DOT/FAA/CT-89/16

FAA Technical Center
Atlantic City International Airport
N.J. 08405

Study of the Engine Bird Ingestion Experience of the Boeing 737 Aircraft

(October 1986 - September 1987)

Peter W. Hovey
Donald A. Skinn

University of Dayton Research Institute
Dayton, Ohio

October 1989

Interim Report

This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

U.S. Department of Transportation
Federal Aviation Administration

NOTICE

This document is disseminated under the sponsorship of the U. S. Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the objective of this report.

Technical Report Documentation Page

1. Report No. DOT/FAA/CT-89/16	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle A STUDY OF THE ENGINE BIRD INGESTION EXPERIENCE OF THE BOEING-737 AIRCRAFT (October 1986 - September 1987)		5. Report Date October 1989 6. Performing Organization Code DOT/FAA/CT-89/16
7. Author's) Peter W. Hovey and Donald A. Skinn		8. Performing Organization Report No. UDR-TR-88-137
9. Performing Organization Name and Address University of Dayton Research Institute Structural Integrity Division 300 College Park (JPC-201) Dayton, Ohio 45469		10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTFA03-88-C-00024
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Technical Center Atlantic City International Airport, NJ 08405		13. Type of Report and Period Covered Interim Report: Medium/Large Inlet Area Engines - October 1986 - September 1987 14. Sponsoring Agency Code ACD-210

15. Supplementary Notes

FAA Contract Monitors: Howard Banilower FAA Technical Center
Joseph Wilson FAA Technical Center

16. Abstract

The Federal Aviation Administration (FAA) Technical Center initiated a study in October 1986 to determine the numbers, sizes, and types of birds which are being ingested into medium and large inlet area turbofan engines and to determine what damage, if any, results. Bird ingestion data are being collected for the Boeing-737 model aircraft which uses either the Pratt and Whitney JT8D medium inlet area turbofan engine or the CFM International CFM56 large inlet area turbofan engine. This interim report analyzes the first of 3 years of data collection. The first year extends from October 1986 through September 1987.

17. Key Words		18. Distribution Statement
Bird Ingestion	Turbofan Engine	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161
Aircraft CFM56	Turbine Engine	
CFM56	Probability of Ingestion	
JT8D	Statistical Analysis	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	100	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

FOREWORD

This interim report provides descriptive and statistical analyses of the data collected over a 1-year period on bird ingestion experiences for the B737 aircraft. The data described in this report were collected under a separate contract by the engine manufacturers.

The report was prepared by the University of Dayton under Department of Transportation, Federal Aviation Administration Contract DTFA03-88-C-00024. The technical project monitors for the FAA during the preparation of the report were Dr. Howard Banilower and Mr. Joseph Wilson. The principal investigator at the University of Dayton was Dr. Peter W. Hovey, and computer support was provided by Mr. Donald A. Skinn.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

EXECUTIVE SUMMARY

An investigation was initiated by the Federal Aviation Administration Technical Center in September 1986 to determine the numbers, weight, and species of birds which are ingested into medium and large inlet area turbofan engines during worldwide service operation and to determine what damage, if any, results. This interim report summarizes the first of 3 years of Boeing-737 data being collected to support this effort.

A total of 2.75 million aircraft operations were flown by Boeing-737 commercial aircraft during the first year of this investigation which extended from October 1986 through September 1987. Boeing-737 aircraft equipped with Pratt and Whitney JT8D medium inlet area turbine engines accounted for 80.8 percent of these flights. The remaining 19.2 percent of the flights were made by aircraft having CFM International CFM56 large inlet area turbofan engines.

A total of 314 engine ingestion events were reported during the first year of data collection. There were 5.49 million engine operations during this same period which yield a probability of engine ingestion of 5.72×10^{-5}. A conclusion of these data is that bird ingestion events are rare, but probable, events.

