPORT AND AIRCRAFT TYPE (Continued)

EUROPE

AIRPORT	LOCALE	AIRCRAFT							AIRPORT TOTALS
		A	A	A	B	B	B	D	
		3	3	3	7	7	7	C	
		0	1	2	4	5	6	1	
		0	0	0	7	7	7	0	
AMS	AMSTERDAM, NETHERLANDS		1		5	1	3		10
BCN	BARCELONA, SPAIN	1							1
BEG	BELGRADE, YUGOSLAVIA			1					1
BFS	BELFAST, N. IRELAND, UK					3			3
BRE	BREMEN, GERMANY		1	1					2
BRU	BRUSSELS, BELGIUM		2	1					3
BSL	BASEL, SWITZERLAND			1		1			2
CDG	PARIS-CDG, FRANCE		2	3	1	1			7
CFU	CORFU, GREECE		1						1
CPH	COPENHAGEN, DENMARK						2		2
DUS	DUSSELDORF, GERMANY		1	3					4
FRA	FRANKFURT, GERMANY			2	1				3
GRQ	GRONINGEN, NETHERLANDS						1		1
GVA	GENEVA, SWITZERLAND					2			2
HAM	HAMBURG, GERMANY		1		1	1			3
HER	HERAKLION, GREECE						1		1
IBZ	IBIZIA, SPAIN	1							1
KEV	KEVLAVICK, ICELAND					1			1
LBA	LEEDS-BRADFORD, ENGLAND, UK		1						1
LGW	LONDON-GATWICK, ENGLAND, UK					1	1		2
LHR	LONDON-LHR, ENGLAND, UK			2		2			4
LIL	LILLE, FRANCE			3					3
LJU	LJUBLJANA, YUGOSLAVIA			1					1
LTN	LONDON-LUTON, ENGLAND, UK						1		1
LXS	LEMNOS, GREECE				1				1
LYS	LYON, FRANCE			2					2
MGQ	MISKOLC, HUNGARY		1						1
MUC	MUNICH, GERMANY						3		3
NCE	NICE, FRANCE		1						1
NTE	NANTES, FRANCE		1						1
ORY	PARIS-ORLY, FRANCE			1			1		2
PIK	PRESTWICK, SCOTLAND, UK		1						1
PMI	PALMA, MALLORCA, SPAIN					2			2
SXF	E. BERLIN, GERMANY		2						2
TIV	TIVAT, YUGOSLAVIA			1					1
TLS	TOULOUSE, FRANCE		2	2					4
VCE	VENICE, ITALY					1			1
VIE	VIENNA, AUSTRIA		1						1
WAW	WARSAW, POLAND						2		2
XFO	UNKNOWN, EUROPE			2	1	6			9
ZRH	ZURICH, SWITZERLAND			1					1
REGION TOTALS		2	19	27	10	22	15	0	95

TABLE 3.3. AIRCRAFT INGESTIONS BY AIRPORT AND AIRCRAFT TYPE (Continued)

PACIFIC									
AIRPORT	LOCALE	AIRCRAFT							AIRPORT TOTALS
		A	A	A	B	B	B	D	
		3	3	3	7	7	7	C	
		0	1	2	4	5	6	1	
		0	0	0	7	7	7	0	
DPS	DENPASAR, BALI	1							1
FUK	FUKUOKA, JAPAN						3	1	4
HIJ	HIROSHIMA, JAPAN						1		1
HND	TOKYO-HND, JAPAN				1		3		4
JKT	JAKARTA, INDONESIA				1				1
KCZ	KOCHI, JAPAN						4		4
KIJ	NIGATA, JAPAN						1		1
MYJ	MATSUYAMA, JAPAN						2		2
NGO	NAGOYA, JAPAN						2	1	3
NRT	TOKYO-NRT, JAPAN				1		1		2
OIT	OITA, JAPAN						1		1
OKA	OKINAWA, JAPAN						1	1	2
OKJ	OKAYAMA, JAPAN						3		3
OSA	OSAKA, JAPAN						2		2
PEN	PENANG, MALAYSIA		2						2
SDJ	SENDAI, JAPAN						3		3
SHI	SHIMOJISHIMA, JAPAN						1		1
SIN	SINGAPORE				1				1
SPK	SAPPORO, JAPAN				1		3	1	5
TAK	TAKAMATSU, JAPAN						1		1
TOY	TOYAMA, JAPAN						3		3
TPE	TAIPEI, TAIWAN				1				1
TYO	TOKYO-TYO, JAPAN						3		3
XFO	UNKNOWN, PACIFIC	1			7		3	4	15
REGION TOTALS		2	2	0	13	0	41	8	66

TABLE 3.3. AIRCRAFT INGESTIONS BY AIRPORT AND AIRCRAFT TYPE (Continued)

ASIA

AIRPORT	LOCALE	AIRCRAFT							AIRPORT TOTALS
		A	A	A	B	B	B	D	
		3	3	3	7	7	7	C	
		0	1	2	4	5	6	1	
		0	0	0	7	7	7	0	
BOM	BOMBAY, INDIA	1		1	1				3
CCU	CALCUTTA, INDIA		1						1
DEL	DELHI, INDIA		1	2	1				4
HKG	HONG KONG				1				1
KHI	KARACHI, PAKISTAN	1	1						2
KTM	KATHMANDU, NEPAL					1			1
KUH	KUSHIRO, INDIA						1		1
PAU	PAUK, BURMA			1					1
PEK	BEIJING, CHINA							1	1
SEL	SEOUL, KOREA	1							1
SHA	SHANGHAI, CHINA	1							1
TRV	TRIVANDRUM, INDIA		1						1
XFO	UNKNOWN, ASIA	1				3			4
REGION TOTALS		5	4	4	3	4	1	1	22

AUSTRALIA-NEW ZEALAND

AIRPORT	LOCALE	AIRCRAFT							AIRPORT TOTALS
		A	A	A	B	B	B	D	
		3	3	3	7	7	7	C	
		0	1	2	4	5	6	1	
		0	0	0	7	7	7	0	
AKL	AUCKLAND, NEW ZEALAND						1		1
BNE	BRISBANE, AUSTRALIA		1						1
LST	LAUNCESTON, AUSTRALIA			1					1
PER	PERTH, AUSTRALIA						1		1
RMA	ROMA, AUSTRALIA			1					1
SYD	SYDNEY, AUSTRALIA			1	1				2
WLG	WELLINGTON, NEW ZEALAND						1		1
REGION TOTALS		0	1	3	1	0	3	0	8

TABLE 3.3. AIRCRAFT INGESTIONS BY AIRPORT AND AIRCRAFT TYPE (Continued)

MIDDLE EAST

AIRPORT	LOCALE	AIRCRAFT							AIRPORT TOTALS
		A	A	A	B	B	B	D	
		3	3	3	7	7	7	C	
		0	1	2	4	5	6	1	
		0	0	0	7	7	7	0	
AMM	AMMAN, JORDAN		1						1
ANK	ANKARA, TURKEY		1						1
AYT	ANTALYA, TURKEY		1						1
DHA	DHAHRAN, SAUDI ARABIA	1							1
ETH	ELAT, ISRAEL						1		1
IST	ISTANBUL, TURKEY		5		1	1			7
JED	JEDDAH, SAUDI ARABIA	2							2
LCA	LARNACA, CYPRUS		3						3
RUH	RIYADH, SAUDI ARABIA	1							1
SHJ	SHARJAH, UA EMIRATES		1				1		2
TLV	TEL AVIV, ISRAEL					1	2		3
XFO	UNKNOWN, MIDDLE EAST	2							2
REGION TOTALS		6	12	0	1	2	4	0	25

AFRICA

AIRPORT	LOCALE	AIRCRAFT							AIRPORT TOTALS
		A	A	A	B	B	B	D	
		3	3	3	7	7	7	C	
		0	1	2	4	5	6	1	
		0	0	0	7	7	7	0	
BJL	BANJUL, GAMBIA		1						1
EBB	ENTEBBE, UGANDA		1						1
HRE	HARARE, ZIMBABWE						1		1
KRT	KHARTOUM, SUDAN	1							1
MBA	MOMBASA, KENYA		2						2
NBO	NAIROBI, KENYA	1					1		2
WDH	WINDHOEK, NAMIBIA				1				1
REGION TOTALS		2	4	0	1	0	2	0	9

4. CHARACTERISTICS OF INGESTED BIRDS.

The numbers, species, and weights of birds that were ingested into the engines are discussed in this section. The bird species and weight were determined by licensed ornithologists upon examination of bird remains recovered from the engines. Numbers of birds were estimated by representatives of the engine manufacturers, usually from the locations and patterns of bird debris in the engines.

Table 4.1 summarizes the data concerning numbers of birds ingested. Three hundred and five (305) of the engine ingestions involved only a single bird while 35 were determined to be multiple bird events. Some estimate of the number of birds ingested was obtained in 342 of the 397 engine events. In 19 of these events the exact number could not be determined but rather a minimum and/or maximum number was given. Four or more birds are known to have been ingested six times. Four of these events were foreign and the other two occurred in a B747 multiple engine-multiple bird ingestion of 14-ounce common rock doves at Los Angeles (event 138). (See Section 5.) Estimates of bird numbers were given as "one or more" for two engine ingestions. It therefore remains undetermined whether these events (154 and 159) were single or multiple bird ingestions.

Despite considerable effort by the data collectors, bird remains were recovered in only 119 of the 381 aircraft events. To date, identifications have been made, each yielding a unique species and weight, in 105 of these aircraft events. Sixteen of these are domestic events and 87 are foreign. It could not be determined whether the ingestion took place inside or outside the United States in two events for which a species identification was made. These are event 137 (a 1.5-ounce horned lark) and event 130 (a 10-ounce black-headed gull).

Table 4.2 summarizes the data regarding bird species. The species codes are taken from reference 4. The number of aircraft ingestions (United States, foreign, and worldwide) are tallied for each species known to have been ingested. Since weights for a given species can vary according to sex, maturity, and geographical location, the modal (most common) estimated ingested weight and the range of estimated weights are also given for each species. The table is ordered by modal weight. Also indicated is the number of single engine-multiple bird (SEMB), multiple engine-single bird (MESB) and multiple engine-multiple bird (MEMB) aircraft events in which each species was involved. The common lapwing, black-headed gull, common rock dove and herring gull were the most frequently identified species. Together they account for 31 percent of the aircraft ingestions in which a verified species was obtained. The "multiple events" column indicates that the common lapwing, black-headed gull, and herring gull are also the most pervasive flocking bird species being encountered. The initial two species are "small" birds, having modal weights of 8 and 10 ounces, while the herring gull modal weight is 40 ounces. Two "bat" events of 0.3 and 0.5 ounces are included in the data, the latter being a multiple engine event (24).

All 105 verified bird weights are tabulated in table 4.3. The unique weights are listed in ascending order, and the number of United States, foreign, and worldwide aircraft ingestions are given for each. Summary statistics (as defined in appendix B) are given in table 4.4 for each of these three geographical weight groupings. The mean, median, and mode for domestic weights are each seen to be larger than their foreign counterparts.

TABLE 4.1. NUMBERS OF INGESTED BIRDS

# OF BIRDS	US	FOREIGN	UNKNOWN	WORLDWIDE
1	24	276	5	305
2	0	12	0	12
3	0	4	0	4
4	1	1	0	2
1 OR MORE	0	2	0	2
2 OR MORE	4	6	3	13
5 OR MORE	1	0	0	1
6 TO 17	0	2	0	2
4 TO 5	1	0	0	1
UNKNOWN	7	44	4	55
TOTALS	38	347	12	397

TABLE 4.2. BIRD SPECIES

SPECIES	SPECIES CODE	MODAL WT(OZ.)	WEIGHT RANGE(OZ.)	US/FOR/WW			MULTIPLE EVENTS
LITTLE BROWN BAT	BAT	0.3,0.5	0.3-0.5	0	2	2	1MESB
DON-SMITH'S NIGHTJAR	5T55	1.25		0	1	1	
FORK-TAILED SWIFT	1U70	1.5		0	1	1	
CHIMNEY SWIFT	1U33	1,2	1-2	0	2	2	
COMMON SKYLARK	17Z72	1.5,2	1.5-2	0	2	2	
HORNED LARK	17Z74	1.5,2	1.5-2	0	1	2	1SEMB
AMERICAN ROBIN	41Z314	2.5	2.5	2	0	2	
SCHRENDK'S BITTERN	1I9	3		0	1	1	
WHT-THT'D NDLE-TLD SWIFT	1U?	3		0	1	1	
KILLDEER	5N33	3		0	1	1	
COMMON NIGHT HAWK	5T5	3		1	0	1	
MOURNING DOVE	2P105	4		1	0	1	
AMERICAN KESTREL	5K26	4		1	0	1	
RING-NECKED DOVE	2P61	5		0	1	1	
COMMON SNIPE	6N47	5		0	1	1	
SENEGAL COUCAL	2R127	7		0	1	1	1SEMB
BANDED PLOVER	5N23	7		0	1	1	
COMMON LAPWING	5N1	7.7,8	7.7-8	0	8	8	2SEMB 2MESB
EURASIAN KESTREL	5K27	8	7.2-8	0	4	4	
GREATER KESTREL	5K24	9.6		0	1	1	
BLACK-HEADED GULL	14N36	10	10	0	6	7	2SEMB 2MEMB
GRAY-HEADED LAPWING	5N20	10	10	0	2	2	1SEMB
RED-BILLED GULL	14N?	11		0	1	1	
COMMON BARN OWL	1S2	11	11	0	2	2	
COMMON ROCK DOVE	2P1	14	10	1	7	8	1MEMB
HUNGARIAN PARTRIDGE	4L85	14	14	0	2	2	1SEMB
COMMON SAND MARTIN	18Z29	16		0	1	1	
RED-LEGGED PARTRIDGE	4I41	16		0	1	1	
EURASIAN STONE CURLEW	6N?	16		0	1	1	1SEMB
RING-BILLED GULL	14N12	17	17	1	1	2	
LITTLE EGRET	1I50	17		0	1	1	
CHUKAR	4L37	18	18	0	2	2	1MEMB
CARRION CROW	22Z94	19		0	1	1	
BLACK-TAILED GULL	14N10	21		0	1	1	
BLACK-CROWNED NITE HERON	1I24	24	24	1	2	3	
AFRICAN EAGLE OWL	2S44	26		0	1	1	
BLACK KITE	3K28	28	28-32	0	5	5	
COMMON POCHARD	2J115	35		0	1	1	1SEMB
GREATER SCAUP	2J124	36		0	1	1	1MEMB
HERRING GULL	14N14	40	32-40	3	7	10	2SEMB 1MEMB
MALLARD DUCK	2J84	40		0	1	1	
RING-NECKED PHEASANT	4L161	40	32-40	2	2	4	1MEMB
WESTERN GULL	14N19	40.4		1	0	1	
JAR FALCON	5N??	46.4		0	1	1	
GLAUCOUS-WINGED GULL	14N22	48		0	1	1	
BLACK VULTURE	1K4	48	48	0	2	2	
HELMETED GUINEA FOWL	5L3	52		0	1	1	
OSPREY	2K1	55		1	0	1	
EGYPTIAN VULTURE	3K43	75	75	0	2	2	
AFRICAN FISH EAGLE	3K??	100		0	1	1	
CANADA GOOSE	2J30	128		1	0	1	
INDIAN WHT-BCKD VULTURE	3K46	192		0	1	1	
TOTALS				16	87	105	

TABLE 4.3. BIRD WEIGHTS BY US/FOREIGN/WORLDWIDE

BIRD WEIGHT	US	FOREIGN	UNKNOWN	WORLDWIDE
0.3		1		1
0.5		1		1
1		1		1
1.25		1		1
1.5		2	1	3
2		3		3
2.5	2			2
3	1	3		4
4	2			2
5		2		2
7		3		3
7.2		1		1
7.7		4		4
8		6		6
9.6		1		1
10		8	1	9
11		3		3
14	1	9		10
16		3		3
17	1	2		3
18		2		2
19		1		1
21		1		1
24	1	2		3
26		1		1
28		3		3
32	1	4		5
34		1		1
35		1		1
36		2		2
40	4	6		10
40.4	1			1
46.4		1		1
48		3		3
52		1		1
55	1			1
75		2		2
100		1		1
128	1			1
192		1		1
TOTALS	16	87	2	105

TABLE 4.4. BIRD WEIGHT SUMMARY STATISTICS - CURRENT STUDY

STATISTIC	US	FOREIGN	WORLDWIDE
SAMPLE SIZE	16	87	105
MEAN	30.4	21.8	22.8
MEDIAN	28	14	14
MODE	40	14	40
STD. DEVIATION	31.4	26.0	26.8
MINIMUM	2.5	0.3	0.3
MAXIMUM	128	192	192
LOWER QUARTILE	4	7.7	7.7
UPPER QUARTILE	40	32	32

TABLE 4.5. BIRD WEIGHT SUMMARY STATISTICS - 1981-83 STUDY

STATISTIC	US	FOREIGN	WORLDWIDE
SAMPLE SIZE	57	185	258
MEAN	29.7	26.6	26.9
MEDIAN	32	18	19
MODE	40	24	40
STD. DEVIATION	21.4	35.4	31.8
MINIMUM	1	1	1
MAXIMUM	112	240	240
LOWER QUARTILE	14	11	11
UPPER QUARTILE	40	28	32

Summary statistics from the 1981-83 study corresponding to those in table 4.4 are given in table 4.5. (Since only verified weights are considered in this report, the numbers in table 4.5 vary somewhat from those in reference 1.) Similarities between bird weights from the two studies are evident upon comparing these tables. The mean, median, and modal weights for all three geographic categories are, in general, within a few ounces of each other. In both studies the United States bird weights are, in terms of these summary statistics, larger than the foreign bird weights.

It should be noted that two additional unverified bird weights, each of 8 ounces, were reported in the current study. They were for events 13 and 265 and were based on visual observation of birds at the ingestion site. Since visual weight estimates are notoriously inaccurate, these weights were not included in the above tables or in any analysis.

For analytical purposes, each bird weight was assigned a weight class as defined in table 4.6. The first class (tiny birds) includes all weights of 3 ounces or less. The remaining weights were grouped into successive 8-ounce intervals as indicated. For example, the 0.5-pound class contains all weights greater than 3 ounces and less than or equal to 11 ounces. This scheme was chosen because it distinguishes between and yields intervals "centered" around 1.5, 2, and 2.5 pounds, weights which are significant in terms of current and proposed certification standards.

The 105 verified bird weights fall into 12 distinct weight classes. Figure 4.1 indicates the frequency of aircraft ingestions of United States, foreign, and unknown origin for each of these weight classes. The vast majority of bird weights fall into the smallest three weight classes (tiny, 0.5 pound, and 1 pound) and relatively few are in the 1.5-pound class. There are, however, a significant number in the 2-pound and 2.5-pound classes. Indeed, the 2.5-pound weight class contains more domestic bird weights (5) than any other class. Four of these events occurred at Kennedy International Airport in New York (68, 98, 263, and 323) and the other (257) at Los Angeles International Airport.

Figure 4.2 plots the cumulative distribution functions (see appendix B) for both United States and foreign bird weights. The two distributions diverge between 10 and 40 ounces, with a larger percentage of foreign bird weights falling into this range. However, apparently because of the sparse number of United States weights, an application of the Kolmogoroff-Smirnov Two-Sample Test (see appendix B) yields $P = 24$ percent and, thus, fails to show that the domestic and foreign bird weight sample distributions are indeed statistically different at a sufficiently high confidence level. (The corresponding distributions were shown to be different by this two-sample test in the previous FAA large engine study, reference 1.)

It is interesting to make further comparisons between bird weights from the two studies. Plots comparing the United States, foreign, and worldwide cumulative bird weight distributions from both studies are contained in figure 4.3. Similarities between the corresponding distributions are evident. It turns out to be more enlightening, however, to compare relative frequency histograms of weight distributions. This is done in figure 4.4(a) for domestic weights and figure 4.4(b) for foreign. Only the nine weight classes up to 4 pounds, as defined in table 4.5, are included in these figures since ingestions of weights over 4 pounds are very rare. In each case, the similarities are notable. Both

TABLE 4.6. BIRD WEIGHT CLASSES - DEFINITIONS

WEIGHT RANGE(oz.)	WEIGHT CLASS(lbs.)
3 or less	Tiny
3+ to 11	.5
11+ to 19	1
19+ to 27	1.5
27+ to 35	2
35+ to 43	2.5
43+ to 51	3
51+ to 59	3.5
59+ to 67	4
67+ to 75	4.5
75+ to 83	5
83+ to 91	5.5
91+ to 99	6
99+ to 107	6.5
107+ to 115	7
115+ to 123	7.5
123+ to 131	8
131+ to 139	8.5
139+ to 147	9
147+ to 155	9.5
155+ to 163	10
163+ to 171	10.5
171+ to 179	11
179+ to 187	11.5
187+ to 195	12