When the species of the ingested bird was reliably identified, gulls were determined to be the most commonly ingested birds. The majority of ingested birds (30 of 37) weighed less than 40 ounces. The bird weight distribution of ingested birds in the United States was different from the distribution in foreign countries. The mean, median, and mode weights of ingested birds were larger in the United States than abroad. The bird ingestion rate within the United States was significantly lower than the foreign bird ingestion rate.

The majority (123 of 144) of aircraft ingestion events, for which the phase of flight was known, occurred within the airport environment during takeoff and landing. There were 39 engine ingestions which resulted in engine damage classified as moderately severe or worse. The majority of bird ingestions resulted in little or no engine damage. The majority of aircraft ingestion events (273 of 302) involved a single bird and a single engine on the aircraft. The remaining 29 aircraft ingestion events involved multiple birds and/or multiple engines.

The following is a summary of the most pertinent statistics extracted from the first year of data for the Boeing-737 aircraft:

Total Engine Ingestion Events	314
Total Aircraft Ingestion Events	302
Average Bird Weight (oz)	
United States	20.7
Foreign	11.1
Median Bird Weight (oz)	
United States	14

Foreign	9
Probability of Ingestion Per Aircraft Operation	
Worldwide	1.10×10^{-4}
United States	0.53×10^{-4}
Foreign	1.79×10^{-4}
Most Commonly Ingested Bird	
United States	Dove/Gull
Foreign	Gull/Lapwing
Engines Experiencing Moderate/Severe Damage	39
Multiple Bird Ingestion Events	20
Multiple Engine Ingestion Events	12
Aircraft Ingestion Events By Phase-of-Flight	
Takeoff and Climb Phase-of-Flight	56.9%
Approach and Landing	30.6%
Airports Reporting Bird Ingestions	137
Ratio of Reported Events to Aircraft Operations	
United States	0.53×10^{-4}
Foreign	1.79×10^{-4}

SECTION 1

INTRODUCTION

1.1 BACKGROUND.

Contention for airspace between birds and airplanes has created a serious bird/aircraft strike hazard. A past study [1] has indicated that birdstrikes to engines are statistically rare events. The probability of a birdstrike during any given flight is extremely low; however, when the number of flights is considered, the number of birdstrikes becomes significant.

The windshield and the engines are particularly vulnerable to the birdstrike threat. Although penetration of the windshield by a bird is primarily a concern for military airplanes operating at high speeds in a low-altitude environment, such a penetration has occurred on a civilian airplane resulting in the death of the co-pilot. Ingestion of birds into airplane engines is a problem for commercial as well as military jet airplanes for it can cause significant damage to the engine resulting in degraded engine performance and possible failure.

In his study of bird ingestions on commercial flights, Frings [1] indicated that nearly all bird ingestion events have occurred in the vicinity of airports during the non-cruise phases of flight. This is understandable because these phases of flight naturally occur closer to the ground where bird concentrations are higher, resulting in a higher probability of birdstrike.

The solutions to the problem of engine damage resulting from bird ingestion are similar to those for windshield birdstrike, e.g., structural design consideration to withstand impact or bird avoidance. Bird avoidance can be facilitated by either of two approaches: (1) keeping airplanes out of airspaces with large bird concentrations, or (2) removing birds from these regions of airspace. Neither bird avoidance approach is well-suited to commercial air fleets because flight schedules place airplanes in specific areas at specific times and the effectiveness of airport bird control programs (if any) varies from airport to airport and country to country.

Structural design of engines to withstand bird ingestions can be accomplished provided that requirements with respect to bird sizes and numbers can be identified. Bird ingestion data for medium/large inlet area turbofan engines and small inlet area turbine engines are currently being collected by several engine manufacturers. Statistical evaluation of bird ingestion data from these data collection efforts and previous bird ingestion studies will be useful in re-evaluating certification test criteria specified in FAA regulation 14 CFR 33.77. As a result, future jet engines can be designed to withstand more realistic bird threats.

1.2 OBJECTIVES.

The objective of this interim report is to determine the relationship of bird weight, geographic location, season, time of day, phase of flight, and engine type to the frequency of bird ingestion events and the extent of engine damage, if any, resulting from the ingested birds. The statistical analysis of reported bird ingestions experienced by commercial Boeing-737 (B737) airplanes worldwide over 1-year reporting period (October 1986 through September 1987) is used to summarize the service threat and level of engine damage experienced by these airplanes. The findings of the analysis will be helpful in defining minimum engine design requirements for resistance to damage as a result of bird ingestions. Moreover, this study will provide a comparison between the experiences of a contemporary high-bypass ratio turbofan engine (CFM56) and an older low-bypass ratio turbofan engine with a smaller inlet (JT8D) exposed to similar aircraft-bird ingestion environments.

1.3 ORGANIZATION OF REPORT.

Section 2 defines, discusses, and differentiates airport operations and aircraft operations. Section 3 identifies the characteristics and behavior of bird species that have been ingested and reliably identified. Section 4 describes bird ingestion rates by location, engine type, and phase of flight. Section 5 provides a geographic placement of bird ingestion events throughout the world. Section 6 summarizes engine damage resulting from bird ingestions. Section 7 examines the probabilities of various bird ingestion events. Section 8 provides a summary of the results obtained during this phase of data analysis.

SECTION 2

AIRCRAFT OPERATIONS AND AIRPORT OPERATIONS

Aircraft and airport operations data are used to determine bird ingestion rates. Operations data (and their sources) used to generate bird ingestion rates are discussed in this section. A Glossary is provided to aid in understanding these data.

An aircraft operation as defined in the glossary is a nonstop flight from one airport (departure airport) to another airport (arrival airport) and consists of 8 phases of flight which include (1) taxi-out, (2) takeoff, (3) climb, (4) cruise, (5) descent, (6) approach, (7) landing, and (8) taxi-in. An airport operation is considered either a departure from or an arrival at an airport. When all scheduled flights are considered, the number of airport operations is twice the number of aircraft operations.

The Official Airline Guide (OAG) is the data source for scheduled airport operations. Counts of airport operations involving B737 airplanes were extracted from OAG magnetic tapes and maintained by airport code. The counts were further categorized by month of year and hour of day so that seasonal and time-of-day analyses could be performed.

Table 2.1 presents the OAG airport operations counts by seasonal months. The counts are also broken down by several geographic regions. Table 2.2 presents the same airport operations counts as table 2.1; however, an adjustment for hemisphere has been made. It should be noted that the number of aircraft operations for each of these categories is one-half the number of airport operations.

Table 2.3 cross tabulates airport operations for each month of the reporting period by OAG destination-arrival code in two ways. The first tabulation includes all airports at which one or more B737 operations were scheduled during the reporting period. The second tabulation is a subset of the first and includes only those airports at which a bird ingestion event was reported during the period. The destination-arrival code is taken directly from the OAG tapes, and its values are presented as a footnote in table 2.3.

A breakdown of aircraft operations by engine type and geographic region is required to obtain bird ingestion rates for these parameters. Table 2.4 presents a breakdown of B737 aircraft operations by engine type and geographic region for the reporting period. The OAG operations data identify implicitly the geographic region through the airport code and also identify explicitly whether the airplane is a B737; however, the engine type of the airplane is not reliably identified in the OAG data. The aircraft operations presented in the ALL ENGINES column of table 2.4 are derived by dividing the airport operations in the TOTAL column of table 2.1 by 2. The aircraft operations for the CFM56 engine were provided by the engine manufacturer as actual flights flown during the reporting period and are considered reliable. Similar data were not available for the JT8D engine. The JT8D aircraft operations were therefore derived by subtracting the CFM56 aircraft operations from the total aircraft operation for both engines.