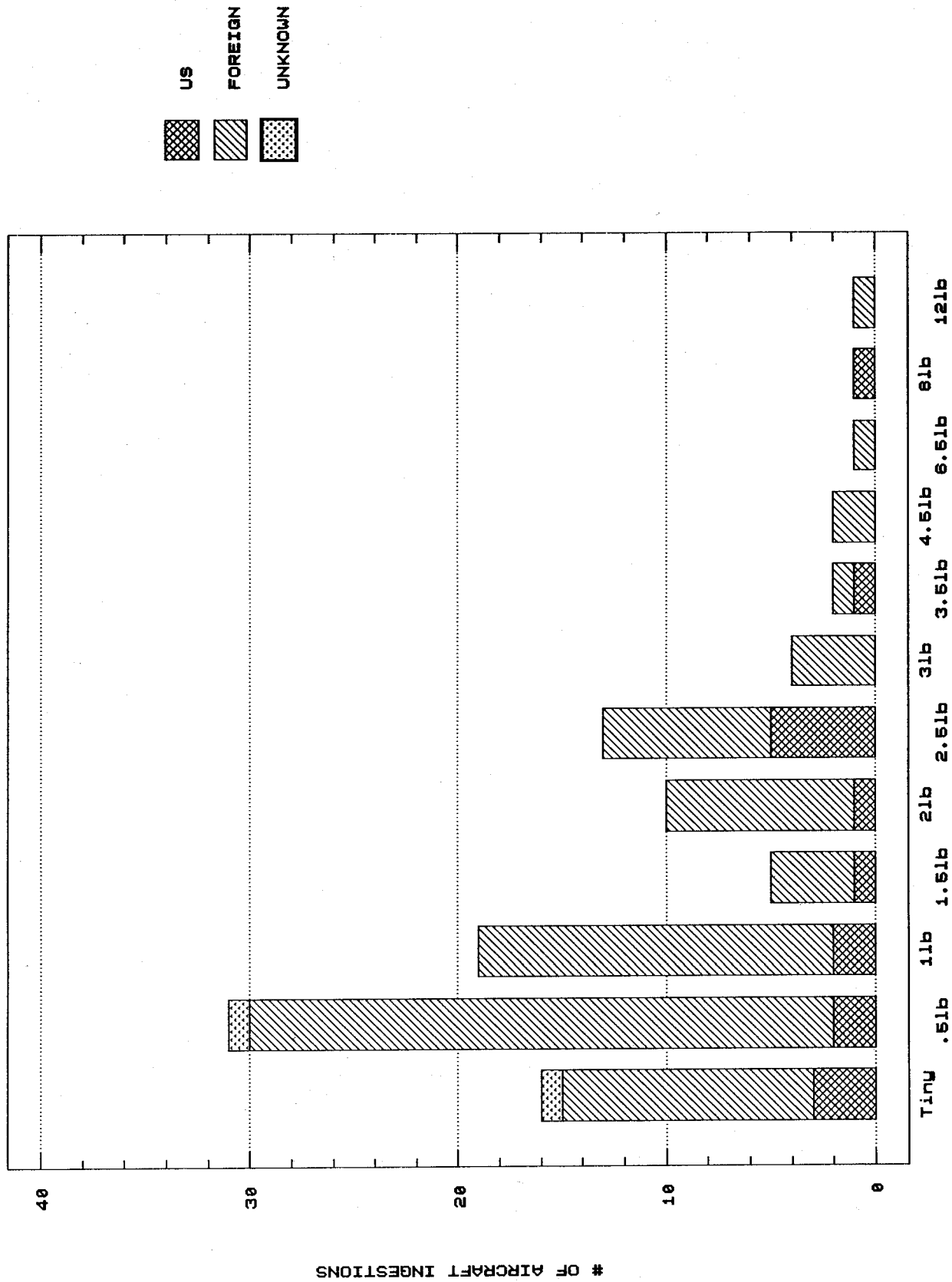


FIGURE 4.1. AIRCRAFT INGESTIONS BY BIRD WEIGHT CLASS, US/FOREIGN

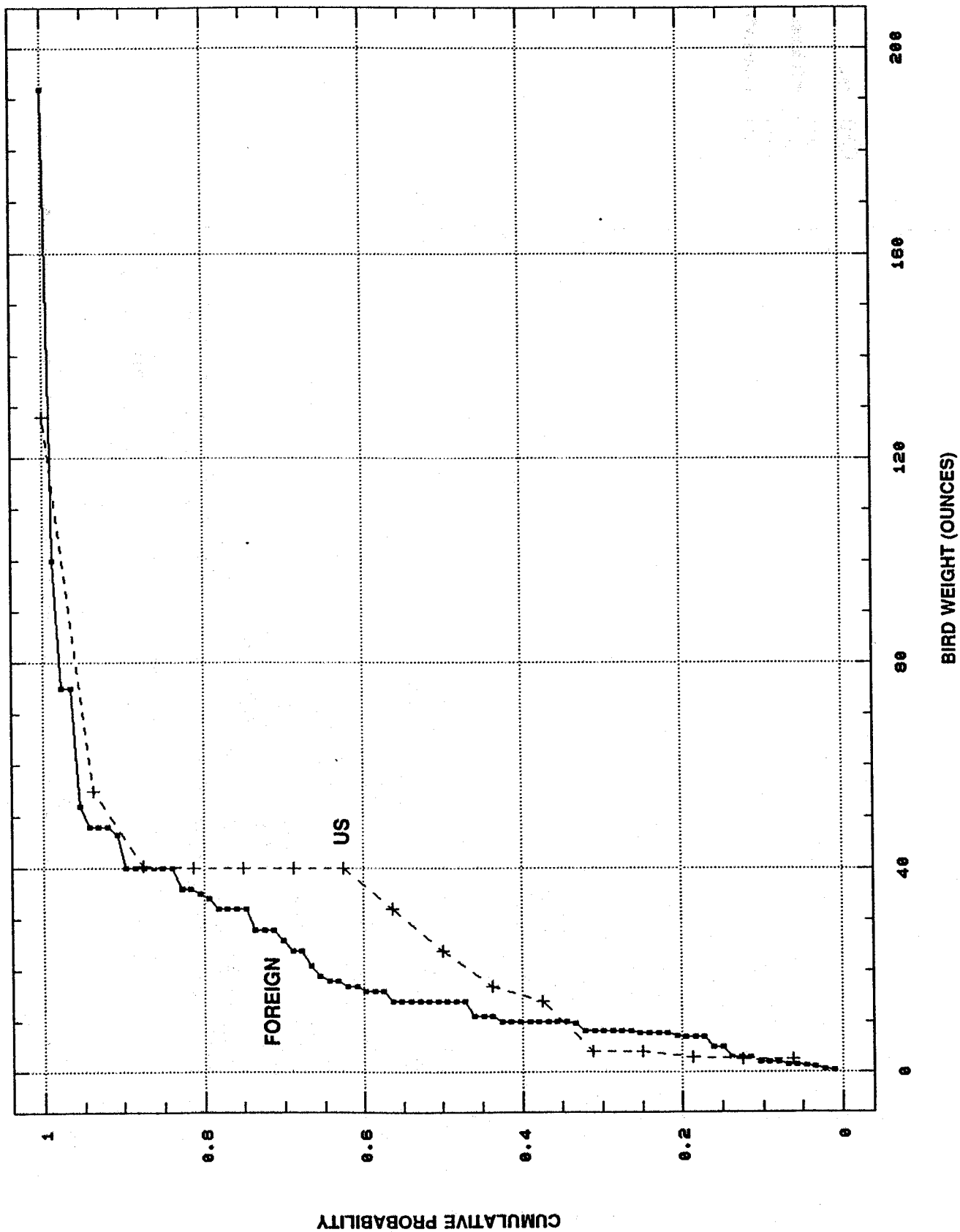


FIGURE 4.2. CUMULATIVE BIRD WEIGHT DISTRIBUTIONS - US VERSUS FOREIGN

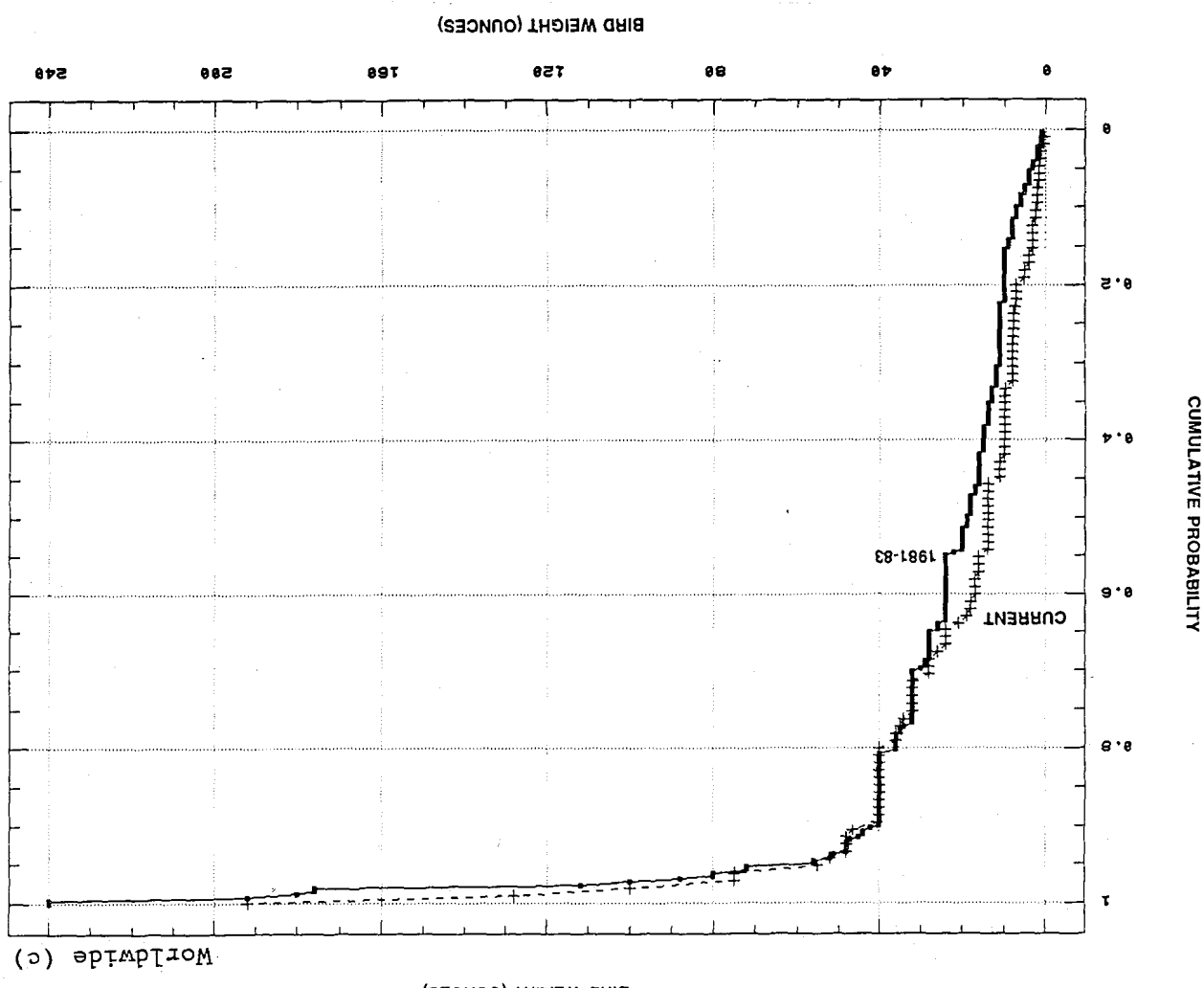
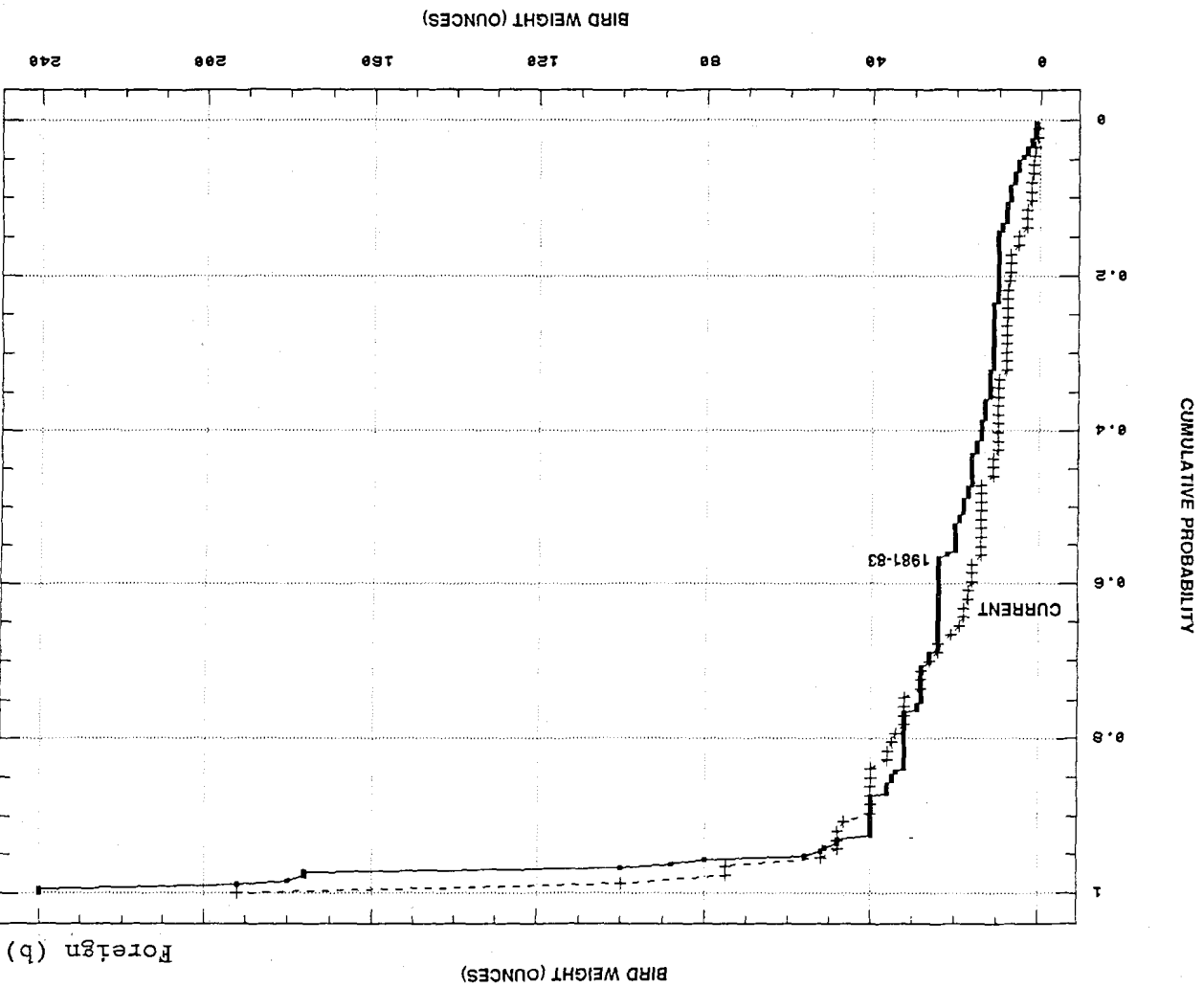
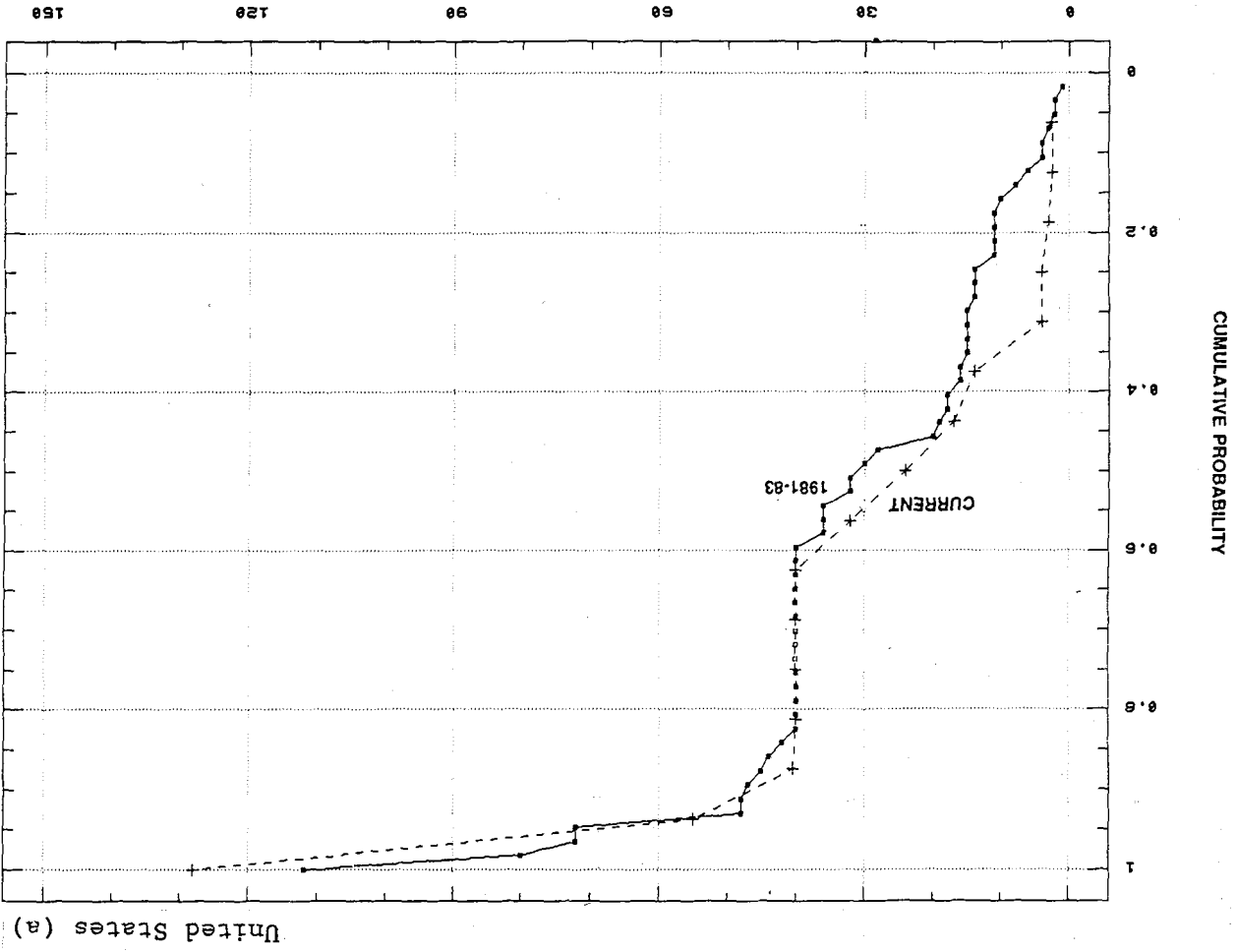


FIGURE 4.3. CUMULATIVE BIRD WEIGHT DISTRIBUTIONS - CURRENT VERSUS 1981-83 STUDY - US/FOREIGN/WORLDWIDE

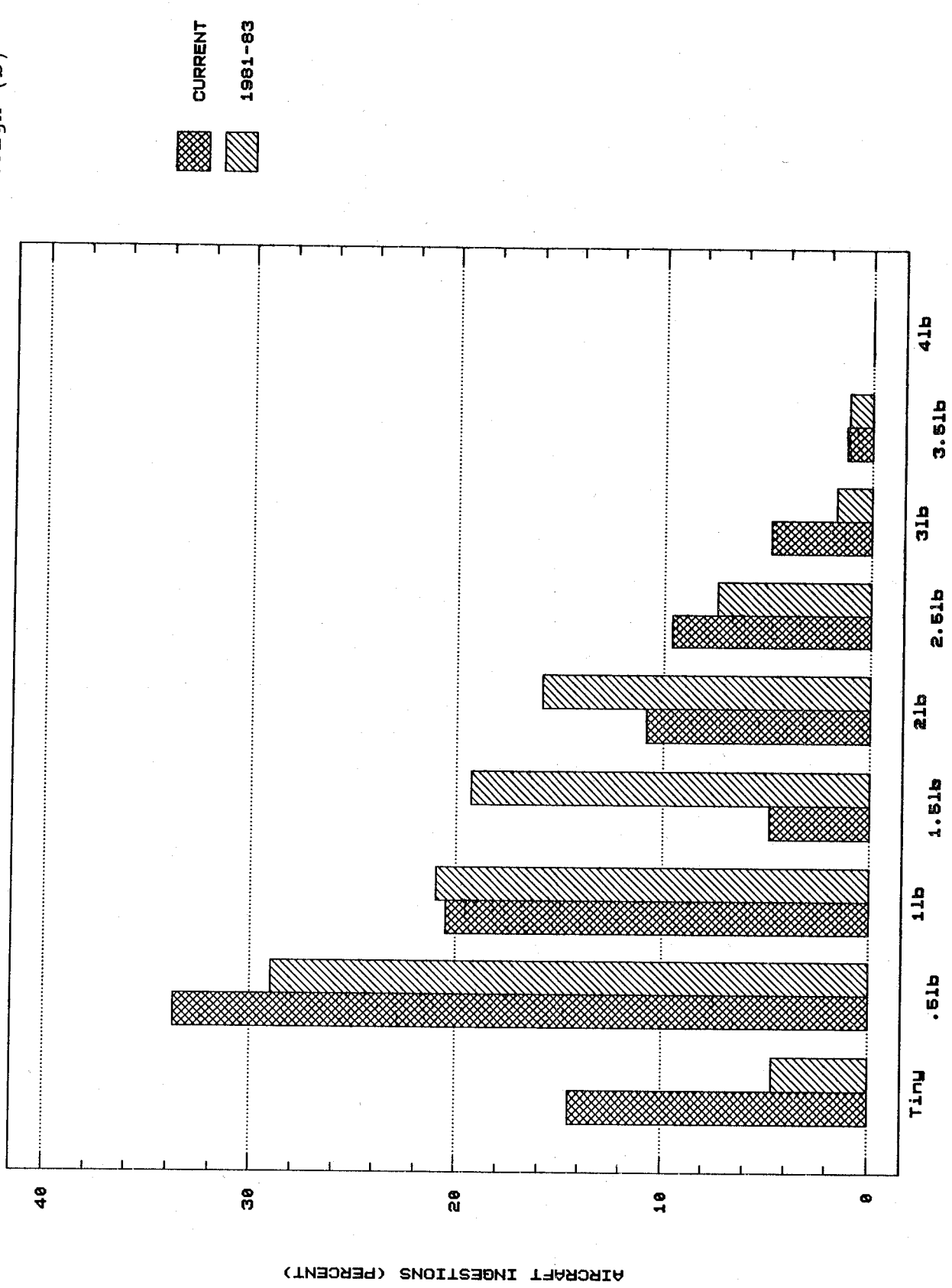
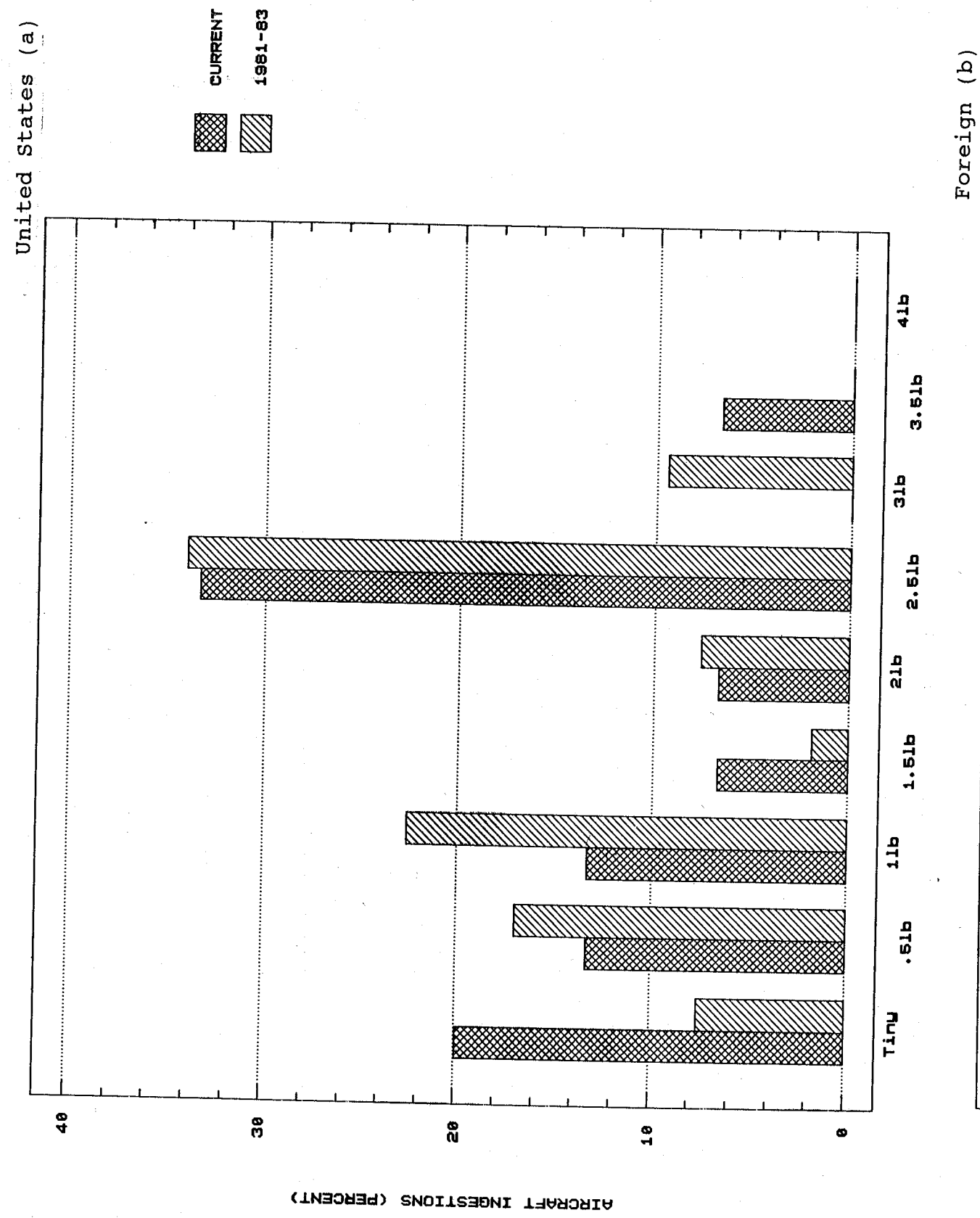


FIGURE 4.4. RELATIVE FREQUENCY BIRD WEIGHT DISTRIBUTIONS - CURRENT VERSUS 1981-83 STUDY - US/FOREIGN

United States distributions are bimodal with about 45 percent of the weights in the 1-pound or smaller classes and about 35 percent in the 2.5-pound class. The foreign distributions are similar in most weight classes. Two exceptions are the "tiny" and 1.5-pound classes. The latter contains relatively fewer weights from the current study while the opposite is true for the former.