TABLE 2.1 SCHEDULED OAG AIRPORT OPERATIONS BY SEASONAL MONTH

GEOGRAPHIC LOCATION	SEASONAL MONTHS MAR-MAY	JUN-AUG	SEP-NOV*	DEC-FEB	TOTAL
Contiguous US	728,180	762,922	685,560	681,306	2,857,968
United States	771,231	807,492	726,309	722,461	3,027,493
Foreign	619,425	647,640	604,935	591,679	2,463,679
Northern Hemisphere	1,235,767	1,296,951	1,181,268	1,166,794	4,880,780
Southern Hemisphere	154,889	158,181	149,976	147,346	610,392
Worldwide	1,390,656	1,455,132	1,331,244	1,314,140	5,491,172

* SEP87, OCT86, and NOV86 combined as Autumn (Northern Hemisphere) and Spring (Southern Hemisphere)

TABLE 2.2 SCHEDULED OAG AIRPORT OPERATIONS BY SEASON

GEOGRAPHIC LOCATION	SEASONS OF THE YEAR SPRING†	SUMMER	AUTUMN†	WINTER	TOTAL
Contiguous US	728,180	762,922	685,560	681,306	2,857,968
United States	771,231	807,492	726,309	722,461	3,027,493
Foreign	614,512	636,805	609,848	602,514	2,463,679
Northern Hemisphere	1,235,767	1,296,951	1,181,268	1,166,794	4,880,780
Southern Hemisphere	149,976	147,346	154,889	158,181	610,392
Worldwide	1,385,743	1,444,297	1,336,157	1,324,975	5,491,172

† SEP 87, OCT86, and NOV86 combined as Autumn (Northern Hemisphere) and Spring (Southern Hemisphere)

TABLE 2.3 OAG AIRPORT OPERATIONS BY MONTH

ALL AIRPORTS WITH SCHEDULED B737 OPERATIONS

MONTH	OAG DESTINATION-ARRIVAL CODES **					
	(0)	(1)	(2)	(3)	(4)	(Total)
OCT'86	193,968	231,432	2,880	0	3,074	431,354
NOV'86	189,972	227,934	2,498	0	2,974	423,378
DEC'86	200,544	242,892	2,916	42	3,614	450,008
JAN'87	201,148	245,030	2,856	102	3,514	452,650
FEB'87	180,814	225,126	2,620	96	2,826	411,482
MAR'87	202,102	253,710	3,092	88	2,758	461,750
APR'87	200,608	249,398	3,172	120	2,730	456,028
MAY'87	207,444	258,486	3,718	158	3,072	472,878
JUN'87	205,696	256,952	3,854	68	3,144	469,714
JUL'87	215,568	269,914	3,680	174	3,412	492,748
AUG'87	215,770	269,582	3,686	196	3,436	492,670
SEP'87	212,012	257,798	3,544	162	2,996	476,512
TOTAL	2,425,646	2,988,254	38,516	1,206	37,550	5,491,172

AIRPORTS EXPERIENCING BIRD INGESTIONS DURING REPORTING PERIOD

MONTH	OAG DESTINATION-ARRIVAL CODES **					
	(0)	(1)	(2)	(3)	(4)	(Total)
OCT'86	70,533	106,978	1,397	0	436	179,344
NOV'86	71,139	105,585	936	0	409	178,069
DEC'86	74,190	112,612	1,160	21	447	188,430
JAN'87	74,233	114,171	1,266	51	422	190,143
FEB'87	67,670	104,265	1,122	48	361	173,466
MAR'87	75,326	116,536	1,102	44	400	193,408
APR'87	75,889	115,078	1,056	60	400	192,483
MAY'87	79,106	118,677	1,166	105	468	199,522
JUN'87	78,199	118,057	1,307	42	454	198,059
JUL'87	81,903	123,270	1,290	118	473	207,054
AUG'87	81,915	122,813	1,230	134	467	206,559
SEP'87	82,407	115,762	1,229	108	430	199,936
TOTAL	912,510	1,373,804	14,261	731	5,167	2,306,473

** =0 Any Carrier. Operation begins and ends out of the US.
=1 Domestic Carrier. Operation begins and ends in the US.
=2 Domestic Carrier. Departure or arrival, but not both, in the US.
=3 Foreign Carrier. Operation begins and ends in the US.
=4 Foreign Carrier. Departure or arrival, but not both, in the US.

The FAA initially provided UDRI with a listing of reported aircraft operations by month and engine type. The total number of aircraft operations for each engine type was later deemed questionable. Monthly percentages were determined for each engine type from the listing and subsequently applied to the JT8D and CFM56 engine totals in table 2.4 to estimate monthly aircraft operations for the reporting period. Figure 2.1 is a histogram showing the estimated aircraft operations for each engine type.

TABLE 2.4 SCHEDULED AIRCRAFT OPERATIONS BY ENGINE TYPE

GEOGRAHIC LOCATION	JT8D	CFM56	ALL ENGINES
United States	1,160,091	353,656	1,513,747
Foreign	1,057,633	174,206	1,231,839
Worldwide	2,217,724	527,862	2,745,586

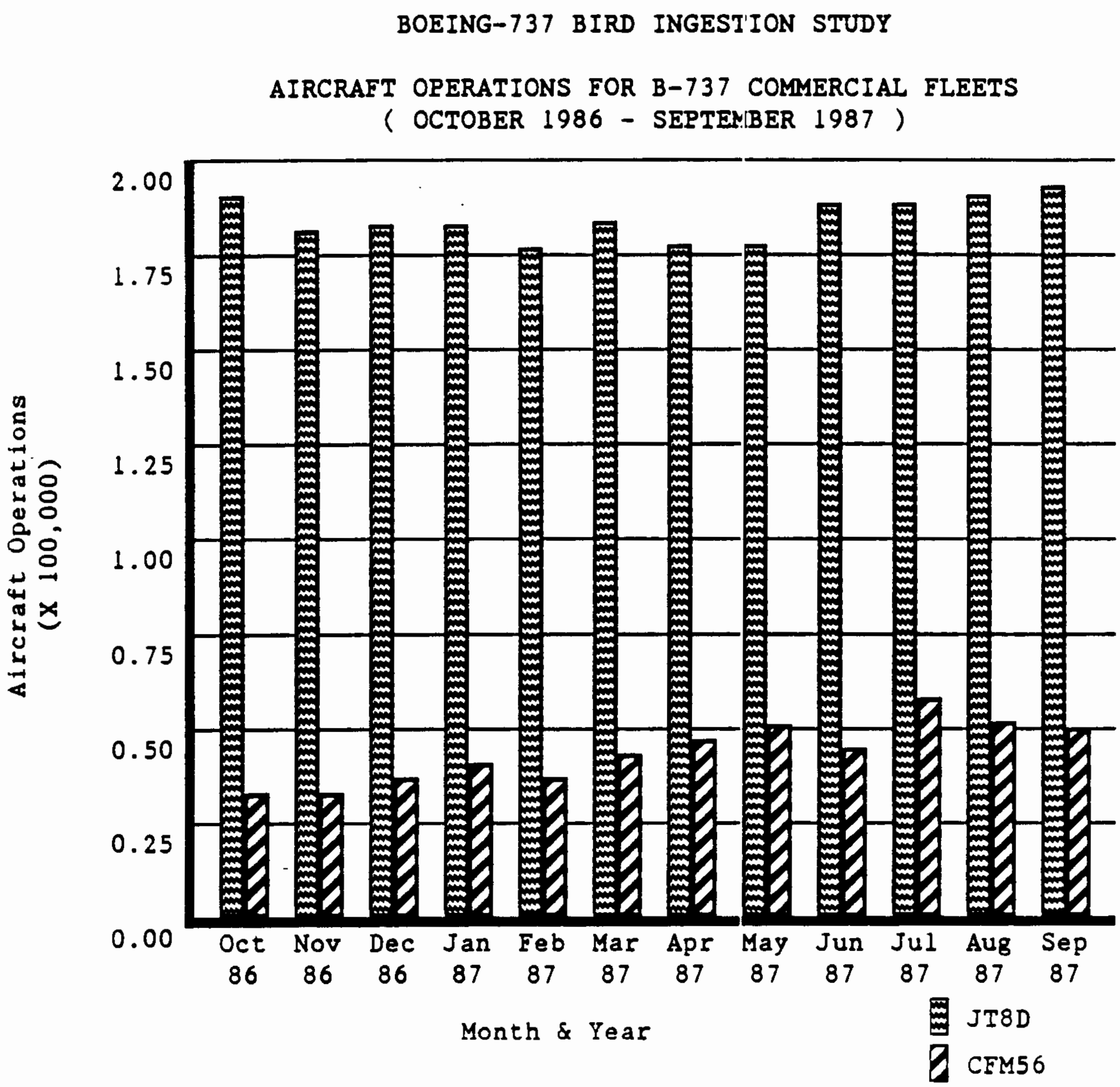

Figure 2.1 Histogram of Aircraft Operations by Month and Engine Type

SECTION 3

CHARACTERISTICS OF INGESTED BIRDS

This section provides a description of the birds that were ingested during the data collection period and an analysis of the extent of the bird ingestion threat. The bird related features that are described in this section include species, weight, seasonal trends, time-of-day trends, and geographic location.

A detailed breakdown of aircraft ingestion events in the United States is presented in figures 3.1 and 3.2. Figure 3.1 is a contour map of the contiguous United States with the height of the contours being proportional to the number of aircraft ingestion events in each state while figure 3.2 is a bar chart with the same information plus Alaska and Hawaii. Texas and California have the greatest number of ingestions followed by Florida, North Carolina, and New York.