As indicated in Section 3, there were 16 multiple engine and 29 multiple bird aircraft events, including 8 that fell into both categories. Bird weights, none of which are over 40 ounces, were obtained in 22 of these 37 events. Figure 4.5 contains a frequency distribution of all bird weights up to the 2.5 pound weight class (the initial portion of figure 4.1). The numbers of single engine-multiple bird (SEMB), multiple engine-single bird (MESB) and multiple engine-multiple bird (MEMB) aircraft events for each weight class are shaded as indicated. The single engine-single bird events (SESB) remain unshaded. The 0.5-pound class contains the greatest number (10) of these "multiple" events, as well as the highest percentage (32 percent). The 1-pound and 2.5-pound classes each contain four "multiple" events, representing 31 percent of the latter's total and 21 percent of the former's. The 1.5-pound class is conspicuous by the absence of any multiple engine or multiple bird events.

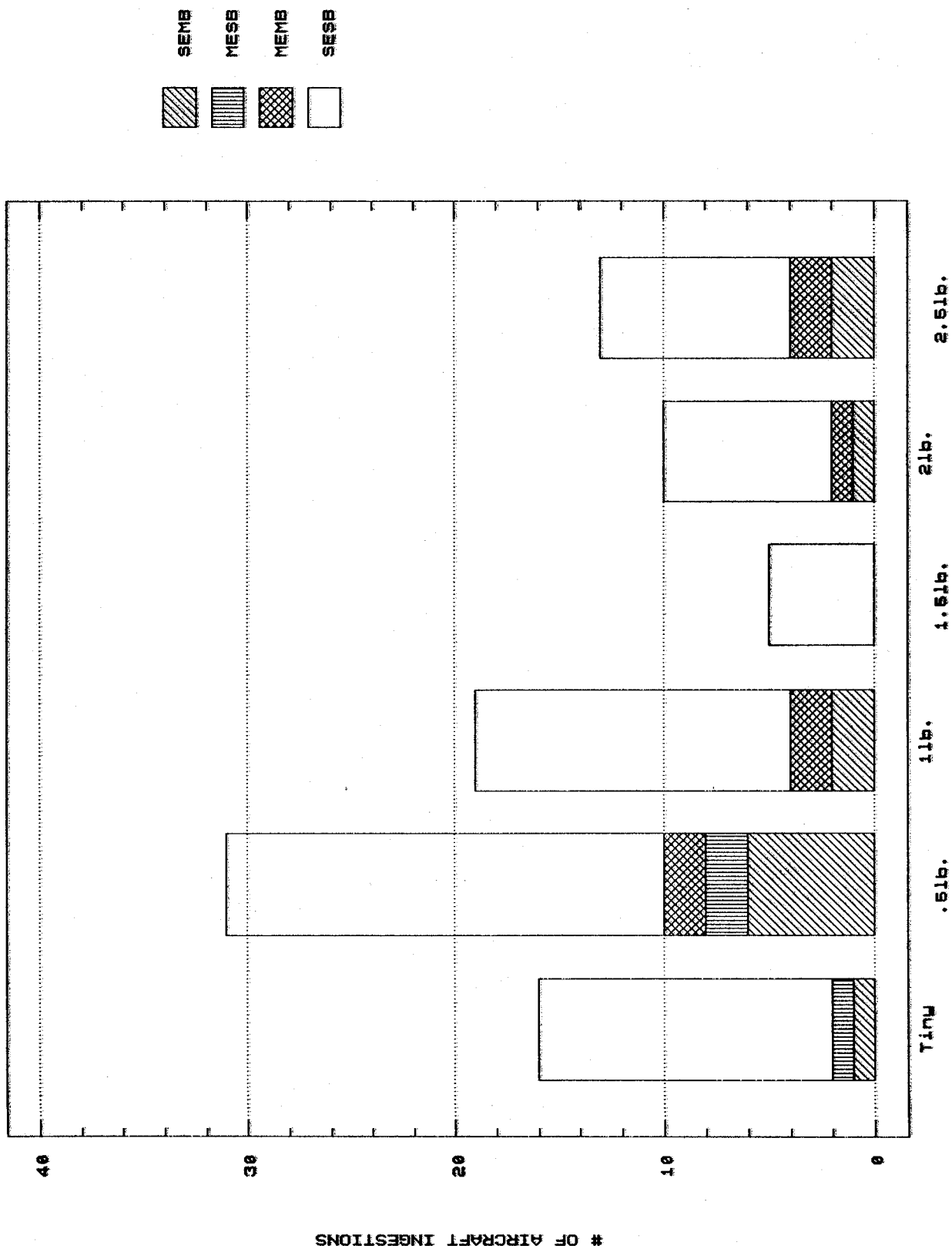


FIGURE 4.5. MULTIPLE ENGINE AND MULTIPLE BIRD EVENTS BY BIRD WEIGHT CLASS

5. EFFECTS ON ENGINES AND FLIGHTS.

The underlying reason for concern about ingestion of birds into aircraft engines is the potential for causing damage to the engines and changes to the aircraft's scheduled flight path by this phenomenon. Aside from economic considerations, these adverse effects can have severe safety repercussions. A B737 crashed on takeoff in Ethiopia in 1988 after both engines failed upon ingesting multiple birds [2]. During this study a B747 narrowly averted disaster after encountering a flock of pigeons during takeoff at Los Angeles (event 138). There are numerous other instances of engine damage and adverse crew actions in the data. These deleterious effects are summarized in this section, and an attempt is made to provide some insight into the relationships among engine damage, effect on flight, and the numbers and weights of ingested birds.

When a bird is ingested into an engine, the first moving part it typically contacts is the fan set. It is usually sliced into pieces by the fan blades, and the resulting matter can go out the bypass ducts or into the primary gas path (core) of the engine. Theoretically, according to the impulse-momentum principle of physics [5], the impulse (integral with respect to time) of the collision force of bird on fan set equals the product of the bird's mass with its striking velocity relative to the fan. For a particular fan set and location of impact, it is this collision force that ultimately determines the stresses, strains, and resulting damage, if any, to the fan blades. These may be nicks, bends, tears, cracks or, in worst cases, pieces of fan blade may break off. Secondary (hard object) damage that can be caused by these pieces is potentially more dangerous to both engine and aircraft than any "soft body" impact between bird matter and machinery.

Thus, all other things being equal, one could expect a direct relationship between "severity" or "extent" of engine damage and mass (weight) of ingested bird. Unfortunately, "all other things" are never quite equal and it is likely that no two bird ingestion events are ever quite the same. There are numerous factors besides bird weight that can influence the effect of a bird ingestion on the engine: the numbers, orientation, and velocity (speed and direction) of the birds; the velocity of the aircraft; the speed and power of the engine; the location and angle of impact; and the engine design. In some cases, a bird is broken up by the inlet cowl and only a portion strikes the fan set. This occurred, for example, in event 118 in which a 12-pound vulture struck the leading edge of the inlet cowl and only a fraction of the bird, believed to be from 1/3 to 1/2, was actually ingested into the engine.

5.1 ENGINE DAMAGE CATEGORIES.

One hundred and eighty-five (185) of the 397 engine ingestion events (47 percent) were reported to have caused some damage to the engine while 211 reported no damage. (It remains undetermined whether event 249 caused any damage to the engine.) Fifteen specific categories of engine damage were tracked in the FAA data base and are defined in table 5.1. The data summary in appendix C specifies all of the damage categories which occurred in each engine event. For purposes of this report, each damage category was classified as "minor" or "significant", as indicated in table 5.1. Engine damage is defined to be "significant" if any "significant" category of damage occurred and "minor" if the engine was damaged, but not significantly. As a result of these definitions, 46 percent of damaging

engine ingestions resulted in significant damage and 54 percent in only minor damage. No attempt was made in this interim report to further quantify "damage severity" or to determine "engine failures." These topics will be addressed in the final report for this study.

5.2 ENGINE DAMAGE BY BIRD MULTIPLICITY.

It is natural to ask whether multiple bird ingestions caused "greater damage" than single bird ingestions. Table 4.1 indicated that there were 35 multiple bird and 305 single bird engine events. Table 5.2 is a 3 x 2 contingency table which classifies these 340 engine ingestions according to category of engine damage and single versus multiple bird. For this table, chi-square = 4.91 with $df = 2$, yielding $P = 9\%$, which is not quite significant statistically. (See appendix B for a discussion of the chi-square test.)

In table 5.2, $13/77 = 16.9$ percent of significantly damaging engine ingestions involved multiple birds while the corresponding frequencies are only $6/85 = 7.1$ percent and $16/178 = 9.0$ percent for the minor damage and no damage categories, respectively. This suggests combining the last two rows of table 5.2 so that only two damage categories are considered. These are (1) significant damage and (2) minor or no damage. For the resulting 2 x 2 contingency table, chi-square = 4.68 with $df = 1$ which is significant at $P = 3\%$. Hence multiple bird ingestions tend to cause significant damage more often than single bird ingestions. This result should not be surprising since two of the defining categories for significant damage, $be/de > 3$ and $torn > 3$, would be more likely to occur, for a given bird weight, in a multiple bird ingestion.

If, on the other hand, the first two rows of table 5.2 are combined so that the two categories of engine damage being considered are (1) damage (of any sort) and (2) no damage, then chi-square = 0.69 with $df = 1$, yielding $P = 41\%$. It cannot therefore be concluded that multiple bird ingestions tend to be damaging more than single bird ingestions. It should be noted that the weight and quantity (if greater than two) of birds were not taken into consideration in the above analyses.

5.3 ENGINE DAMAGE BY PHASE OF FLIGHT.

Among the factors previously mentioned which may affect engine damage are engine speed/power and aircraft velocity. Although provision was made in the data base for recording the engine power setting at time of ingestion, this information was actually reported in only 5 of the engine events, while aircraft speed was reported only 49 times. There is, however, a relationship between each of these factors and the phase of flight of the aircraft. For example, fan speed is usually over 90 percent of maximum during the takeoff and climb phases, is roughly 65 percent during final approach, and falls below 40 percent during descent and landing. Since, as noted in Section 3, some indication of flight phase was reported in nearly 60 percent of the aircraft events, it is natural to examine the relationship between phase of flight and engine damage.

The frequency of significant damage, minor damage, and no damage for each reported category of phase of flight is illustrated in figure 5.1 for the 237 engine events in which this information is known. The "takeoff," "takeoff roll," "climb," "landing roll," and "approach" categories each contain several damaging events. However, more than half of the engine ingestions in each of the latter

TABLE 5.1. ENGINE DAMAGE CATEGORIES - DEFINITIONS

CATEGORY	DESCRIPTION	CLASSIFICATION
LEADEDGE	FAN BLADE LEADING EDGE DISTORTION	MINOR
BEDE<=3	1 TO 3 BENT/DENTED FAN BLADES	MINOR
TORN< =3	1 TO 3 TORN FAN BLADES	MINOR
SHINGLED	SHINGLED (TWISTED) FAN BLADE(S)	MINOR
ACPAFNAB	ACOUSTIC PANEL OR FAN RUB STRIP DAMAGED	MINOR
NACELLE	ENGINE ENCLOSURE DENTED OR PUNCTURED	MINOR
BEDE>3	MORE THAN 3 FAN BLADES BENT/DENTED	SIGNIFICANT
TORN>3	MORE THAN 3 FAN BLADES TORN	SIGNIFICANT
BROKEN	FAN BLADE LEADING EDGE OR TIP PIECES MISSING	SIGNIFICANT
TRVSFRAC	FAN BLADE BROKEN CHORDWISE, PIECE LIBERATED	SIGNIFICANT
RELEASED	BLADE RETENTION MECHANISM FAILED	SIGNIFICANT
FLANGE	FLANGE SEPARATIONS	SIGNIFICANT
CORE	COMPRESSOR BLADES/VANES DMGD. OR AIRFLOW BLOCKED	SIGNIFICANT
TURBINE	TURBINE DAMAGED	SIGNIFICANT
SPINNER	SPINNER/CAP DAMAGED	SIGNIFICANT

TABLE 5.2. ENGINE DAMAGE CATEGORIES BY BIRD MULTIPLICITY

	SINGLE	MULTIPLE	TOTALS
SIGNIFICANT	64 (83.1%)	13 (16.9%)	77
MINOR	79 (92.9%)	6 (7.1%)	85
NONE	162 (91.0%)	16 (9.0%)	178
TOTALS	305	35	340

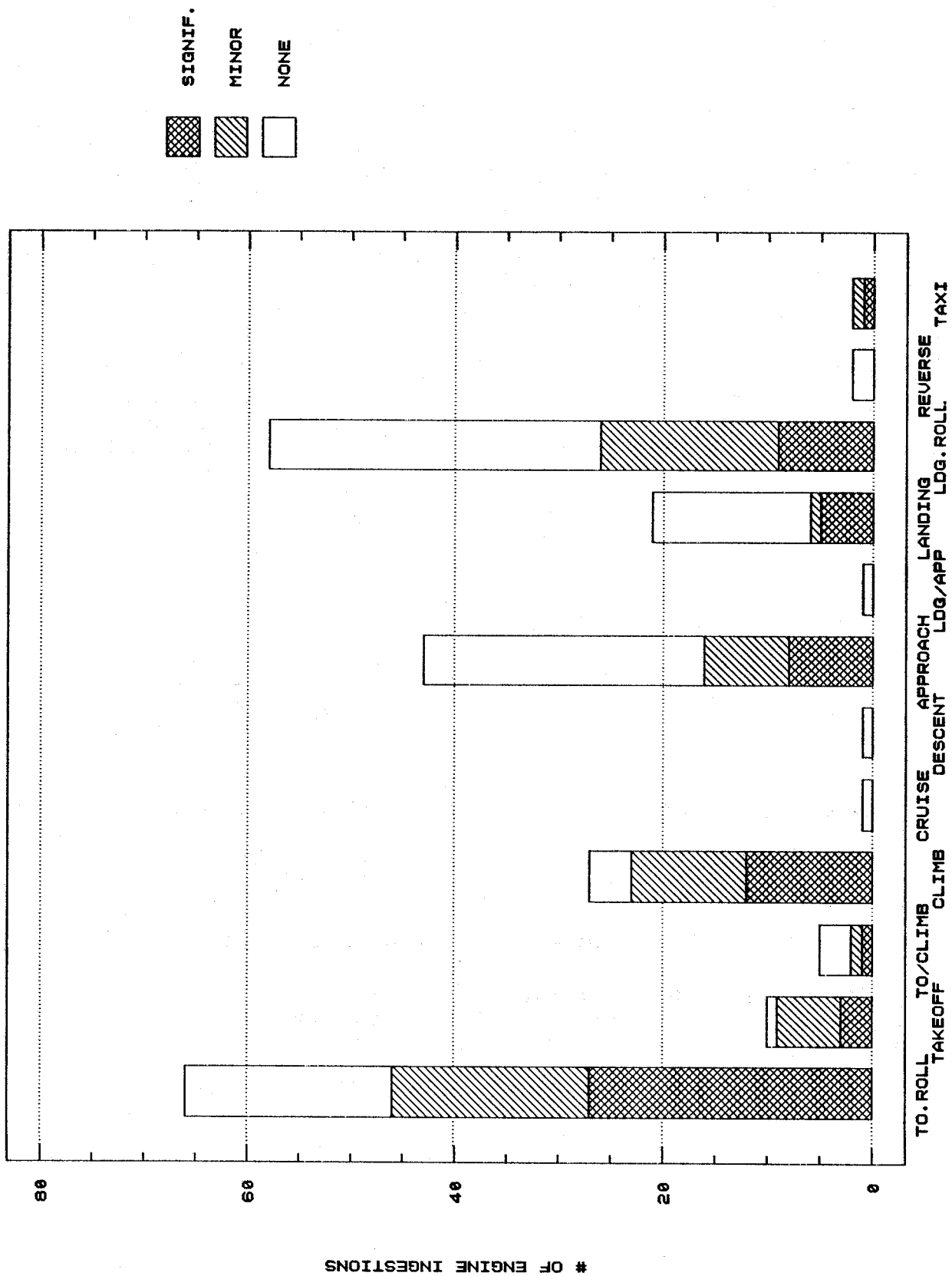


FIGURE 5.1. ENGINE DAMAGE FREQUENCIES BY PHASE OF FLIGHT

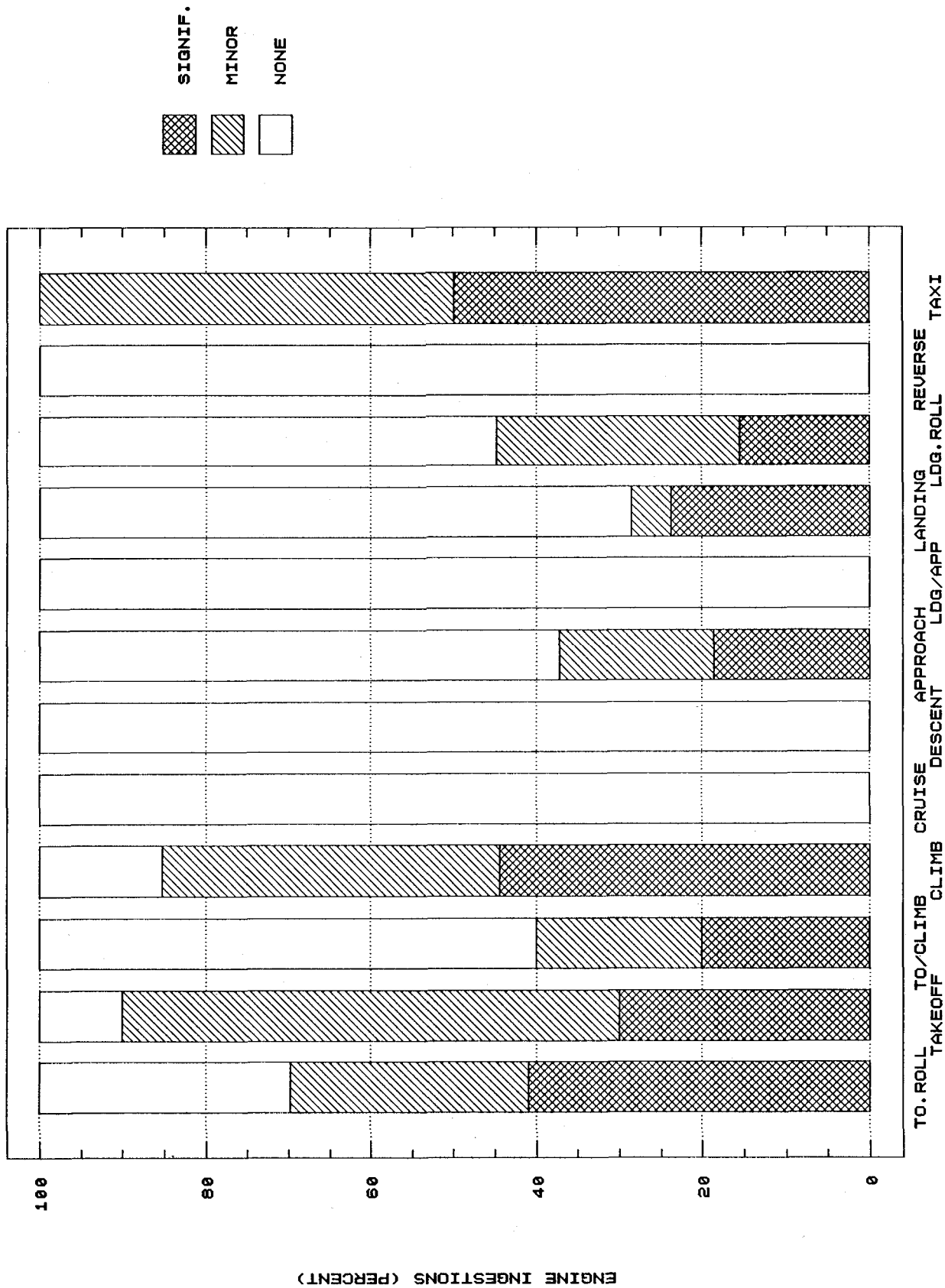


FIGURE 5.2. RELATIVE FREQUENCY OF ENGINE DAMAGE BY PHASE OF FLIGHT

two categories were nondamaging. This suggests looking at the "relative frequencies" of damage for each phase of flight category, which is shown in figure 5.2. Clearly the "climb," "takeoff," "takeoff roll," and "taxi" phases have the highest percentages of both minor and significant damage. However, as figure 5.1 shows, the taxi phase contains only two events. Among the departure phases, only the "takeoff/climb" category (which contains but 5 events) has relatively few damaging events. These facts, along with the above remarks concerning fan speed in various phases of flight, suggest grouping phases of flight according to "departure" and "arrival" for analysis of engine damage.

Table 5.3 is a 3 x 2 contingency table which compares the aforementioned two phase-of-flight categories with the usual three categories of engine damage. In this table "departure" includes all takeoff or climb phases while "arrival" represents the descent, approach, or landing phases. (The five "cruise," "reverse," or "taxi" events have been excluded.) For table 5.3, chi-square = 29.9 with $df = 2$, giving a P-value near 0. Hence it is a statistical certainty that the factors in table 5.3 are dependent. Note that $43/65 = 66.2\%$ of the significantly damaging engine ingestions and $37/63 = 58.7\%$ of those with minor damage occurred during takeoff or climb. In contrast, only $28/104 = 26.9\%$ of nondamaging engine events occurred during departures.

If the first two rows of table 5.3 are combined, yielding the damage categories (1) damage (of any sort) and (2) no damage, then chi-square = 29.2 with $df=1$, giving a P-value near 0. On the other hand, if the last two rows of table 5.3 are combined giving the damage categories (1) significant damage and (2) minor or no damage, then chi-square = 13.9 with $df = 1$, which also gives a P-value near 0. Hence in both 2 x 2 contingency tables, the respective damage categories and phases of flight are dependent. Therefore, "departure" ingestions tend to cause both damage and significant damage more often than "arrival" ingestions.