Table 3.1 provides a tally of all the species that were positively identified by an ornithologist during the collection period. The counts in the United States, Foreign, and Overall columns of table 3.1 indicate the number of aircraft ingestion events in which each bird species was ingested. The species are listed by order and family; and it is apparent that gulls, doves and the lapwing/plover family are the most commonly ingested birds with six ingestions each. Doves and gulls were the most commonly ingested bird in the United States while the lapwings appear to be mainly a foreign species.

One of the disappointing features of the B737 bird ingestion data base is the low bird identification rate. The bird species was positively identified in only 28 out of 302 aircraft ingestion events that were recorded giving a 9.3 percent identification rate. The identification rate for events in which the engine sustained damage was slightly better (12.5 percent) than the identification rate for events which caused no engine damage (5.2 percent); which could indicate that the group of identified birds is biased to include more birds in the size and weight ranges that tend to damage engines when ingested. Any conclusions about the population of ingested birds should be viewed with the caution that the sample might be more representative of the population of birds that damage engines than of all birds that are ingested.

The species-related descriptions of ingested birds in this report probably provide a conservative view in that the birds that caused damage are better represented in the sample than birds that did not cause damage. The bird features that influence damage cannot be discerned, however, because of the possible bias in the identifications. That is, the differences between the birds that cause damage and the birds that don't cause damage cannot be readily identified since there is less information about the birds that didn't cause damage.