5.4 ENGINE DAMAGE BY BIRD WEIGHT.

The relationship between engine damage and weight of ingested birds is examined next. Figure 5.3 is a frequency histogram depicting engine damage category according to bird weight class for the 115 engine ingestions in which a species identification was made. The weight classes are the same as those used in the previous section, as defined in table 4.5. The number of engine ingestions that resulted in no damage, minor damage, and significant damage is shown for each weight class. The 2.5-pound weight class had the greatest number of events with significant damage while the 1.5-pound and 2-pound weight classes had relatively few. Three (3) of the four ingestions in the 3-pound class caused damage. All ingestions over 3 pounds were damaging, for the most part significantly, but were few in number. The 0.5-pound class contains a large number of damaging ingestions but more than half in this class were nondamaging.

As figure 5.3 indicates, engine damage information was not reported for one (2-pound) ingestion. Using the remaining 114 engine events, figure 5.4 examines bird weight versus engine damage from the relative frequency viewpoint. Here the percentage in each damage category is represented for each weight class. With few exceptions, the overall trend is for the relative frequency of both damaging and significantly damaging ingestions to increase with bird weight.

In reference 2, a logistic model is used for the probability of various "severities" of damage as a function of bird weight. Specifically, the logarithm

TABLE 5.3. ENGINE DAMAGE CATEGORIES BY DEPARTURE/ARRIVAL

	DEPARTURE		ARRIVAL		TOTALS
SIGNIFICANT	43	(66.2%)	22	(33.8%)	65
MINOR	37	(58.7%)	26	(41.3%)	63
NONE	28	(26.9%)	76	(73.1%)	104
TOTALS	108		124		232

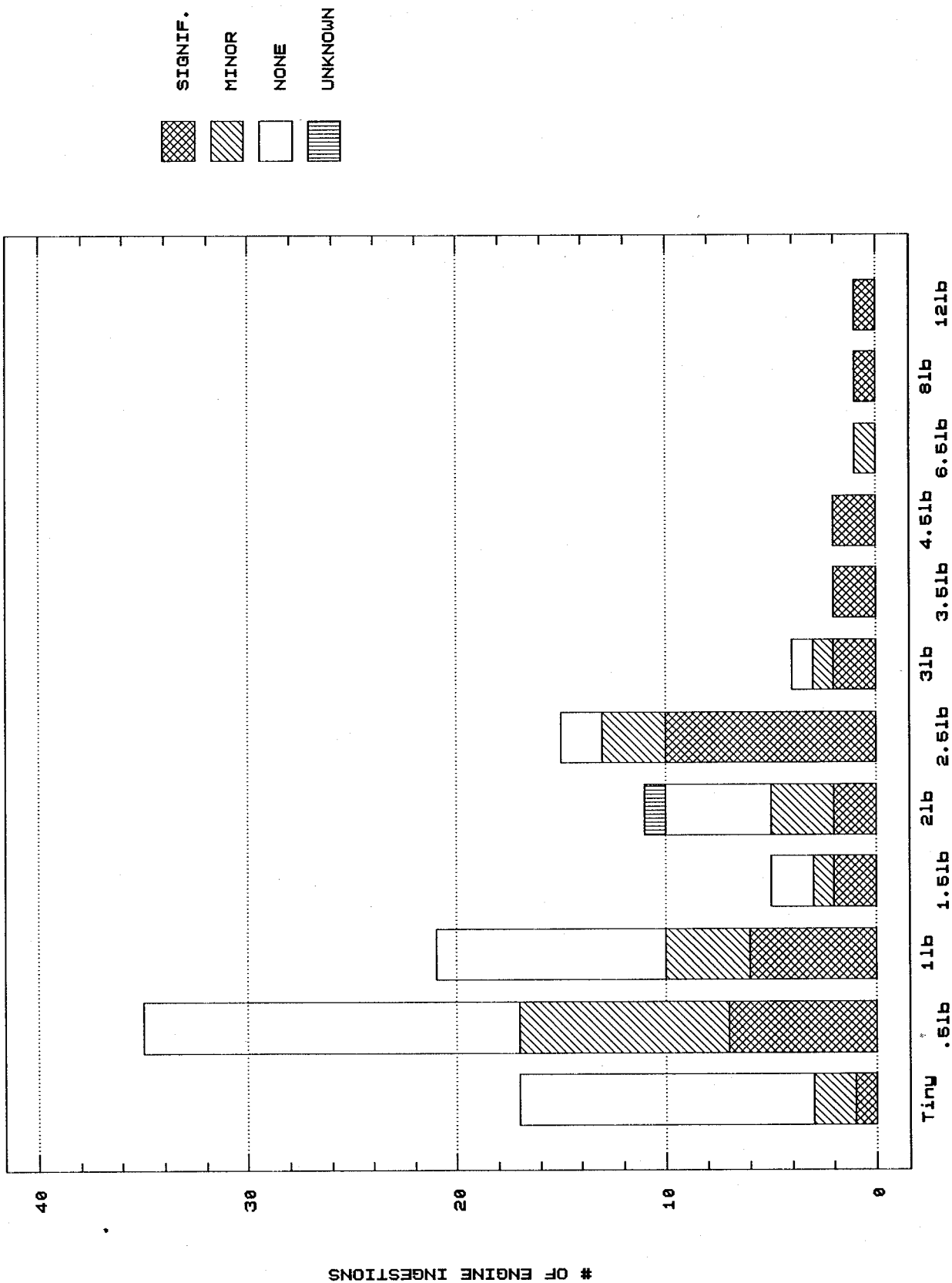


FIGURE 5.3. ENGINE DAMAGE FREQUENCIES BY BIRD WEIGHT CLASS

ENGINE INGESTIONS (PERCENT)

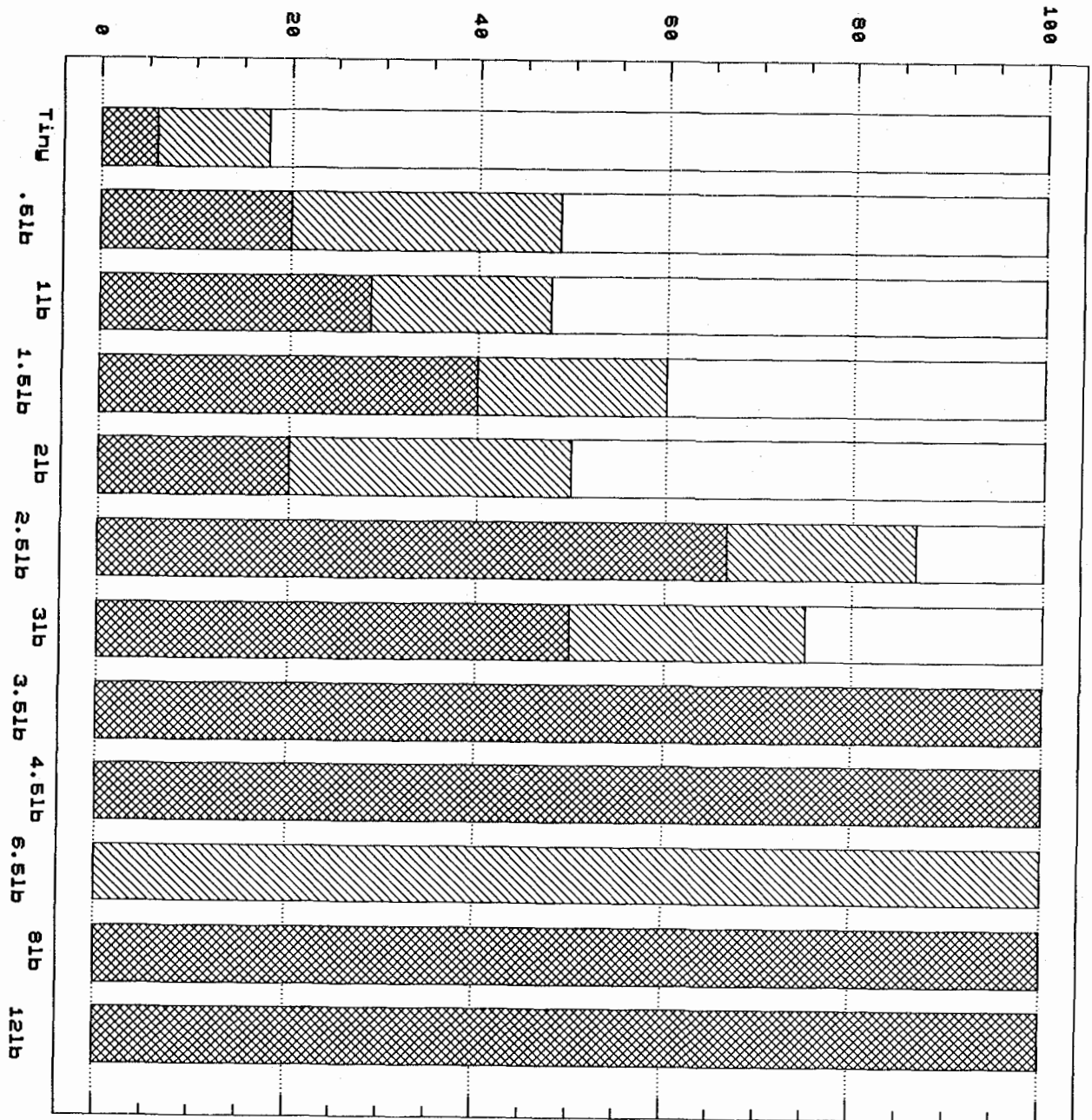


FIGURE 5.4. RELATIVE FREQUENCIES OF ENGINE DAMAGE BY BIRD WEIGHT CLASS

of the odds ratio, $\log(\text{probability}/(1-\text{probability}))$, is modeled as a linear function of bird weight. A rationale for choosing this particular model is also presented there. The same computer program used in reference 2, which also generates a lower 95 percent confidence bound, was applied to the data in this report. The resultant probability of damage (resp. significant damage) curves are given in figure 5.5 (resp. figure 5.6). The probability of damage reaches 50 percent at about 10.7 ounces and the probability of significant damage curve does likewise at 36 ounces. It should be kept in mind, however, that these probability curves are a result of "smoothing" the data which generated figure 5.4 by means of a particular model and should not be taken as gospel. For example, figure 5.6 puts the probability of significant damage at around 50 percent for a 2-pound bird ingestion while figure 5.4 places it at 20 percent. It should also be noted that this model assumes that probability of damage increases with bird weight. Moreover, no factors other than bird weight were used to generate the curves in figures 5.5 and 5.6. In particular, the phase of flight and the number of birds ingested were both ignored.

5.5 CREW ACTION EVENTS.

There were 13 aborted takeoffs (ATO's) among the aircraft events. Three of these involved multiple engines or multiple birds. Besides the ATO's there were 40 other occasions of an adverse "crew action," i.e., a change in the planned flight path of the aircraft. These included 33 air turnbacks (ATB's), 6 diversions to a landing at an unscheduled airport (DIV's), and 1 change of altitude (ALT) on a subsequent flight. Four of these 53 events involved multiple engines and 7 involved multiple birds, including 2 aircraft ingestions that were both multiple engine and multiple bird events.

Figure 5.7 is a tree diagram which indicates the damage category breakdown for each of the above classes of crew action events. The "damage category of an aircraft event" (none, minor, or significant) is defined to be the most severe category of damage sustained by any engine on the aircraft. Thirty-one (31) of the 33 ATB events were damaging, 19 significantly. These totals include one event (317) in which an engine sustained extensive turbine damage and, upon inspection, was discovered to have ingested a single 1-ounce bird on some prior flight. The engine damage, which was caused by a casting defect, was unrelated to the bird ingestion. (This event was considered nondamaging in all engine damage versus bird weight analysis.) Half of the DIV events involved significant damage as did 38 percent of the ATO's. Five of the eight nondamaging crew action events were ATO's. An engine "surge" was noted in four ATO events. In one of these, event 152, both engines surged but only one engine sustained damage. The three other events (22, 34, and 215) were all single engine and nondamaging. Event 22 resulted in an engine in-flight shutdown (IFSD).

There are nine other occurrences of an IFSD in the 53 crew action events. The IFSD's are indicated in the next level of the tree in figure 5.7. Seven of these, six of which involved significant engine damage, are in the ATB's. All IFSD events are discussed below.

Verified bird weights were obtained in 28 of the 53 crew action events. Figure 5.8 indicates the bird weight class involved in each of these events, and for the "no crew action" and "unknown crew action" events as well. The greatest number of crew action events, eight, occurred in the 0.5-pound class, followed by seven for the 2.5-pound class. This latter class, however, contains the

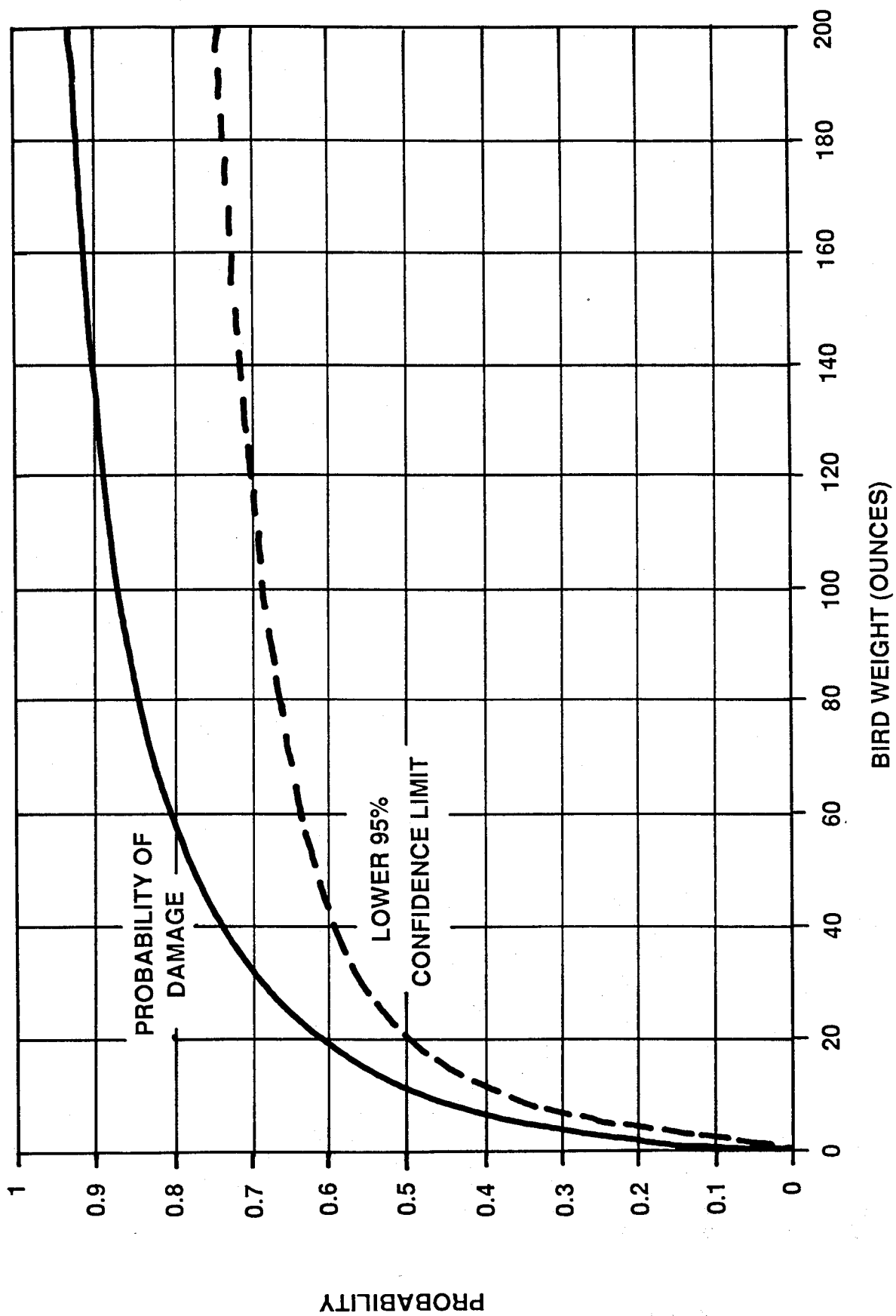


FIGURE 5.5. PROBABILITY OF ENGINE DAMAGE BY BIRD WEIGHT - LINEAR LOGISTIC MODEL

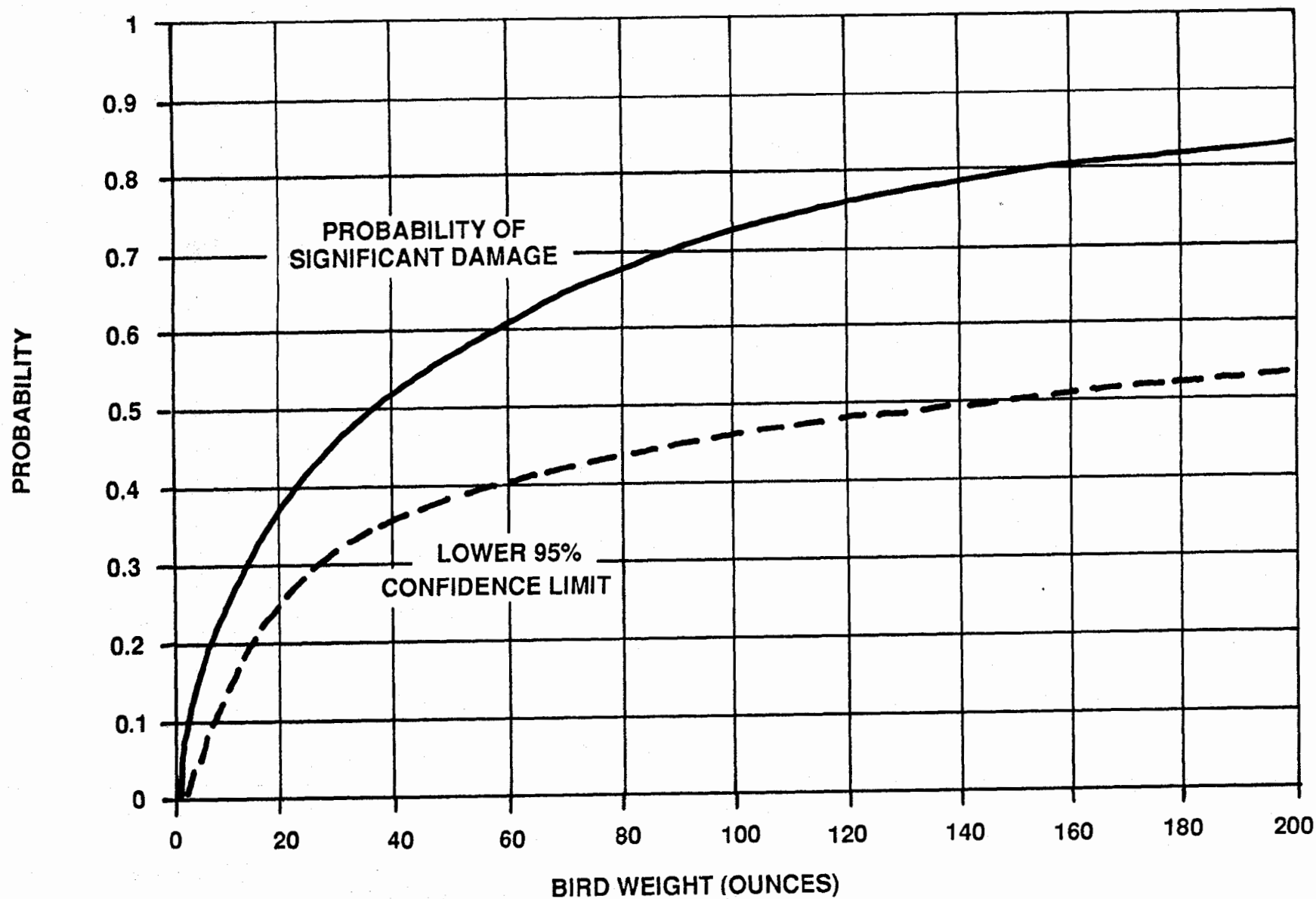


FIGURE 5.6. PROBABILITY OF SIGNIFICANT ENGINE DAMAGE BY BIRD WEIGHT - LINEAR LOGISTIC MODEL

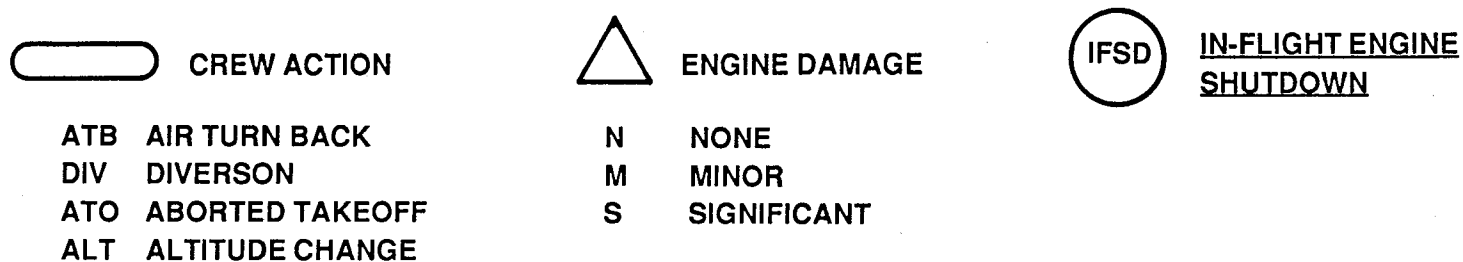
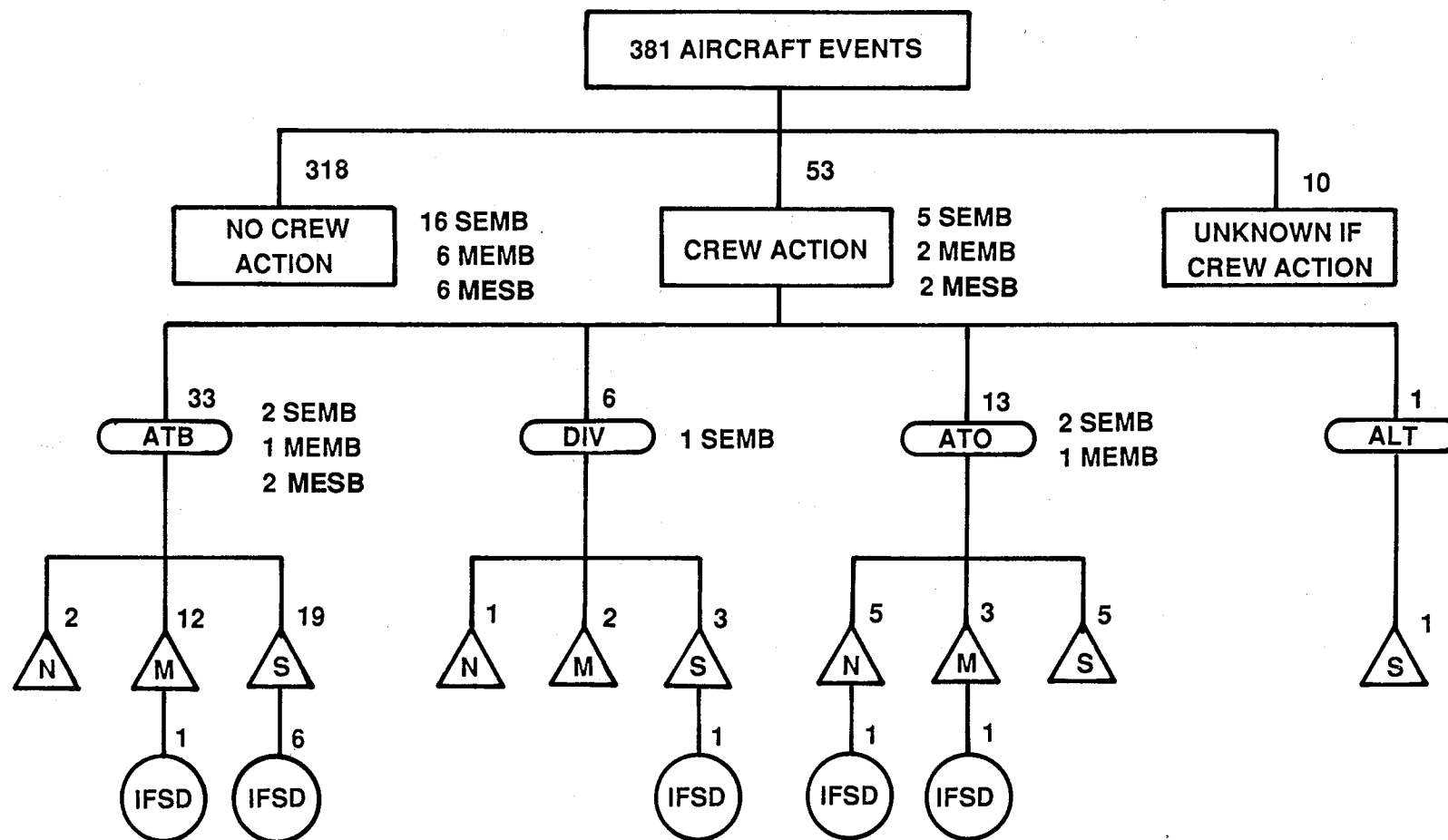


FIGURE 5.7. CREW ACTION TREE DIAGRAM

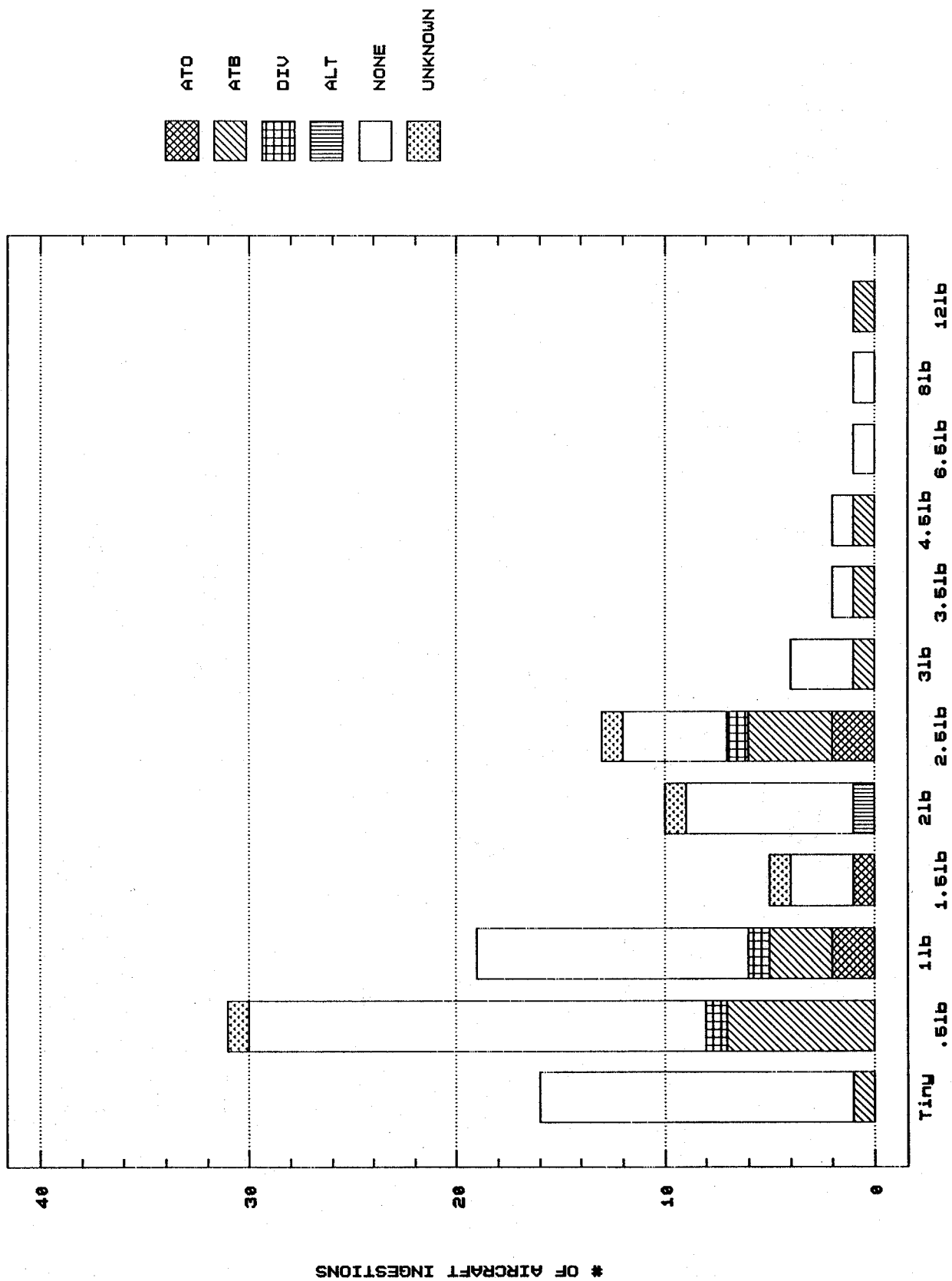


FIGURE 5.8. CREW ACTIONS BY BIRD WEIGHT CLASS

largest relative frequency of crew action events, 54 percent. The aforementioned event (317) in which an ATB was evidently unrelated to the bird ingestion, accounts for the single "tiny" bird event in figure 5.8.

5.6 IN-FLIGHT SHUTDOWN EVENTS.

As previously noted, 10 of the "crew action" events resulted in an IFSD. All told, there are 11 IFSD events in the data, which are summarized in table 5.4. A "Y" denotes occurrence and a "blank" nonoccurrence. Acronyms used for phases of flight are defined in appendix C. Multiple birds were ingested into three of the engines that were shut down in flight. There were no multiple engine IFSD's although in event 138, two engines of the B747 ingested birds. No cause was given for the IFSD in event 317, which, as noted above, sustained turbine damage unrelated to the bird ingestion. In the remaining nine events, increased engine vibration was cited seven times as a contributing factor. Other symptoms given in IFSD's were high exhaust gas temperature (three times), an engine surge (twice), and a bird smell (once). An involuntary power loss was reported in 5 of the 11 IFSD events. Verified bird identifications were obtained in 7 events. Four of these involved birds in the 2.5-pound weight class of which three (events 32, 241, and 247) were herring gulls. Three herring gulls were ingested into a single engine in event 32.

5.7 UNCONTAINED EVENTS.

As noted at the beginning of this section, fragments from broken fan blades can cause secondary damage to the engine following a bird ingestion. These fragments sometimes exit through the engine's case or nacelle (an "uncontained" event) and have the potential for seriously damaging the aircraft. There were no incidents of engine case uncontainment; although in two events (74 and 103), blade fragments punctured the metallic engine casing but were contained by the Kevlar containment system. In the latter event, fragments did exit through the nacelle. Event 103 and the four additional instances of uncontained nacelle damage are summarized in table 5.5. Fortunately, there were no reports of further damage to the aircraft in any of the uncontained events; although in event 241, a piece of blade from one engine ricocheted off the runway and struck the adjacent engine of the B747. Both affected engines in event 138 received uncontained damage to the nacelle. Bird identifications were obtained in all uncontained events. Herring gulls weighing 2.5 pounds were cited in two of these events (and also in the aforementioned event 74). The other three uncontained events all resulted from ingestions of multiple birds in the 1-pound weight class.

5.8 INVOLUNTARY POWER LOSS EVENTS.

An involuntary loss of power was reported in six engine events. As noted above, five of these resulted in a mandatory IFSD and are included in table 5.4. In the other, event 103, the engine was not shut down but rather was reversed during an aborted takeoff. This was an uncontained event and appears in table 5.5.

5.9 MULTIPLE ENGINE EVENTS.

All transport category aircraft are certificated to perform safely, during all flight phases, with any single engine inoperable. (See CFR Title 14, Part 25.) Multiple engine ingestion events are of particular interest because an in-flight

TABLE 5.4 IN-FLIGHT SHUTDOWN EVENTS

evt #	date	acft	eng	eng pos	crew actn	pow loss	surge	smell	inc vibe	hi egt	trvs frac	bird wt	mult bird	eng dmg	pof
22	04/12/89	B747	JT9D	1	ATO		Y							N	TR
32	05/10/89	A300	JT9D	1	ATB	Y	Y			Y		36	Y	S	TR
140	07/25/89	A320	V2500	1	ATO			Y					Y	M	TR
75	08/14/89	B767	CF6	1	ATB	Y			Y			48		S	CL
76	08/18/89	A310	CF6	1					Y					M	CL
138	09/12/89	B747	JT9D	2	ATB	Y			Y	Y	Y	14	Y	S	TR
267	05/04/90	A320	CFM56	1	ATB				Y					M	TR
247	05/31/90	A300	JT9D	1	ATB	Y			Y	Y		40		S	TR
241	06/27/90	B747	JT9D	3	DIV				Y			40		S	TR
257	07/30/90	B757	2000	2	ATB	Y			Y			40.4		S	CL
317	08/10/90	A300	4000	1	ATB							1		N	TC

TABLE 5.5 UNCONTAINED EVENTS

evt #	date	unc case	unc nacl	acft	eng eng	pos	ifsd	pow loss	surge	inc vibe	hi egt	trvs frac	bird wt	mult bird	pof
138	09/12/89		Y	B747	JT9D	1			Y				14	Y	TR
138	09/12/89		Y	B747	JT9D	2	Y	Y	Y	Y	Y	Y	14	Y	TR
103	10/23/89		Y	A310	CF6	1		Y		Y		Y	16	Y	TR
231	03/16/90		Y	A300	JT9D	2				Y			40		CL
241	06/27/90		Y	B747	JT9D	3	Y			Y			40		TR

loss of two engines during the critical takeoff or climb phases could be catastrophic, even in three- or four-engine aircraft. Table 5.6 summarizes the 16 multiple engine events in the data, all of which involved two engines. In event 138, one engine lost power due to a fan blade transverse fracture and was shut down. The cockpit symptoms following ingestion were a surge and high exhaust gas temperature. The other affected engine also surged and, fortunately, recovered. This is the only event in which two engines were damaged significantly. Three other events, 102, 201, and 323, resulted in multiple engine damage. Significant damage in a single engine occurred in the first and the last of these events. The B767 in event 201 received minor damage in each engine and performed an air turnback. As noted above, both engines of the B767 in event 152 surged, but evidently recovered. The takeoff was aborted. It is interesting to note that the affected engines were on the same wing in all four B747 multiple engine events. Verified bird weights were obtained in 10 of the multiple engine events. They are listed in table 5.6 and were included in figure 4.5 of the previous section.

TABLE 5.6. MULTIPLE ENGINE EVENTS

evt #	date	acft	eng	eng pos	eng dmg	crew actn	pow loss	surge	ifsd	inc vibe	hi egt	trvs frac	bird wt	mult bird	pof
97	12/14/89	A310	CF6	1	M								10	Y	LR
				2	N								10	Y	
193	01/16/90	A310	CF6	1	N										
				2	N										
244	02/09/90	A310	JT9D	1	N										
				2	N										
85	11/21/89	A320	CFM56	1	N										
				2	N										
102	10/21/89	B747	CF6	3	S										CL
				4	M										
138	09/12/89	B747	JT9D	1	S	ATB		Y					14	Y	TR
				2	S		Y	Y	Y			Y	14	Y	
171	08/31/89	B747	4000	3	N									Y	LR
				4	N									Y	
382	09/04/90	B747	CF6	1	N								10	Y	LR
				2	N								10	Y	
1	01/24/89	B757	RB211	1	N	ATB							8		TR
				2	M								8		
112	10/07/89	B757	RB211	1	N										LD
				2	N										
214	06/17/90	B757	RB211	1	N								32	Y	LD
				2	N								32	Y	
323	08/14/90	B757	2000	1	S								40	Y	TO
				2	M								40		
24	04/18/89	B767	JT9D	1	N								0.5		
				2	N								0.5		
152	10/12/89	B767	JT9D	1	N	ATO		Y					18	Y	TR
				2	M			Y					18	Y	
201	02/21/90	B767	CF6	1	M	ATB							7.7		TR
				2	M								7.7		
225	02/21/90	B767	JT9D	1	S								36	Y	AP
				2	N								36		

6. SUMMARY AND CONCLUSIONS.

Data in this report were generated by a fleet of over 1100 aircraft flying more than 2 million operations worldwide during the period January 1989 to September 1990.

A total of 381 aircraft ingestions was reported, yielding a worldwide ingestion rate that is approximately 80 percent of the rate in the 1981-83 FAA study. The foreign aircraft ingestion rate is currently over four times the domestic rate compared with two and one-half times in the previous study. More effective bird control measures at United States airports is one possible explanation for this disparity. It is also conceivable that foreign carriers have been more diligent than domestic carriers in reporting bird ingestions.

Aircraft ingestions were reported to have occurred at 120 different airports worldwide. One airport had 10 events and two others had 7 each. All three were outside the United States. The largest number of events at any domestic airport was four.

There were 16 multiple engine events, yielding a rate slightly under 8 per million operations. Each involved two engines of the aircraft. Thirty-five (35) of the 397 engine ingestions are known to have involved multiple birds.

The species of birds ingested are consistent with the 1981-83 study. The herring gull, common lapwing, black-headed gull, and common rock dove were the most frequently identified species. The first three were also the most frequently encountered birds during multiple engine or multiple bird ingestions.

Bird weights, both domestic and foreign, are markedly similar to those in the previous study. This is true not only in terms of summary statistics (median, mode, mean, etc.) but also in terms of the distribution functions for the weights. As before, birds ingested in the United States tend to be heavier than foreign birds.

Forty-seven (47) percent of engines that ingested birds had some reported damage, compared to 62 percent in previous study. Fifty-four (54) percent of current engine damage was classified as "minor," which typically consisted of leading edge distortions or at most three bent, dented, or torn fan blades.

The aircraft ingestion events were fairly evenly split between departure (takeoff or climb) and arrival (descent, approach or landing) phases of flight. However, engines ingesting birds during departures sustained damage at about twice the rate as in arrivals.

An unscheduled crew action was performed in 14 percent of the aircraft events, which is half the rate in the previous study. There were 11 in-flight engine shutdowns, representing less than 3 percent of all engine events. In the previous study, nearly 13 percent of engine events resulted in an IFSD.

The engines included in the current study were designed and certificated to more stringent bird ingestion standards than most of those from the previous study. It is therefore not surprising that the current fleet has performed better in terms of the adverse effects of bird ingestions on engines and flights. However,

one needs to simply recall the near-catastrophic B747 multiple engine event in Los Angeles to be convinced that the ingestion of birds into engines continues to present a serious threat to aircraft safety.

Table 6.1 contains a summary of some data from the current and previous FAA studies. Except where noted, all numbers represent worldwide data.

TABLE 6.1. DATA SUMMARY

	Current Study	1981-83 Study
# aircraft	1162 (5/90)	1513 (6/84)
# operations	2,056,676	2,738,320
# aircraft ingestions *	34/333/381	97/484/638
ingestion rate ($\times 10^{-4}$) *	0.54/2.34/1.85	0.99/2.80/2.33
# multiple engine events	16	25
multiple engine ingestion rate ($\times 10^{-6}$)	7.78	9.86
# engine ingestions	397	666
# multiple bird engine ingestions	35	65
% multiple bird ingestions	8.8	9.8
# damaging engine ingestions	185	416
% damaging engine ingestions	47	62
median bird weight (oz.) *	28/14/14	32/18/19
modal bird weight (oz.) *	40/14/40	40/24/40
mean bird weight (oz.) *	30/22/23	30/27/27
# crew action a/c events	53	129
% crew actions	13.9	28.2
# IFSD engine events	11	85
% IFSD's	2.8	12.8

* US/FOREIGN/WORLDWIDE

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8. GLOSSARY.

Aircraft operation - One complete flight cycle of an aircraft, from engine startup at departure to engine shutdown upon arrival.

Bird ingestion - The entrance of a bird into the inlet of a turbine engine during an aircraft operation.

Engine ingestion event - The simultaneous ingestion of one or more birds into an engine.

Aircraft ingestion event - The simultaneous ingestion of one or more birds into one or more engines of an aircraft.

APPENDIX A

BIRD INGESTION CERTIFICATION STANDARDS

The following is a summary of current bird ingestion certification standards as they pertain to engines in this study. The complete regulations, which were last amended in February 1984 are contained in 14 CFR 33.77. The small (3-ounce size) bird test mentioned there has been omitted from this summary. It does not apply to engines in this study since none of them have inlet guide vanes.

<u>TEST REQUIREMENT</u>	<u>MEDIUM BIRD TEST</u>	<u>LARGE BIRD TEST</u>
BIRD SIZE	1.5 pound	4 pound
# OF BIRDS	1 for the first 300 square inches of inlet area plus 1 for each additional 600 square inches or fraction thereof.	1
MAXIMUM NUMBER OF BIRDS	8	1
BIRD SPEED	Initial climb speed of typical aircraft.	Liftoff speed of typical aircraft.
ENGINE OPERATION	Takeoff	Takeoff
INGESTION PATTERN	In rapid sequence to simulate a flock encounter and aimed at critical areas.	Aimed at critical areas.
POST INGESTION REQUIREMENTS: Ingestion may NOT	1. Cause more than 25% sustained power or thrust loss. 2. Require engine shutdown within 5 minutes. 3. Result in a potentially hazardous condition.	Cause engine to: 1. Catch fire. 2. Burst. 3. Generate loads greater than maximum specified. 4. Lose capability of being shut down.

APPENDIX B

STATISTICAL TERMINOLOGY

Sample mean. The mean of a sample of size n is the average of the n numbers. It is obtained by summing the numbers and dividing by n .

Sample median. The median of a sample is the observation in the middle of the sample. That is, half the observations are at least as large as the median and half are as small as the median or smaller. We commonly find the median by sorting the sample and taking the middle observation, or observations, in the sorted sample. For example, the sample 1 3 2 6 8 is sorted to give 1 2 3 6 8, and the median is 3, the 3rd largest number. Or the sample 3 7 5 6 9 3 is sorted to give 3 3 5 6 7 9, and the median is 5.5, the average of the 3rd and 4th observations.

Sample mode. The mode is the most frequently occurring observation in the sample. In the 2nd example illustrating the median, the mode is 3. The mean, median, and mode are usually close together in moderate size, or larger, samples whose histograms are bell-shaped.

Sample variance. The sample variance is computed in three steps: (1) Centering the sample, by subtracting the sample mean from each observation. (2) Summing the squares of the centered observations. (3) Dividing by the sample size less 1, $n - 1$. The variance is the average squared deviation of the observations from their mean.

Sample standard deviation (SD). The sample standard deviation is the square root of the sample variance. It is a measure of the dispersion of the observations in the sample, that is, how far each observation is from the sample mean on the average. Typically, in a sample that has a histogram that resembles a bell-shaped curve, around 68 percent of the observations lie within one standard deviation of the sample mean, and 95 percent of the observations lie within two standard deviations of the sample mean.

Maximum, minimum, and range. The maximum and minimum of the sample are the largest and smallest observations in the sample, respectively. The range is the difference, maximum minus minimum.

Upper and lower quartiles, and interquartile range (IQR). The upper and lower quartiles are defined like the median. One-quarter of the observations in the sample are at least as large as the upper quartile, and three-quarters of the observations are as small or smaller. These fractions are reversed in defining the lower quartile, so that three-quarters of the observations are at least as large as the lower quartile, and one-quarter of the observations are as small or smaller. The interquartile range is the difference, upper quartile minus lower quartile. It is an alternative measure of sample dispersion. When the histogram resembles a bell-shaped curve, the interquartile range is about 1.35 times as large as the standard deviation.

Outliers. Outliers are observations that are exceptionally large or small, so that they appear to be atypical of the majority of observations in the sample. For example, the sample 1 4 3 5 15 contains a single outlier 15. The choice of observations to call outliers is aided by an outlier cutoff rule. For example,

using the boxplot rule, an observation is a high outlier if it is more than $1.5 \times \text{IQR}$ larger than the upper quartile. There are several alternative outlier cutoff rules, and judgement must play an important role in selecting observations to classify as outliers and then perhaps to remove from the sample. If the sample includes outliers, the sample mean will be pulled towards those observations and the standard deviation will be markedly larger than when the outliers are excluded. The minimum, maximum, and range of the sample are very affected by outliers. The sample median and the interquartile range are not affected by outliers. The sample median and interquartile range are so-called resistant summaries of center and dispersion, respectively. They are thus included in a selection of summary statistics (table 4.4) for their reliability.

Cumulative distribution function. The cumulative distribution function at a given value (of bird weight, for example) is the fraction of observations less than or equal to that value. For example, the cumulative distribution function of the sample 1 3 3 4 is 0 for any value less than 1; is the fraction $1/4$ for any value equal to or greater than 1 but less than 3; is the fraction $3/4$ for any value equal to or greater than 3 but less than 4; and is 1 for any value equal to or greater than 4.

Kolmogorov-Smirnov two-sample test. The distributions of two samples can be compared using the Kolmogorov-Smirnov test. It is a nonparametric procedure, meaning that a minimum of theoretical assumptions are made about populations underlying the two samples. The Kolmogorov-Smirnov test is based on the largest absolute difference between the two cumulative distribution functions at any value (bird weight). If the difference is large, the two distributions are judged to be different. Tables and statistical algorithms are available to compute P-values and critical values to use in deciding how different the distributions are and whether the difference is significant.

P-value. In statistical testing, it is usual to state a null hypothesis; for example, that there is no difference between two distributions. Of course the two samples are different, but some differences are expected by chance even if each sample is chosen at random from a common pool or population. The P-value is the probability that a difference as large or larger than the observed difference between the two samples will be observed if two samples of the given sizes are drawn from the same population. The largest absolute difference used in the Kolmogorov-Smirnov test is a specific way of measuring the difference between the distributions of two samples. A P-value of 5 percent or lower is commonly interpreted to mean that the observed difference is unlikely to have occurred by chance, so that there is strong evidence for a substantive difference between the two groups. When the P-value is larger than 5 percent, we are more willing to accept the possibility that the two populations are the same. That does not mean that we have proved that they are the same, only that the evidence for a difference is weaker. A P-value around 10 percent can be interpreted as weak evidence that the populations are not the same. A P-value around 40 percent is no evidence at all. A P-value less than 1 percent is very strong evidence.

Critical value. The choice of P-value of 5 percent as a dividing point appears to be based on a historical perception of what is an unlikely event. Other choices are perfectly permissible, for example when we wish to strongly "protect" the null hypothesis, and not declare that there is a difference unless the evidence is very convincing. The critical value is the point at which we make

this declaration. For example, it may be the value of the largest absolute difference in the Kolmogorov-Smirnov test when the P-value equals 5 percent. The critical value will depend on the sample sizes involved.

Chi-square test. Counts of events are often arranged in a two-way table, with levels of two factors, for example damage severity and number of birds, represented by the rows and columns, respectively. These factors will be dependent if the proportion of engines with significant damage is larger (or perhaps smaller) among engines ingesting only one bird than among engines ingesting more than one bird. There is a symmetry to these statements: Equivalently we can say that engine events where there is significant damage involve multiple bird ingestions in a disproportionately high fraction of cases (relative to engine events where there is no damage or only minor damage).

When there is no dependence, the row and column factors are said to be independent. When the row and column factors are independent, the typical, or expected, number of observations in a given cell of the two-way table is simply the product of the row and column totals for that cell divided by the overall total. For example, in table 5.2 there are 77 engine events with significant damage, and 305 out of 340 engine events involve only a single bird. Therefore, if damage severity and number of birds were independent, the number of engine events with significant damage where a single bird is ingested would be around $77 \times 305/340$, or 69 (after rounding). The observed number is 77. As described above, the observed numbers will always differ from the expected numbers, whether or not the two factors are independent. However, larger differences will typically occur when the factors are dependent than when they are independent. (The differences are both positive and negative, since each row total and column total must be the same using either the observed or expected number of observations.) The chi-square statistic is computed by summing the differences over all the cells of the table, specifically using the formula

$$\text{chi-square} = \sum_{\text{all cells}} \frac{(\text{observed} - \text{expected})^2}{\text{expected}}$$

When the factors are independent, and the expected number of observations in each cell is not too small (at least 5, for example), the chi-square statistic is said to have an approximate chi-square distribution on $(r - 1) \times (c - 1)$ degrees of freedom (df), where r and c are the number of rows and columns in the table, respectively. The P-values and critical values are computed based on this distribution (using tables or algorithms) and, as with the Kolmogorov-Smirnov test, are used as evidence for and against the null hypothesis that the differences in the relative proportions between rows (or columns) of the table are due to chance fluctuations alone.

Probability of a difference. When a P-value of, for example, 14 percent is computed for a chi-square test, the claim might be made that the probability that the two factors are dependent is 86 percent. Analogously, when a P-value of 3 percent occurs using the Kolmogorov-Smirnov test, the claim might be made that the probability that the two populations are the same is only 3 percent. The probability that the two populations are different is 97 percent. These claims are justifiable if additional, Bayesian, assumptions are made about the data. They give an impression of the weight of evidence, which is the interpretation used above.

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APPENDIX C

SUMMARY OF DATA BASE CONTENTS

This appendix summarizes the contents of the FAA data base used to generate this report. Each line of information pertains to a unique engine ingestion event. The events are ordered chronologically. Unless otherwise specified, "N" denotes "no" or "none" and a "blank" entry means the information is "unknown."

The column headings are defined as follows:

DATE	Date of ingestion
EVT#	Aircraft ingestion event number (repeated in last column)
A/C	Aircraft type
ENG	Engine model
DASH	Engine model dash
POS	Engine position
SIG EVT	Significant Event (SEMB=single engine-multiple bird, MEMB=multiple engine-multiple bird, MESB=multiple engine-single bird, AIRWORTHY, TRVS FRAC=transverse fracture, INVOLPOWLOS=involuntary power loss)
ALT	Altitude of aircraft (feet AGL)
SPD	Speed of aircraft (knots, V1=decision speed, VR=rotation speed, TAXI)
CREW	Crew Action (ATO=aborted takeoff, ATB=air turn back, DIV=diversion, ALT=altitude change)
POF	Phase of flight (TR=takeoff roll, TO=takeoff, TC=takeoff or climb, CL=climb, CR=cruise, DE=descent, AP=approach, LA=landing or approach, LD=landing, LR=landing roll, RV=thrust reverse, TX=taxi)
CITYPRS	Scheduled departure-arrival airports
APT	Airport of ingestion
LOCALE	Location of airport
US	Y=US (50 states), N=Foreign (non-US), U=Unknown
BIRDNAME	Bird species - English name
SPEC	Bird species code (from reference [4])
#BDS	Number of birds ingested
WT	Bird weight (ounces)
POWLOSS	Power loss (100%, 50%, SURGE, STALLS, INVOLUNTARY, Y=yes)
VIBE	Engine vibration (maximum units, INC=increased, HIGH=high)
IFSD	In-flight engine shutdown reasons (SURGE, HI EGT=high exhaust gas temperature, SMELL=bird smell, VIBES=engine vibration, NOT BIRD=IFSD not due to bird, Y=no reason given for IFSD)

In columns A through Q, "Y"=occurrence, "blank"=non-occurrence. Columns A through Q represent specific categories of engine damage as defined in table 5.1.

A	LEADEDGE	Fan blade leading edge distortion
B	BEDE<=3	1 to 3 bent or dented fan blades
C	TORN<=3	1 to 3 torn fan blades
D	SHINGLED	Shingled (twisted) fan blades
E	ACPAFNAB	Acoustic panel or fan rub strip damaged
F	NACELLE	Engine enclosure dented or punctured
G	BEDE>3	More than 3 fan blades bent or dented
H	TORN>3	More than 3 fan blades torn
I	BROKEN	Pieces missing from fan blade leading edge or tip
J	TRVSFRAC	Fan blade broken chordwise, piece liberated
K	RELEASED	Blade retention mechanism failed
L	FLANGE	Flange separations
M	CORE	Compressor blades/vanes damaged or airflow blocked
N	TURBINE	Turbine damaged
O	SPINNER	Spinner/cap damaged
P	Other engine damage (see REMARKS)	
Q	Engine damage of unknown type (see REMARKS)	

NMS Classification of engine damage (0=no damage, 1=minor damage, 2=significant damage)

REMARKS The Remarks often contain more specific descriptions of engine damage as well as other pertinent information

DATE	EVT#	A/C	ENG	DASH	POS	SIG/EVT	ALT	SPD	CREW	POF	CITY/PRS	APT	LOCALE	US BIRD/NAME	SPEC	#BDS	WT	POW/LOSS	VIBE	IFSD	ABCODE:FGHIJ:KLHNO:PO:NHS	REMARKS	EVT#		
01/17/89	166	B747	JT90	7Q	2	N			N		SIN-OSA	XFO	SINGAPORE OR OSAKA	N		1	N		N				0	166	
01/24/89	1	B757	R8211	535C	1	MESB	0		ATB	TR	CDG-LHR	CDG	PARIS-CDG, FRANCE	N	COMMON LAPHING	5N1	1	8	N	N			0 BIRD MATTER ON NOSE COWL, OUTSIDE OF FAN	1	
01/24/89	1	B757	R8211	535C	2	MESB	0		ATB	TR	CDG-LHR	CDG	PARIS-CDG, FRANCE	N	COMMON LAPHING	5N1	1	8	N	4.7	N	YV Y Y		1 #2 ENG VIBR DUE TO CLAPPER LOCKUP	1
01/29/89	2	B757	R8211	535E4	1	N			N			XFO	GENOA, ITALY?	N		1	N		N		YV		1 DMG BLD FOUND ON GRD INSP AT BAH	2	
01/30/89	3	B757	R8211	535E4	2	N			N	LD	-PHI	PHI	PALMA, MALLORCA, SPAIN	N	GULL	1	N		N				0 BLOOD ON BLD TIPS FOUND ON GROUND INSP	3	
02/17/89	15	B747	JT90	7R462	2	N			N		-NRT	XXX	TOKYO-NRT, JAPAN?	U			N		N				0 HPC BSCOPED. NO DMG FOUND	15	
02/23/89	176	B757	2000	2037	2	N			N	CL	MCO-MSP	MCO	ORLANDO, FLORIDA	Y				STALLS		N			0 2 AUDIBLE STALLS, FLAMES FROM TAILPIPE	176	
02/25/89	111	B757	R8211	535C	1	N			N		-LHR	XFO	LONDON-LHR??	N		1	N		N				2 1 IPC BL BE/DE	111	
01/11/89	19	DC10	JT90	59A	1	N	0		N	LR	HND-FUK	FUK	FUKUOKA, JAPAN	N			N		N		Y		1 1 FB BENT AT TIP	19	
01/11/89	165	B747	JT90	7Q	3	N			N		AMS-VIE	XFO	AMSTERDAM OR VIENNA	N		1	N		N				0	165	
01/12/89	16	B747	JT90	70A	3	AIRWORTHY			N	CL	NRT-ANC	NRT	TOKYO-NRT, JAPAN	N	COMMON ROCK DOVE	2P1	1	14	N	INC		V V Y		2 10 PR FB REPLCD, 127 COHL RIVETS FRACTRD	16
01/13/89	17	A310	4000	4152	1	SEHB			N	AP	VIE-VIE	VIE	VIENNA, AUSTRIA	N	BLACK-HEADED GULL	14N36	3	10	N				0 TRAINING FLIGHT	17	
01/17/89	4	B757	R8211	535C	2	N			N			XFO	LONDON-LHR??	N			N		N				0	4	
01/17/89	179	A310	4000	4152	1	N			N			TLS	TOULOUSE, FRANCE	N			N		N				0 VIBES EXISTED PRIOR TO BIRDSSTRIKE	179	
01/18/89	18	B767	4000	4060	1	N	200	150	ATB	CL	MUC-FAD	MUC	MUNICH, GERMANY	N	COMMON LAPHING	5N1	1	7.7	N				0 SURGE, FLAMES LITU SUD INT'L. ENG REMVD.	18	
01/18/89	28	B767	4000	4060	1	N	0		ATB	TR	MUC-ATH	MUC	MUNICH, GERMANY	N			N		N				0 LTU SUD INTL	28	
01/22/89	20	DC10	JT90	59A	3	N			N		FUK-HND	XFO	FUKUOKA OR TOKYO-HND, JAPAN	N					N				0 C6 LE BL DENTS NOT CAUSED BY BIRD INGESTN	20	
01/31/89	167	B747	JT90	7Q	2	N			N		SIN-ADL	XFO	SINGAPORE OR ADELAIDE	N	"SEA GULL"	1	N		N				0 2 OTHER A/C STRIKES	167	
04/01/89	5	B757	R8211	535E4	1	N	150	135	N	TO	LHR-HAN	LHR	LONDON-LHR, ENGLAND, UK	N	"MEDIUM WHITE"	1	N		N		Y		1 1 FB LE DEFLECTION	5	
04/01/89	6	B757	R8211	535E4	2	N			N		AGP-AMS	XFO	MALAGA OR AMSTERDAM	N		1	N		N				0 BLOOD STAINS UPPER OUTER SIDE OF INTAKE	6	
04/04/89	21	B757	2000	2037	2	N	0	150	N	TR	MEM-MSP	MEM	MEMPHIS, TENN.	Y	AMERICAN ROBIN	412314	1	2.5	N			Y V Y	2 FAN CASE STRUT DMG. THUD. IFB BROKEN.	21	
04/12/89	22	B747	JT90	7R462	1	N	0	130	ATO	TR	MDH-ABJ	MDH	WINDHOEK, NAMIBIA	N		1		SURGE		SURGE			0 LOUD BANG(SURGE)	22	
04/15/89	23	B767	JT90	7R40	2	N			N		SFO-SFO	SFO	SAN FRANCISCO, CAL.	Y	BLACK-CROWNED NITE HERON	1124	1	24	N			Y	2 TRNG FLT. 5 FB BE.	23	
04/17/89	26	B747	JT90	7Q	4	N			N		SEL-NRT	XFO	SEOUL, KOREA OR TOKYO-NRT	N		1	N		N				0 BLOOD ON INLET LIP	26	
04/18/89	24	B767	JT90	7R40	1	MESB			N		FUK-HND	XFO	FUKUOKA OR TOKYO-HND, JAPAN	N	LITTLE BROWN BAT	BAT	1	0.5	N				0 UNRELATED HPC DMG. ENG REMVD.	24	
04/18/89	24	B767	JT90	7R40	2	MESB			N		FUK-HND	XFO	FUKUOKA OR TOKYO-HND, JAPAN	N	LITTLE BROWN BAT	BAT	1	0.5	N				0 WHEN, WHERE UNKNOWN	24	
04/19/89	25	B747	JT90	7Q	3	N			N		YVR-NRT	XFO	VANCOUVER OR TOKYO-NRT	N	COMMON ROCK DOVE	2P1	1	14	N				0 MAINT. FOUND BIRD REMAINS IN INLET	25	
04/20/89	7	B757	R8211	535E4	2	N	0		DIY	TR	HAM-LPA	HAM	HAMBURG, GERMANY	N	"GULL"			N	1.9	N	Y	Y	1 DIV TO HUC AT END OF CLIMB	7	
04/23/89	30	B747	JT90	7Q	2	N			N		TYO-OSA	XFO	TOKYO-TYO OR OSAKA, JAPAN	N		1	N		N				0 BLOOD FOUND IN TOKYO PRE-DEPART CHECK	30	
04/30/89	27	A310	JT90	7R4E1	2	N			N	AP	-BRU	BRU	BRUSSELS, BELGIUM	N	COMMON ROCK DOVE	2P1		14	N				0 BIRD RMNS. ON FB'S	27	
05/02/89	168	B747	JT90	7R462	2	SEHB			N		SIN-	XXX		U		>1	N		N				0 50 FLT #447 SPINNER HIT	168	
05/04/89	31	B767	JT90	7R40	2	SEHB	0	100	N	TR	HND-	HND	TOKYO-HND, JAPAN	N	GRAY-HEADED LAPHING	5N20	3	10	N				0 SMALL WHITE BIRDS-TBI	31	
05/10/89	32	A300	JT90	59A	1	SEHB, INVOLPOHLOS	0	VR	ATB	TR	BCN-MAD	BCN	BARCELONA, SPAIN	N	HERRING GULL	14N14	3	36	100Z, SURGE	HI	EGT	Y	Y Y	2 EPR=0, HI EGT, SURGE, VIDEO TAPE	32
05/14/89	33	A300	JT90	7R4H1	1	N	0	VI	N	TR	KRT-JED	KRT	KHARTOUM, SUDAN	N	RING-NECKED DOVE	2P61		5	N			Y	1 2 PR FB REPLACED	33	
05/17/89	8	B757	R8211	535E4	1	N	1000	135	N	AP	AMS-PHI	PHI	PALMA, MALLORCA, SPAIN	N	COMMON SAND MARTIN	18229	1	16	N				0 STRIKE ON OUTSIDE OF COWL	8	
05/24/89	9	B757	R8211	535C	2	N	0		N	LR	ESB-IST	IST	ISTANBUL, TURKEY	N	"GULL"	1	N		N		Y	Y	1 LINING DMG AFT OF FAN	9	
05/28/89	10	B757	R8211	535C	1	N			N		FCO-LHR	XFO	ROME OR LONDON-LHR	N		1	N		N			Y	1 1 FB CLAPPER DMGCD	10	
06/02/89	169	B747	JT90	7R462	1	N	0	100	ATO	TR	BOH-SIN	BOH	BOMBAY, INDIA	N		1		SURGE		N			0	169	
06/03/89	34	A310	4000	4152	1	N	0	100	ATO	TR	PEN-SIN	PEN	PENANG, MALAYSIA	N	"FISH EAGLE"	1		SURGE		N			0 SURGE, NO BIRD REMAINS	34	
06/07/89	35	B767	JT90	7R40	2	N			N		SPK-NGO	XFO	SAPPORO OR NAGOYA, JAPAN	N			N		N				0 BD. REMNS. FD ON GRD AT NAGOYA-SPINNR. FEGV	35	
06/09/89	36	B767	JT90	7R40	1	N	1000		N	AP	NGO-SPK	SPK	SAPPORO, JAPAN	N	FORK-TAILED SHIT	1070	1	1.5	N				0 FOUND ON WALKAROUND	36	
06/10/89	42	A320	V2500	A1	1	N			N	AP	-ZRH	ZRH	ZURICH, SWITZERLAND	N				N					0 INLET COWL HIT. NO INGESTION EVIDENCE	42	
06/13/89	11	B757	R8211	535E4	1	N	0	120	ATO	TR	VCE-LGH	VCE	VENICE, ITALY	N	"SEAGULL"	1	N		4.0	N	Y	YV	1 2 FB SHAGLD, TIP DMG	11	
06/14/89	12	B757	R8211	535C	1	N			N	LD	CFN-LGH	LGH	LONDON-GATWICK, ENGLAND, UK	N			N		N		Y	Y	2 1 IPC BL BE/DE	12	
06/18/89	37	A320	V2500	A1	1	N			N		BEG-LJU	BEG	BELGRADE, YUGOSLAVIA	N	EURASIAN KESTREL	5K27		7	N				0 BDRSTRIKE EVIDENCE FOUND ON WALKAROUND	37	
06/18/89	39	B747	JT90	7R462	3	AIRWORTHY			ALT	CL	SPK-HND	SPK	SAPPORO, JAPAN	N	BLACK KITE	3K28	1	32	N		Y	Y	2 12 FB BE. PLANNED ALT WAS CHANGED.	39	
06/18/89	40	B747	JT90	7Q	3	N			N	AP	LAX-ANC	ANC	ANCHORAGE, ALASKA	Y					N				0 BIRD RMNS IN GUIDE VANES	40	
06/24/89	44	DC10	JT90	59A	1	N	0		N	LR	OSA-OKA	OKA	OKINAWA, JAPAN	N	"SMALL BIRDS"			N					0 FLOCK OF SMALL BIRDS	44	
07/01/89	69	B767	CF6	80C2	2	N	0		N	LR	-TOY	TOY	TOYAMA, JAPAN	N		1	N		N			Y	2 6 HPC BLD5 DMGD	69	
07/02/89	13	B757	R8211	535E4	2	N	0		N	TR	TLV-FCO	TLV	TEL AVIV, ISRAEL	N		1	N		N				0 FLT CONTINUED NORMALLY. UNVALD TO 8oz WT	13	
07/02/89	41	B767	JT90	7R40	2	N	0		N	LR	FUK-OKA	FUK	FUKUOKA, JAPAN	N	COMMON ROCK DOVE	2P1		14	N				0 BRD REMNS FAN EXIT GUIDE VANES	41	
07/02/89	170	A310	4000	4152	1	N	15		N	TO	PEN-SIN	PEN	PENANG, MALAYSIA	N	"1 LARGE BIRD"	1	N		N		Y	Y	1 1 FB DMGD. HPC BLS MINOR NICKS	170	
07/04/89	38	A320	V2500	A1	2	N	0		N	AP	DEL-BOH	BOH	BOMBAY, INDIA	N	"EAGLE"	1	N		N		YV	Y	1 2FB, FAN CASE PANEL. PASSNGR SAW GLB EAGLE	38	
07/06/89	177	B757	2000	2037	2	N	0		N	TR	XUS			Y			N		INC	N	Y		1 IFSD?? 1-2 FB BE	177	
07/12/89	14	B757	R8211	535C	2	N	0	120	N	LR	LHR-GVA	GVA	GENEVA, SWITZERLAND	N	GREATER KESTREL	5K24	1	9.6	N				Y	2 4 IPC BL BENT. HI IDLE=38% FAN SPEED	14
07/12/89	43	A320	V2500	A1	2	N	0	40	N	RV	LJU-TIV	TIV	TIVAT, YUGOSLAVIA	N	HERRING GULL	14N14	1	32	N				0 A/C AT FULL THRUST REVERSE, "1/2 BIRD"	43	
07/14/89	49	A320	CFM56	5	1	N			N		-HEL	XFO	MELBOURNE, AUSTRALIA?	N		1	N		N				0 PREFLIGHT INSP.	49	
07/14/89	70	B767	CF6	80C2	2	N			N			XFO	JAPAN	N		1	N		N				0 GROUND INSP.	70	
07/15/89	45	B747	JT90	7R462	2	N			N	LD	-CDG	CDG	PARIS-CDG, FRANCE	N					N				0	45	
07/15/89	55	B767	CF6	80A	1	N			N	AP	-NGO	NGO	NAGOYA, JAPAN	N		1			N		Y		1 2 FB BENT	55	
07/17/89	46	A320	V2500	A1	1	N			N	LD	BEG-LJU	LJU	LJUBLJANA, YUGOSLAVIA	N	EURASIAN KESTREL	5K27		8	N		Y	Y	1 DMG FN CASE PANEL CONTINUE IN SERVICE	46	

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DATE	EVT#	A/C	ENG	DASH	POS	SIG/EVT	ALT	SPD	CREW	POF	CITY/PRS	APT	LOCALE	US BIRD/NAME	SPEC	#BDS	HT	POW/LOSS	VIBE	IFSD	ABCD:FGHIJ:KLMO:PO:NHS	REMARKS	EVT#	
12/13/89	86	A320	CFH56	5	2	N			N		-SAN	XUS	SAN DIEGO, CAL.	Y		1	N		N				0	86
12/14/89	97	A310	CF6	80A	1	MEMB	0		N	LR	ANK-IST	IST	ISTANBUL, TURKEY	N	14N36	6-17	10	N		N	Y	1 20 FB SHGLD, 1FB BLENDABLE	97	
12/14/89	97	A310	CF6	80A	2	MEMB	0		N	LR	ANK-IST	IST	ISTANBUL, TURKEY	N	14N36	6-17	10	N		N		0 HIT IMMED. AFTER TOUCHDOWN. OVER 100HIT AC	97	
12/15/89	221	B747	JT90	7Q	1	N			N		TPE-BKK	XFO	TAIPEI OR THAILAND	N						N		0 EVIDENCE FOUND IN INLET ON GROUND	221	
12/19/89	216	A310	JT90	7R4	2	N	0		ATB	TR	BRU-	BRU	BRUSSELS, BELGIUM	N	5N1	1	7.7			N	Y:YV Y	2 INV. 4FB BE, 2FB BKN. 14FB DMG. ALL FB RPLCD	216	
12/19/89	220	A300	JT90	7R4H	1	N	0		N	LR	MED-JED	JED	JEDDAH, SAUDI ARABIA	N						N		0 POWER AT REVERSE IDLE	220	
12/20/89	109	B767	CF6	80C2	2	N			N	LD	-TYO	TYO	TOKYO-TYO, JAPAN	N		1	N		N	N	Y:YV	2 7 FB DMG, STG 1 OMP BLS. TORN	109	
12/23/89	110	A310	CF6	80C2	2	N			N		-HBR	XFO	HOMBASA, KENYA?	N		1	N			N		0 SLIGHT FB DMG WITHIN LIMITS	110	
12/28/89	116	B757	R8211	535C	2	SEMB	800	150	DIV	TO	BFS-LHR	BFS	BELFAST, N. IRELAND, UK	N	5N1	3	8	N		N	YV: Y	2 4FB, 15IPC BL BE/DE. INVESTGTD	116	
12/31/89	87	A320	CFH56	5	1	N	0		N	LR	-LYS	LYS	LYON, FRANCE	N		1	N			N	YVY	1	87	
01/01/90	215	B767	4000	4056	2	N	0	80	ATO	TR	HRE-LGW	HRE	HARARE, ZIMBABWE	N	2544	1	26					0 BANG, SHEL, FLAMES, SURGE. VOL POWER RED.	215	
01/01/90	218	A310	4000	4158		N			N			XFO	KOREA OR INDONESIA	N	TBI	1						0 FOUND DURING OVERHAUL. INTO CORE. ENG DMG?	218	
01/02/90	191	B747	CF6	80C2	2	N	0		N	LR	-HKG	HKG	HONG KONG	N		1	N		5.0	N	Y	1 1 FB LE DISTORTION	191	
01/09/90	192	A310	CF6	80C2	1	N			N	LD	-LCA	LCA	LARNACA, CYPRUS	N		1	N			N		0 DENT ON INLET COWL LIP GRD INSP	192	
01/14/90	184	B767	CF6	80A	1	SEMB	0		N	LR	-LTN	LTN	LONDON-LUTON, ENGLAND, UK	N	4L85	2	14	N		N	YV Y	1 3 FB RPLCE. LE DENT, TIP CURL.	184	
01/15/90	219	B767	JT90	7R4	1	SEMB	300	145	N	AP	HND-SPK	SPK	SAPPORO, JAPAN	N	2J115	2	35				YV: Y Y	2 BENT CS BLD PREVIOUS STRIKE EVIDENCE	219	
01/16/90	193	A310	CF6	80C2	1	MESB			N		-DLA	XFO	DOUALA, CAMEROON ???	N		1	N			N		0 PREFLITE INSP AT DLA	193	
01/16/90	193	A310	CF6	80C2	2	MESB			N		-DLA	XFO	DOUALA, CAMEROON ???	N		1	N			N		0 PREFLITE INSP AT DLA	193	
01/18/90	194	A310	CF6	80C2	2	N			N	LD	-SKF	SKF	E. BERLIN, GERMANY	N	"CROW"?	1	N			N		0 STAIN ON SPINNER, BOOSTER INLET.	194	
01/24/90	195	B767	CF6	80C2	1	N	0		N	LR	-IGU	IGU	IGUASSA FALLS, BRAZIL	N		1	N			N		0 ING. INTO BOOSTER AREA	195	
01/28/90	185	A310	CF6	80A	2	N			ATB	CL	ANK-	ANK	ANKARA, TURKEY	N		1	N		3.5	N	Y Y	1 2 FB LE DISTORT	185	
01/28/90	196	A300	CF6	80C2	2	N			N		BKK-CNX	XFO	THAILAND	N		1	N			N		0	196	
01/29/90	197	B767	CF6	80C2	2	N			N		-VYZ	XFO	TORONTO, CANADA ??	N		1	N			N		0 GRD. INSP.	197	
01/30/90	180	A320	CFH56	5	2	N	0		ATB	CL	CDG-	CDG	PARIS-CDG, FRANCE	N	TBI	1	N			N	Y	1 8 OGV FAIRINGS BRN. 5 PR FB RPLCD	180	
02/02/90	186	B767	CF6	80A	1	N			N		-MYJ	XFO	HATSUYAMA, JAPAN ??	N		1	N			N		0 EUDNCE FOUND GRD. INSP.	186	
02/08/90	222	B767	JT90	7R4D	2	N			N		TLV-CDG	XFO	TEL AVIV OR PARIS-CDG	N						N	Y	1 2 FB BE	222	
02/09/90	244	A310	JT90	7R4E	1	MESB			N		SIN-CMB	XFO	SINGAPORE/COLOMBO, SRILANKA	N								0 WALK AROUND. ZULU TIME.	244	
02/09/90	244	A310	JT90	7R4E	2	MESB			N		SIN-CMB	XFO	SINGAPORE/COLOMBO, SRILANKA	N								0 WALK AROUND. ZULU TIME.	244	
02/10/90	198	B747	CF6	80C2	1	N	0		N	LR	-JKT	JKT	JAKARTA, INDONESIA	N		1	N			N		0	198	
02/11/90	187	B767	CF6	80A	2	N			N		-JFK	XUS	NEW YORK-JFK, NY ???	Y		1	N			N		1 1 FB RPLCD	187	
02/11/90	226	B747	4000	4056	2	SEMB			N		LAX-SYD	XXX	LOS ANGELES/SYDNEY, AUSTRALIA	U		>1					Y	1 3 FB DMG	226	
02/11/90	243	A310	JT90	7R4E	2	N	1340	130	N	AP	KTH-CCU	CCU	CALCUTTA, INDIA	N	"BIG HAWK"	1						0	243	
02/12/90	199	B767	CF6	80C2	2	N			N		-OSA	XFO	OSAKA, JAPAN ???	N		1	N			N		0 GRD. INSP.	199	
02/12/90	224	DC10	JT90	59A	3	N			N		NRT-BKK	XFO	TOKYO-NRT OR BANGKOK	N	6N47	1	5			N		0 GRD INSP. C1 STATOR HIT	224	
02/13/90	181	A320	CFH56	5	1	N			N		BRE-FRA	XFO	BRENNEN/FRANKFURT, GERMANY	N	TBI	1	N			N		0 ODD ON PREVIOUS FLIGHT	181	
02/13/90	227	A310	JT90	7R4E	2	N					-BRU	XFO	BRUSSELS, BELGIUM??	N	2J84	1	40					0 BIRD INTO CORE. WALKAROUND.	227	
02/14/90	182	A320	CFH56	5	1	N	0		N	LR	-TLS	TLS	TOULOUSE, FRANCE	N		1	N			N		0	182	
02/14/90	251	A300	JT90	59A	1	N	0		N	TR	DPS-	DPS	DENPASAR, BALI	N		1					Y	1 3 FB BE	251	
02/18/90	200	B747	CF6	80C2	4	N	0		N	LR	-AMS	AMS	AMSTERDAM, NETHERLANDS	N		1	N		4.1	N		2 11 DMG FB.	200	
02/19/90	188	B767	CF6	80A	1	N			N			XFO	BRAZIL?	N	1K4	1	48	N		N	Y	2 12 HPC STG 1 BL DMG. ENG RPLCD.	188	
02/21/90	201	B767	CF6	80C2	1	MESB	0	V1	ATB	TR	AMS-	AMS	AMSTERDAM, NETHERLANDS	N	5N1	1	7.7	N		N	Y	1 3 FB TIP CURL	201	
02/21/90	201	B767	CF6	80C2	2	MESB	0	V1	ATB	TR	AMS-	AMS	AMSTERDAM, NETHERLANDS	N	5N1	1	7.7	N		N	Y	1	201	
02/21/90	225	B767	JT90	7R4D	1	MEMB	800		N	AP	OSA-HND	HND	TOKYO-HND, JAPAN	N	2J124	>1	36				Y	2 BENT 5-8 BLADES MULTI-BIRD??	225	
02/21/90	225	B767	JT90	7R4D	2	MEMB	800		N	AP	OSA-HND	HND	TOKYO-HND, JAPAN	N	2J124	1	36					0	225	
02/24/90	223	A300	JT90	7R4H	1	N	0	VR	ATB	TR	NBO-JED	NBO	NAIROBI, KENYA	N	5L3	1	52		2.0	N	Y Y:Y Y	2 SHEL, BANG. 3FB LE TIP BRKN, FEGV BRKN	223	
02/26/90	202	B767	CF6	80C2	2	N	0		N	LR	-SHJ	SHJ	SHARJAH, UA EMIRATES	N		1	N			N		0	202	
02/27/90	206	A310	CF6	80C2	2	N	V1+		ATB	TO	SKF-	SKF	E. BERLIN, GERMANY	N	4L85	1	14	N		2.8	N	YV	1 1FB TORN, 1FB DISTORTED	206
03/02/90	228	B757	2000	2037	2	N			N		ATL-MSV	XUS	ATLANTA OR NEW ORLEANS	Y		1	N			N	Y	2 3 FB DMG, 1 LE TIP BRK OUT	228	
03/04/90	203	B767	CF6	80C2	2	N			N		-AXT	XFO	AKITA, JAPAN ???	N		1	N			N		2 3 STG 1 COMP BL SHIFTED--SERVICEABLE	203	
03/05/90	183	A320	CFH56	5	2	N	0	120	N	TR	LST-HEL	LST	LAUNCESTON, AUSTRALIA	N	TBI	1	N		9.9	N	YV: Y	2 20 FB DMG. ENG RMVD. 1 FB TIP FRAG.	183	
03/05/90	189	B767	CF6	80A	1	N			N		-OKJ	XFO	OKAYAMA, JAPAN ??	N		1	N			N		0 FD. GROUND INSP.	189	
03/07/90	204	B747	CF6	80C2	3	N	0		N	LR	JFK-AMS	AMS	AMSTERDAM, NETHERLANDS	N	4L161	1	32	N		N	Y	1 3 FB LE DISTORT-RPLCD	204	
03/09/90	229	B767	4000	4056	1	N	0	70	N	LR	HRE-NBO	NBO	NAIROBI, KENYA	N	3K28	1	28	N		N	Y	1 STRONG SHEL. 1 BL BE.	229	
03/16/90	230	A300	JT90	7R4H1	1	N			N		RUH-JED	XFO	RIYADH OR JEDDAH, S. ARABIA	N		1					Y	1 DENTED COWL LIP. WALK AROUND.	230	
03/16/90	231	A300	JT90	7R4H	2	N	144		N	CL	DHA-RUH	DHA	DAHHRAN, SAUDI ARABIA	N	14N14	1	40		HIGH	N	U Y	2 INLET COWL: 46 HOLES. 2 FB BRK. OUT	231	
03/17/90	207	B757	R8211	535C	1	N			N		LHR-MAN	XFO	LONDON-LHR/MANCHESTER, ENG.	N		1	N			N		0 BIRD MATTER DOWN BYPASS DUCT	207	
03/24/90	190	B767	CF6	80A	1	N			N		-TYO	XFO	TOKYO-TYO, JAPAN ???	N		1	N			N		0 FD. GRD INSECT	190	
03/24/90	232	B747	JT90	7Q	3	N	0		N	TR	BUE-RIO	BUE	BUENOS AIRES, ARGENTINA	N		1	N			N	Y: Y	2 AT CRUISE RPM 1.5.7 FB DMG, 3FB BRKN	232	
03/26/90	205	A310	CF6	80C2	2	N			N		-FRA	XFO	FRANKFURT, GERMANY ??	N		1	N			N		0 GRD INSP	205	
04/02/90	276	A310	CF6	80A	2	N			N	AP	-SHJ	SHJ	SHARJAH, UA EMIRATES	N		1	N			N	Y:	2 16FB DMG BEYOND LIMITS. 6ACOU LINERS DMG	276	
04/04/90	233	B767	JT90	7R4D	1	N	300		N	AP														

DATE	EVT#	A/C	ENG	DASH	POS	SIG/EVT	ALT	SPD	CREW	POF	CITY/PRS	APT	LOCALE	US BIRDNAME	SPEC	#BDS	HT	POWLOSS	VIBE	IFSD	ABCODE	FGHIJ	KLHNO	PQ	NMS	REMARKS	EVT#
04/06/90	265	A320	CFH56	5	2	SEMB	137	N			LIL-LIL	LIL	LILLE, FRANCE	N "DOVES"		2	N		9.9	N						2 7FB DMG, 14FB RPLCD. TO OR LD? UNVAL 8ozHT	265
04/06/90	277	B767	CF6	80A	1	N		N			-ARB	XFO	ARLANDA, SWEDEN??	N		1	N		N							0 EVIDENCE ON HP STATOR VANES. GRD INSP	277
04/06/90	292	B767	CF6	80C2	2	SEMB	10	N			-WAW	WAW	WARSAW, POLAND	N BLACK-HEADED GULL	14N36	>1	10	N		N						0 DEBRIS ON ALL FB. MIDSPAN CORE ING	292
04/09/90	279	A310	CF6	80A	1	N	0	N			-DUS	DUS	DUSSELDORF, GERMANY	N		1	N		N							0	278
04/11/90	293	B767	CF6	80C2	2	N		N			LAX-YVR	XXX	LOS ANGELES OR VANCOUVER	N		1	N		N							0 DEBRIS IN BOOSTER & COMP INLET. GRD INSP.	293
04/12/90	266	A320	CFH56	5	2	N		N			LHR-DUS	LHR	LONDON-LHR, ENGLAND, UK	N		1	N		5.9	N		Y	Y			1 2 FB DE, 8 FB RPLCD	266
04/13/90	235	B757	2000	2037	2	N		N			AP MSP-OC	OC	WASHINGTON-NATIONAL, DC	Y OSPREY	2K1	1	55			N				Y		2 6 SETS FB RPLCD.	235
04/16/90	279	B767	CF6	80A	1	N		N			-FUK	XFO	FUKUOKA, JAPAN???	N		1	N		N							0 GROUND INSP	279
04/16/90	294	B747	CF6	80C2	2	N	0	N			LR YOH-AMS	AMS	AMSTERDAM, NETHERLANDS	N RING-NECKED PHEASANT	4L161	1	34	N		N						0 NO CORE ING	294
04/16/90	295	B767	CF6	80C2	1	N		N			-TYO	XFO	TOKYO-TYO, JAPAN???	N		1	N		N							0 GRD INSP.	295
04/16/90	296	B767	CF6	80C2	2	N		N			-TYO	XFO	TOKYO-TYO, JAPAN???	N		1	N		N							0 GRD INSP	296
04/17/90	208	B747	RB211	524G	3	N		N			LD PAE-PAE	PAE	EVERETT, WASHINGTON	Y CANADA GOOSE	2J30	1	128	N		N				Y		2 16 HPC BL BE-NOT SOFT BODY PRE DLVRV	208
04/18/90	297	B767	CF6	80C2	1	N	0	V1+	ATB	TR	ORY-JFK	ORY	PARIS-ORY, FRANCE	N		1	N		N			Y				1 3FB DMGD. 2 PR FB RPLCD.	297
04/19/90	298	B767	CF6	80C2	1	N	1000	N			AP YVR-VYZ	VYZ	TORONTO, CANADA	N		1	N		N							0 BIRD ING. INTO CORE	298
04/19/90	299	A310	CF6	80C2	2	N	0	V1+	ATB	TR	AVT-	AVT	ANTALYA, TURKEY	N EGYPTIAN VULTURE	3K43	1	75	N		2.6	N		Y	Y		2 ALL FB RPL, MIN DMG INLET/COIL, ACOL. PANEL	299
04/23/90	280	B767	CF6	80A	2	N		N			-TYO	XFO	TOKYO-TYO, JAPAN???	N		1	N		N							0 GROUND INSP	280
04/25/90	300	B747	CF6	80C2	4	N		N			AND-FUK	XFO	TOKYO-AND OR FUKUOKA, JAPAN	N COMMON SKYLARK	17272	1	1.5	N		N						0 DEBRIS ON COIL, FB'S, SPINNER, PRIM. GASPATH	300
04/26/90	301	B767	CF6	80C2	1	N		N			-HYJ	XFO	HATSUYAMA, JAPAN??	N		1	N		N			YY				1 1 FB WITH DE & AXIAL CRACK RPLCD.	301
04/26/90	302	A310	CF6	80C2	1	N		N			SXF-PFO	XFO	E. BERLIN OR CYPRUS	N		1	N		N							0 GRD INSP AT PHAPHOS, CYPRUS	302
04/30/90	236	A310	4000	4152	1	N	0	N			TX BNE-POM	BNE	BRISBANE, AUSTRALIA	N "HAWK"		1						Y	Y			1 TAXI OUT. 1FB NICKED. FAIRING DELAM	236
05/02/90	258	A310	4000	4152	2	N		N			-TPA	XUS	TAMPA, ST. PETE ??	Y		1	N		N			Y				1 2 FB LE BE. WALKAROUND	258
05/02/90	281	B767	CF6	80A	1	N		N			-TOY	XFO	TOYAMA, JAPAN ??	N		1	N		N							0 HIT FAN OGV'S & INLET GOWL LIP. GRD INSP.	281
05/02/90	303	A310	CF6	80C2	2	N	0	N			LR EBB	EBB	ENTERBE, UGANDA	N AFRICAN FISH EAGLE	3K??	1	100	N		3.4	N		Y			1 VIBES ON SUBS. FLITE. 5FB RPLD, 3FB SHGLD.	303
05/03/90	259	B747	4000	4056	3	N		N			CL TPE-HKG	TPE	TAIPEI, TAIWAN	N		1				4.9	N		Y			1 3 FB BE. BANG. NO SURGE. PARAMETER SHIFT	259
05/03/90	304	A310	CF6	80C2	2	N	0	N			LR LBA	LBA	LEEDS-BRADFORD, ENGLAND, UK	N "GULL"		1	N		N							0 AT TOUCHDOWN	304
05/04/90	267	A320	CFH56	5	1	N	0	V1+	ATB	TR	LIL-	LIL	LILLE, FRANCE	N		1	N		INC	Y		Y				1 3 PR FB RPLCD LE DISTORTION	267
05/05/90	305	A300	CF6	80C2	1	N		N			-BKK	XFO	BANGKOK, THAILAND??	N		1	N		N			Y				1 FB#11 DE & REPAIRED	305
05/08/90	282	B767	CF6	80A	1	N		N			AP HYJ	HYJ	HATSUYAMA, JAPAN	N		1	N		N					Y		2 STG 1 HPC BL BE DE	282
05/09/90	237	B767	JT90	7R40	2	N		N			AP MRT-NGO	NGO	NAGOYA, JAPAN	N LITTLE BROWN BAT	BAT	1	8.3		N							0 BAT HIT COIL.	237
05/10/90	306	B767	CF6	80C2	1	N		N			AP TOY	TOY	TOYAMA, JAPAN	N		1	N		N							0 BIRD HIT FB'S, OGV, LPC IGV'S	306
05/11/90	283	B767	CF6	80A	1	N		N			-OSA	XFO	OSAKA, JAPAN ???	N		1	N		N							0 GRD. INSP	283
05/12/90	249					N		N				XFO	N BLACK KITE	3K28		29										SHOP FINDING. LITTLE DATA. DAMAGED??	249
05/13/90	239	B767	4000	4060	1	N		N				XFO	N JAR FALCON	5K??		1	46.4									0	239
05/15/90	209	B757	RB211	535E4	2	N		N			TFS-AMS	XFO	TENERIFE OR AMSTERDAM	N		1	N		N						Y	2 SPINNER RUBBER TIP DMGD	209
05/17/90	284	A310	CF6	80A	2	N		N			-STR	XFO	STUTTGART, GERMANY ??	N		1	N		N							0 BLOOD IN CORE INLET. GRD INSP.	284
05/18/90	285	A310	CF6	80A	1	N	0	N			LR LHR-LCA	LCA	LARNACA, CYPRUS	N COMMON LAPHING	5N1	1	7.7	N		N		Y				1 2 FB RPLCD	285
05/20/90	307	B747	CF6	80C2	4	N		N			-GIG	XFO	RIO DE JANEIRO, BRAZIL??	N		1	N		N							0 GRD INSP	307
05/22/90	210	B757	RB211	535E4	1	N		N			LD -KEV	KEV	KEVLAVICK, ICELAND	N "LARGE"		1	N		N							0 HEAVY DEBRIS IN BY-PASS "L6"BD	210
05/23/90	268	A320	CFH56	5	1	SEMB	0	V1+	N	TR	SYD-MEL	SYD	SYDNEY, AUSTRALIA	N		2	N		INC	N		Y			Y	2 SFBDMGD, 2FBLE TEARS. 2 SPINNER CONES RPLCD	268
05/26/90	248	B767	JT90	7R40	2	N	0	120	N	TR	SHI-	SHI	SHIMOJISHIMA, JAPAN	N LITTLE EGRET	1I50	1	17									0 DATA NOT ON REPORT	248
05/27/90	211	B757	RB211	535E4	1	N	13000	N			CR XXX	XXX	MEXICO OR TEXAS	U		1	N		N							0 MEXICAN GOVT A/C	211
05/29/90	308	B767	CF6	80C2	2	N		N			-NGS	XFO	NAGASAKI, JAPAN??	N		1	N		N							0 GRD. INSP.	308
05/30/90	309	A310	CF6	80C2	1	N		N			CL MGO-	MGO	MISKOLC, HUNGARY	N		1	N		3.4	N					Y	2 4 FB DMGD BEYOND LIMITS	309
05/31/90	247	A300	JT90	59A	1	INVOLPOMLOS	0	VR	ATB	TR	IBZ-	IBZ	IBIZIA, SPAIN	N HERRING GULL	14N14	1	40	INVOLUNTARY	INC	HIEGT, VIBES				Y	Y	2 FUEL DUMPED. SURGE. DAMAGED? CONTAINED?	247
05/31/90	250	B767	JT90	7R4E	1	N		N			CL AKL-SYD	AKL	RUCKLAND, NEW ZEALAND	N		1	N									0 INTO CORE	250
06/01/90	238	B767	4000	4056	1	N	0				TR LIM-SCL	LIM	LIMA, PERU	N "SMALL SEAGULL"		1	N									0 SHELL. 8-12 OZ. SEAGULL.	238
06/04/90	310	A300	CF6	80C2	2	N		N			-LTN	XFO	LONDON-LUTON, ENGLAND??	N		1	N		N							0 GRD INSP. NO CORE ING.	310
06/07/90	269	A320	CFH56	5	1	N		N			-MSP	XUS	MINNEAPOLIS??	Y		1	N							Y	Y	2 SLITE HPCATHSTGVANE YIELDING. 50GVSPACERS	269
06/07/90	311	B767	CF6	80C2	2	N		N			AP -KCZ	KCZ	KOCHI, JAPAN	N		1	N		1.9	N		Y				1 3 FB SHINGLED-REPLCD.	311
06/07/90	312	A310	CF6	80C2	1	N	0	N			LR -LCA	LCA	LARNACA, CYPRUS	N CHUKAR	4L37	1	18	N		N						0 BIRD HIT MIDSPAN SHROUD AREA	312
06/08/90	313	B767	CF6	80C2	2	N		N			-OSA	XFO	OSAKA, JAPAN???	N		1	N		N							0 CORE ING.	313
06/09/90	212	B757	RB211	535C	2	N		N			-MAN	XFO	MANCHESTER, ENG ???	N		1	N		N					Y		2 UNK# IPC BL DMG. ENG RMVD	212
06/09/90	270	A320	CFH56	5	2	N	0	V1	ATO	TR	BSL-LHR	BSL	BASEL, SWITZERLAND	N		1	N								Y	2 17 FB DMGD, REPLCD	270
06/10/90	271	A320	CFH56	5	1	N	0	N			LR -RMA	RMA	ROMA, AUSTRALIA	N		1	N		N							0 ALL ENG PARAMS NORMAL	271
06/11/90	286	B767	CF6	80A	1	N		N			-TAK	XFO	TAKAMATSU, JAPAN ??	N		1	N		N							0 BIRD HIT SPINNER. GRD INSP	286
06/12/90	272	A320	CFH56	5	1	N	0	V1+	ATB	TR	LVS-BOO	LVS	LYON, FRANCE	N		1	N		6.0	N		Y			Y	2 7 FB SEVERE DMG, DEFORM. SHRODS PRFB RPLCD	272
06/12/90	314	A300	CF6	80C2	1	N	100	140	N	LD	PEK-SHA	SHA	SHANGHAI, CHINA	N COMMON ROCK DOVE	2P1	1	14	N		N						0 BIRD ENTERED BOOSTER, EXITED VBV DOOR	314
06/13/90	213	B757	RB211	535E4	1	N		N			ALA-MUC	XFO	MALTA OR MUNICH	N		1	N		N							0 DEBRIS FOUND GROUND INSP.	213
06/13/90	287	B767	CF6	80A	1	N	0	N			LR -SDJ	SDJ	SENDAI, JAPAN	N		1	N		N							0 BIRDS HIT ENG. COCKPIT CABIN FLOCK????	287
06/14/90	273	A320	CFH56	5	2	SEMB		N			-MEL	XFO	MELBOURNE, AUSTRALIA??	N "SMALL"		2	N		N			Y				1 VIBES ON SUBSEQUENT FLITES. FAN SET RPLCD	273
06/17/90	214	B757	RB211	535E4	1	MEMB	30	110	N	LD	-BOS	BOS	BOSTON, MASS.	Y HERRING GULL	14N14	>1	32	N		N						0 DEBRIS DOWN BY-PASS	214

DATE	EVT#	A/C	ENG	DASH	POS	SIG/EVT	ALT	SPD	CREW	POF	CITY/PRS	APT	LOCALE	US BIRDNAME	SPEC	#BDS	WT	POWLOSS	VIBE	IFSD	:A:B:C:D:E:F:G:H:I:J:K:L:M:N:O:P:Q:R:S:T:U:V:W:X:Y:Z:	REMARKS	EVT#
06/17/90	214	B757	RB211	535E4	2	MEMB	30	110	N	LD	-BOS	BOS	BOSTON, MASS.	Y HERRING GULL	14N14	4-5	32	N	N	N	:	0 3 BDS HIT FAN, 1-2 DOWN CORE	214
06/19/90	274	A320	CFH56	5	1	N	0	V1+	N	TR	PAU-ORY	PAU	PAUK, BURMA	N		1	N		N	N	:	0 OROR. ALL ENG PARAMS NORMAL	274
06/19/90	315	A300	CF6	80C2	1	N	0	V1+	N	TR	BOM-DXB	BOM	BOMBAY, INDIA	N BLACK KITE	3K28	1	28	N	3.0	N	:VY:	1 3 FB BE, 3 OGV'S SPLIT TRAILING EDGE	315
06/20/90	246	B747	4000	4158	1	N	0	TAXIN			SEL-CDG	XFO	SEOUL OR PARIS-CDG	N		1	N		N	N	:	0 WALKAROUND. FRESH REMNS FB'S & EXIT VANES	246
06/20/90	288	B767	CF6	80A	2	N			N		-KMH	XFO	KUHAMOTO, JAPAN??	N		1	N		N	N	:	0 GRD INSP	288
06/22/90	289	B767	CF6	80A	2	N			N		-NGS	XFO	NAGASAKI, JAPAN ??	N		1	N		N	N	:	0 BIRD HIT FAN BOOSTER IGV 6:00 POSITION	289
06/25/90	290	B767	CF6	80A	2	N			N		-OSA	XFO	OSAKA, JAPAN ??	N		1	N		N	N	:	0 GRD INSP.	290
06/26/90	291	B767	CF6	80A	1	N			N		-OSA	XXX	OSAKA, JAPAN ??	U		1	N		N	N	:	0 GRD INSP	291
06/27/90	241	B747	JT90	7A	3	N	0	VR	DIV	TR	LXS-ATH	LXS	LENNOS, GREECE	N HERRING GULL	14N14	1	40		HIGH	VIBES	:Y:VY:Y:	2 COHL PEN. 4FB BE, 1 BROKEN, PIECE HIT #4 ENG	241
06/29/90	240	B767	JT90	7R4E	2	N	400	ATB	CL	ALG-MEL	ALG	WELLINGTON, NEW ZEALAND	N RED-BILLED GULL	14N7	1	11		HIGH	N	N	:Y:Y:	1 1 BL BE. VOL POWER RED.	240
06/29/90	275	A320	CFH56	5	1	N	0	V1-	N	TR	FRA-	FRA	FRANKFURT, GERMANY	N		1	N		N	N	:	0 OROR IN CABIN STAINS ON FAN & CORE	275
07/01/90	344	A320	CFH56	5	2	N			N	AP	-LHR	LHR	LONDON-LHR, ENGLAND, UK	N		1	N		N	N	:	0 MARK ON AIRFRAME. ENG. INGESTION?	344
07/02/90	242	B767	4000	4060	1	N			N	AP	ENR-CPH	CPH	COPENHAGEN, DENMARK	N EURASIAN KESTREL	5K27	1	8				:	0 RHNS ON FAN EXIT VANE	242
07/02/90	322	A300	4000	4158					N		YUL-ORY	XFO	MONTREAL OR PARIS	N CHIMNEY SWIFT	1U33	1	2				:	1 1 FB BE. ENG POS?	322
07/05/90	337	B757	RB211	535E4	2	N			N			XUS	TULSA, OKLAHOMA ??	Y		1	N		N	N	:VY:	1 2 FB LE CURL	337
07/05/90	369	A310	CF6	80C2	1	N	400		N	AP	-TLS	TLS	TOULOUSE, FRANCE	N "SMALL BIRD"		1	N			N	:	0	369
07/06/90	339	B757	RB211	535C	2	N	0	120	ATB	TR	LHR-	LHR	LONDON-LHR, ENGLAND, UK	N		1	N		4.0	N	:Y:Y:	1 3 FB BE. 2 FB SHGLD. "PIGEONS OR GULLS"	339
07/12/90	254	B767	4000	4060	1	N			N		CPH-CPH	CPH	COPENHAGEN, DENMARK	N		1	N				:	0 HIT LPC INLET, FAN EXIT VANES. TRNG FLITE	254
07/13/90	370	B767	CF6	80C2	2	N	0		N	TX	TYO-	TYO	TOKYO-TYO, JAPAN	N		1	N		3.2	N	:Y:Y:	2 INPCBLE TIP MSG. NOSP. SHRO OVLAP. REMVD	370
07/14/90	371	A300	CF6	80C2	2	N			N		-BGI	XFO	BARBADOS??	N		1	N			N	:VY:Y:	1 1FB BE, CRACKED, NOTCHED 1FB LE NICKED	371
07/14/90	372	A310	CF6	80C2	2	N			N	CL	CFU-MUC	CFU	CORFU, GREECE	N EGYPTIAN VULTURE	3K43	1	75	N		N	:Y:Y:	2 4 FB LE BE. 2 HPC BL DMG. ENG RMVD.	372
07/15/90	338	B757	RB211	535E4	2	N			N		AMS-VVZ	XFO	AMSTERDAM OR TORONTO	N KILLDEER	5N33	1	3	N		N	:	0 DEBRIS ON OGV'S. WALKAROUND.	338
07/16/90	345	A320	CFH56	5	2	N			N		-DUS	XFO	DUSSELDORF, GERMANY??	N		1	N			N	:	0 DEBRIS OF FB'S & 1ST STG LPC.	345
07/17/90	252	A300	JT90	7R4H	2	N	0		N	TR	RUH-ABT	RUH	RIYADH, SAUDI ARABIA	N		1	N		INC	N	:Y:Y:	2 4 FB BE, 1 BRK OUT	252
07/17/90	373	B767	CF6	80C2	1	N			N		-TYO	XFO	TOKYO-TYO, JAPAN??	N		1	N			N	:	0 GRD-INSPECT. AT TYO	373
07/18/90	355	A310	CF6	80A	2	N			N	AP	-NCE	NCE	NICE, FRANCE	N "SEAGULL"		1	N			N	:Y:	1 3 FB SHINGLED	355
07/22/90	255	B767	JT90	7R4E	1	N	ATB	CL	PER-NRT	PER	PERTH, AUSTRALIA	N BANDED PLOVER	5N23	1	7					N	:Y:Y:	2 1 FB LE BRKN, 2 FB BE. HIGH VIBES ON LOG	255
07/23/90	253	B767	JT90	7R4E	2	N			N			XFO	ETHIOPIA???	N		1					:	1 1 FB BE	253
07/24/90	321	DC10	JT90	59A	1	N			N	TC	NGO-FUK	NGO	MAGUYA, JAPAN	N		1					:	0 SHELL INTO CORE. DAMAGE???	321
07/24/90	356	A310	CF6	80A	2	N			N		AMS-LCA	XFO	AMSTERDAM OR LARNACA	N COMMON ROCK DOVE	2P1	1	14	N		N	:	0 DEBRIS IN CORE	356
07/24/90	374	B767	CF6	80C2	1	N			N		-OSA	XFO	OSAKA, JAPAN??	N		1	N			N	:	0 GRD. INSP. AT OSAKA	374
07/24/90	375	B767	CF6	80C2	2	N			N		-MYJ	XFO	MASUYAMA, JAPAN??	N		1	N			N	:	0 GRD INSP AT MATSUYAMA	375
07/25/90	320	B767	JT90	7R4D	1	N			N	LA	-FUK	FUK	FUKUOKA, JAPAN	N		1				N	:	0	320
07/27/90	256	B767	JT90	7R4D	2	N			N		-HND	XFO	TOKYO-HND, JAPAN ??	N		1	N			N	:	0 DISCOVERED UPON ENGINE REMOVAL	256
07/27/90	319	DC10	JT90	59A	1	N			N		OKI-HND	XFO	OKI ISLAND/TOKYO-HND, JAPAN	N		1					:	0	319
07/28/90	262	A310	4000	4152	2	N			N	CL	KHI-	KHI	KARACHI, PAKISTAN	N							:Y:	1 1 DAMAGED?? #BDS???	262
07/28/90	318	DC10	JT90	59A	1	N			N		OSA-PUS	XFO	OSAKA, JAPAN/PUSAN, KOREA	N		1					:	0	318
07/28/90	346	A320	CFH56	5	1	N	0		N	LR	-YUL	YUL	MONTREAL, CANADA	N RING-BILLED GULL	14N12	1	17	N		N	:Y:	1 1FB DMG. DEBRIS IN OGV'S	346
07/28/90	357	B767	CF6	80A	1	N			N		-KOJ	XFO	KAGOSHIMA, JAPAN???	N		1	N			N	:	0 BIRD INTO CORE.	357
07/29/90	358	B767	CF6	80A	2	N			N		-KMI	XFO	MIYAZAKI, JAPAN??	N		1	N			N	:	0 GRD. IN P. AT MIYAZAKI	358
07/30/90	257	B757	2000	2037	2	TRVS FRAC	800	ATB	CL	LAX-SLC	LAX	LOS ANGELES, CAL.	Y WESTERN GULL	14N19	1	40.4	502		HIGH	VIBES	:Y:VY:VY:Y:	2 CONTNO. TRUS FRAC. 3FB INVTGD. COHL HOLES	257
07/30/90	376	A300	CF6	80C2	1	N			N		-BKK	XFO	BANGKOK, THAILAND??	N		1	N		HIGH	N	:Y:Y:	2 2 HPC BL TIPS MSG. 7 W/L E TIP CURL. REMVD	376
07/31/90	377	A310	CF6	80C2	1	N	0		N	LR	-DEL	DEL	DELHI, INDIA	N		1	N			N	:Y:	2 OLD HPC BL DMG NOT BY BIRDSTRIKE. 3 OR 0?	377
08/01/90	260	B757	2000	2037	1	N			N		-DTW	XUS	DETROIT, MICHIGAN???	Y AMERICAN ROBIN	412314	1	2.5				:Y:	1 UNCONFIRMED. 3 FB DMG BEYOND LIMITS	260
08/01/90	261	B757	2000	2040	2	N			N		ABY-MOB	XUS	ALBANY, GA OR MOBILE, ALA	Y AMERICAN MOURNING DOVE	2P105	1	4				:VY:	2 CRACK F BLADE	261
08/04/90	359	B767	CF6	80A	2	N	0		N	LR	-KCZ	KCZ	KOCHI, JAPAN	N		1	N			N	:	0	359
08/05/90	263	B747	JT90	7A	4	N	0		ATO	TR	JFK-	JFK	NEW YORK-JFK, NY	Y HERRING GULL	14N14	1	40				:Y:	2 INTO CORE. SURGE, HI EGT. DAMAGE??	263
08/05/90	316	B767	4000	4060	1	N	500	ATB	TO	AMS-HER	AMS	AMSTERDAM, NETHERLANDS	N		1						:Y:	2 4 FB BE	316
08/06/90	347	A320	CFH56	5	1	N	0	V1+	DIV	TR	LIL-LVN	LIL	LILLE, FRANCE	N		1	N		5.8	N	:Y:Y:	2 HPC STG 589 DMG. ENG CHANGED. DIV TO ORLY	347
08/08/90	324	A300	4000	4158	1	N			N		JIB-ORY	XFO	DJIBOUTI OR PARIS	N DON-SMITH'S NIGHTJAR	5T55	1	1.25				:Y:	0 WALK AROUND. # BIRDS?	324
08/10/90	317	A300	4000	4158	1	N	ATB	TC	SEL-PUS	SEL	SEOUL, KOREA	N CHIMNEY SWIFT	1U33	1	1				NOT BIRD	N	:Y:Y:	0 3 FRAC. HPT BLOS. IFSD-NOT DUE TO BIRDS.	317
08/10/90	378	A310	CF6	80C2	1	N			N		-BOM	XFO	BOMBAY, INDIA??	N		1	N			N	:Y:	1 GRD INSP AT BOMBAY. OGV DMG	378
08/11/90	325	A300	4000	4158	1	U			N		-SEL	XFO	SEOUL, KOREA??	N							:Y:	2 REMOVED. DAMAGE?? #BIRDS??	325
08/12/90	325	B767	4000	4060	1	N			N	AP	-AMS	AMS	AMSTERDAM, NETHERLANDS	N							:	0 WALK AROUND. #BIRDS??	325
08/12/90	379	B767	CF6	80C2	1	N			N		ORY-ALG	XFO	PARIS-ORY OR ALGIERS	N		1	N			N	:	0 DEBRIS ON SPINNER AND FB'S	379
08/13/90	348	A320	CFH56	5	1	N	0	V1+	N	TR	BRE-	BRE	BREHLEN, GERMANY	N		1	N			N	:Y:	0 NI VIBES FLUCTUATED. ODOOR IN CABIN.	348
08/14/90	323	B757	2000	2037	1	MEMB	10	VR+	N	TO	JFK-SLC	JFK	NEW YORK-JFK, NY	Y RING-NECKED PHEASANT	4L161	>1	40				:Y:Y:	2 SHELL. 1 FB BKN INTO CORE?	323
08/14/90	323	B757	2000	2037	2	MEMB	10	VR+	N	TO	JFK-SLC	JFK	NEW YORK-JFK, NY	Y RING-NECKED PHEASANT	4L161	1	40				:Y:	1 3 FB BE INTO CORE? (SHELL).	323
08/16/90	360	B767	CF6	80A	2	N	0		N	LR	-OKJ	OKJ	OKAYAMA, JAPAN	N		1	N			N	:	0	360
08/16/90	380	A310	CF6	80C2	2	N	0		N	LR	-NTE	NTE	NANTES, FRANCE	N		1	N			N	:	0	380
08/20/90	349	A320	CFH56	5	1	N			N		-LVN	XFO	LYON, FRANCE??	N		1	N			N	:	0 GRD INSPECTION AT LYON	349

DATE	EVT#	A/C	ENG	DASH	POS	SIG/EVT	ALT	SPD	CREW	POF	CITY/PRS	APT	LOCALE	US BIRDNAME	SPEC	#BDS	HT	POWLOSS	VIBE	IFSD	:AB	CDE	:FGHI	:J	:KL	MNO	:PQ	:RMS	REMARKS	EVT#	
08/20/90	350	A320	CFH56	5	1	N	0	N	LR	-DUS	DUS DUSSELDORF, GERMANY	N		N		1	N		N		:	:	:	:	:	:	:	:	0	350	
08/21/90	361	A310	CF6	80A	1	N	0	N	LR	-IST	IST ISTANBUL, TURKEY	N	"LGE SEAGULL"	N		1	N		3.5	N	:VV	Y	:	:	:	:	:	:	1 1 FB LE BE, 2 FB SHGLD	361	
08/22/90	351	A320	CFH56	5	2	N	0	V1+	N	TR	ORY-TLS	ORY	PARIS-ORLY, FRANCE	N		1	N		N		:Y	:	:	:	:	:	:	:	1 2 FB BE	351	
08/24/90	362	B767	CF6	80A	1	N	0	N	LR	-SDJ	SDJ SENDAI, JAPAN	N		N		1	N		N		:	:	:	:	:	:	:	:	0	362	
08/25/90	352	A320	CFH56	5	1	N		N			-YUL	XFO MONTREAL, CANADA???	N		N	1	N		N		:	:	:	:	Y	:	:	:	2 STG1BL CRACK, 2BL PIECE MISSING. NO FB DMG	352	
08/28/90	363	B767	CF6	80A	2	N	0	N	LR	-TAK	TAK TAKAHATSU, JAPAN	N		N		1	N		N		:Y	:	:	:	:	:	:	:	1 1 FB BE - TRIMMED	363	
08/29/90	327	B747	JT90	7R462	4	N		N	AP	-FRA	FRA FRANKFURT, GERMANY	N		N		1	N		N		:	:	:	:	:	:	:	:	0 4 BIRDS ??	327	
08/31/90	381	B747	CF6	80C2	3	N	0	100	N	LR	-AMS	AMS AMSTERDAM, NETHERLANDS	N			1	N		N		:Y	:	:	:	:	:	:	:	1 2 FB DISTORTED, RPLCD.	381	
09/04/90	353	A320	CFH56	5	2	N	0	N	LR	-CDG	CDG PARIS-CDG, FRANCE	N		N		1	N		N		:	:	:	:	:	:	:	:	0	353	
09/04/90	382	B747	CF6	80C2	1	MEMB	0	120	N	LR	-AMS	AMS AMSTERDAM, NETHERLANDS	N	N BLACK-HEADED GULL	14N36	2	10	N		N		:	:	:	:	:	:	:	:	0	382
09/04/90	382	B747	CF6	80C2	2	MEMB	0	120	N	LR	-AMS	AMS AMSTERDAM, NETHERLANDS	N	N BLACK-HEADED GULL	14N36	2	10	N		N		:	:	:	:	:	:	:	:	0	382
09/04/90	383	A310	CF6	80C2	2	N	0	N	LR	YYZ-VVR	VVR VANCOUVER, CANADA	N	N GLAUCOUS-WINGED GULL	14N22	1	48	N		N		:Y	:	:	:	:	:	:	:	1 2 FB SHINGLED--WERE UNSHGLD	383	
09/05/90	364	A310	CF6	80A	1	N		N	AP	-IST	IST ISTANBUL, TURKEY	N	N HERRING GULL	14N14	1	40	N		3.5	N	:Y	:	:	:	Y	:	:	:	1 FINL AP. 2FB MIDSPN SHRD LCKUP, MINOR SHGL	364	
09/05/90	365	A310	CF6	80A	2	N		N	DIV	CL	IST-DXB	IST ISTANBUL, TURKEY	N			1	N		7.5	N	:VVV	:	:	:	:	:	:	:	1 3 FB TIP CURL, 1 FB TORN	365	
09/06/90	340	B757	RB211	535C	1	N		N	DE	LHR-AMS	AMS AMSTERDAM, NETHERLANDS	N		N		1	N		N		:	:	:	:	:	:	:	:	0	340	
09/09/90	384	B767	CF6	80C2	1	N		N			-KOJ	XFO KAGOSHIMA, JAPAN??	N		N	1	N		N		:	:	:	:	:	:	:	:	0 WALKAROUND	384	
09/10/90	354	A320	CFH56	5	1	N		N			-DTW	XUS DETROIT, MICHIGAN??	Y		N	1	N		N		:	:	:	:	:	:	:	:	0 GRD. INSP AT DETROIT	354	
09/10/90	385	B767	CF6	80C2	1	N		N			-TYO	XFO TOYAMA, JAPAN??	N		N	1	N		N		:	:	:	:	Y	:	:	:	2 MAT. MISSING FR LE HPC 2 PLACES. ENG RENVD	385	
09/10/90	386	B767	CF6	80C2	2	N	0	V1+	N	TR	YYZ-VUL	YYZ	TORONTO, CANADA	N		1	N		INC	N	:	:	:	:	:	:	:	:	0 NO CREWAC?	386	
09/11/90	387	A310	CF6	80C2	2	N	0	V1+	ATB	TR	MBA-	MBA	MOHABA, KENYA	N	TBI	1	N		HIGH	N	:Y	Y	:	:	:	:	:	:	1 2 FB LE DISTORTION & SHINGLED.	387	
09/13/90	388	B767	CF6	80C2	1	N		N			-CTS	XFO SAPPORO-CHITOSE, JAPAN??	N		N	1	N		N		:Y	:	:	:	:	:	:	:	1 2 FB SHINGLED-LATER REPLACED	388	
09/17/90	366	B767	CF6	80A	2	N	0	N	LR	-OKJ	OKJ OKAYAMA, JAPAN	N		N		1	N		N		:	:	:	:	:	:	:	:	0	366	
09/17/90	389	B767	CF6	80C2	2	N	10	N	LD	-WAW	WAW WARSAW, POLAND	N	N BLACK-HEADED GULL	14N36	1	10	N		N		:	:	:	:	:	:	:	:	0 50-100 BIRD FLOCK. 5 HIT A/C	389	
09/18/90	341	B747	RB211	5246	2	N		N			PAE-PAE	PAE	EVERETT, WASHINGTON	Y					N	N	:	:	:	:	:	:	:	:	0 MAIDEN FLITE	341	
09/18/90	342	B757	RB211	535C	2	N	0	N	LR	LHR-GVA	GVA GENEVA, SWITZERLAND	N		N				N	N		:	:	:	:	:	:	:	:	0 DEBRIS DOWN BYPASS DUCT	342	
09/18/90	367	B767	CF6	80A	2	N		N			-OSA	XFO OSAKA, JAPAN??	N		N	1	N		N		:	:	:	:	:	:	:	:	0	367	
09/18/90	390	B767	CF6	80C2	2	N		N			-AUH	XFO ABU DHABI, U.A.E.??	N		N	1	N		N		:	:	:	:	:	:	:	:	0 GRD INSPECT.	390	
09/19/90	391	A310	CF6	80C2	2	N		N			-MUC	XFO MUNICH, GERMANY??	N		N	1	N		N		:	:	:	:	:	:	:	:	0 GRD. INSPECT	391	
09/23/90	343	B747	RB211	5246	4	N		N			TO	SYD-MEL	SYD SYDNEY, AUSTRALIA	N		1	N		N	N	:	V	:	:	:	:	:	:	1 IDG INTAKE CONTAMINATED	343	
09/24/90	368	A310	CF6	80A	2	N	0	V1+	N	TR	BRE-FRA	BRE	BREHEN, GERMANY	N	"SEAGULL"	TBI	1	N		6.0	N	:	V	Y	Y	Y	:	:	2 10 FB DMGD, 2 HPC BLS TIP MISSING	368	
09/30/90	392	B767	CF6	80C2	1	N	0	N	LR	-OIT	OIT OITA, JAPAN	N		N		1	N		N		:	:	Y	:	:	Y	:	:	2 5FB, 20GV, BLOCKER DOOR DMGD. THRUST REVERSL	392	