Table 3.2 is a frequency table of weights for the positively identified birds. The numbers in table 3.2 represent the total number of ingested birds. It should be noted that 2 was used as the number of birds when the exact number of positively identified ingested birds is unknown for a multiple bird ingestion event. The bird weights are derived from the species identification and when possible are adjusted for the age and sex of the ingested bird. The modes in table 3.2 therefore represent the weights of the more commonly identified bird

CONTOUR MAP OF CONTINENTAL US BIRD INGESTION EVENTS

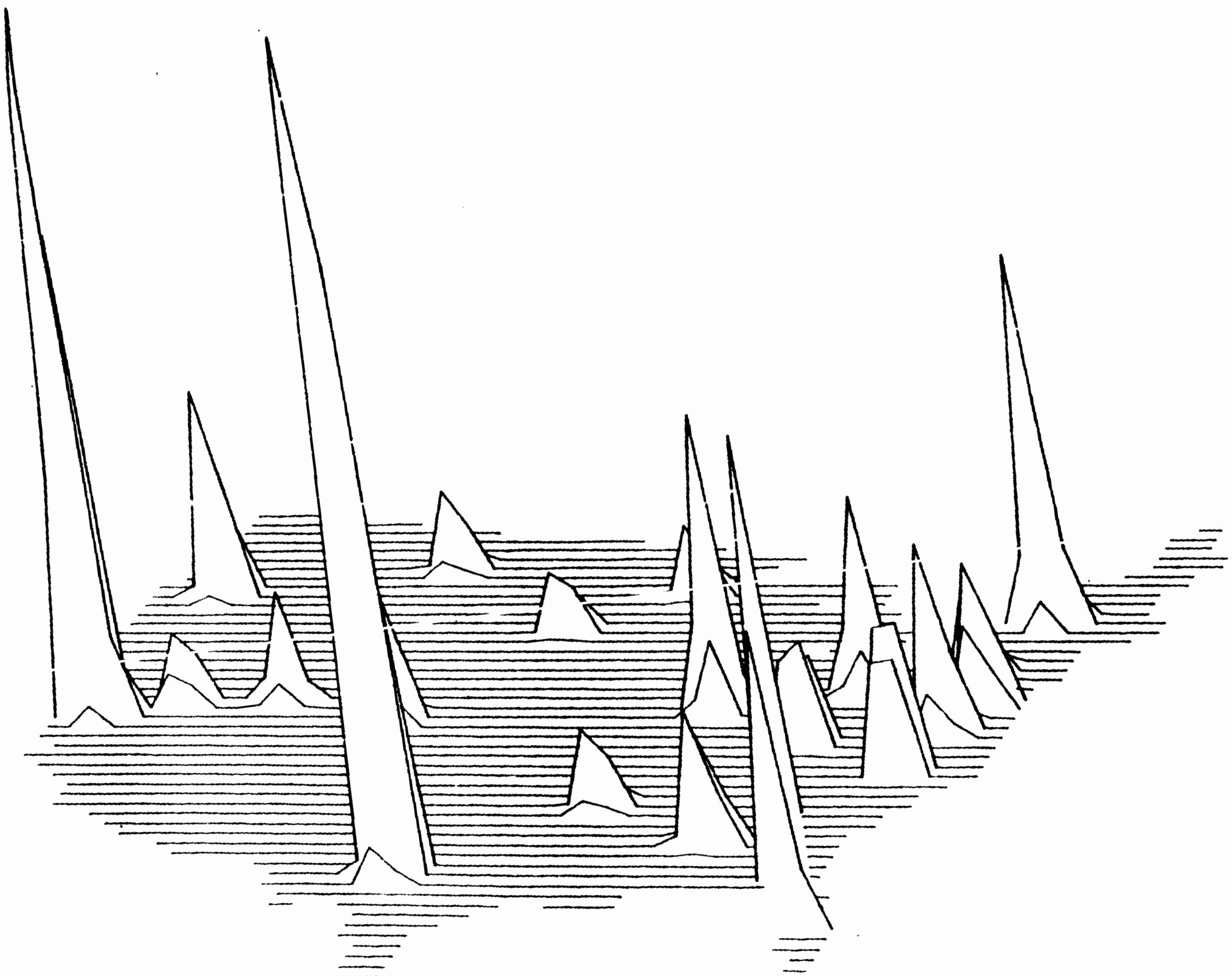

Figure 3.1 Contour Map of Domestic Bird Ingestion Events

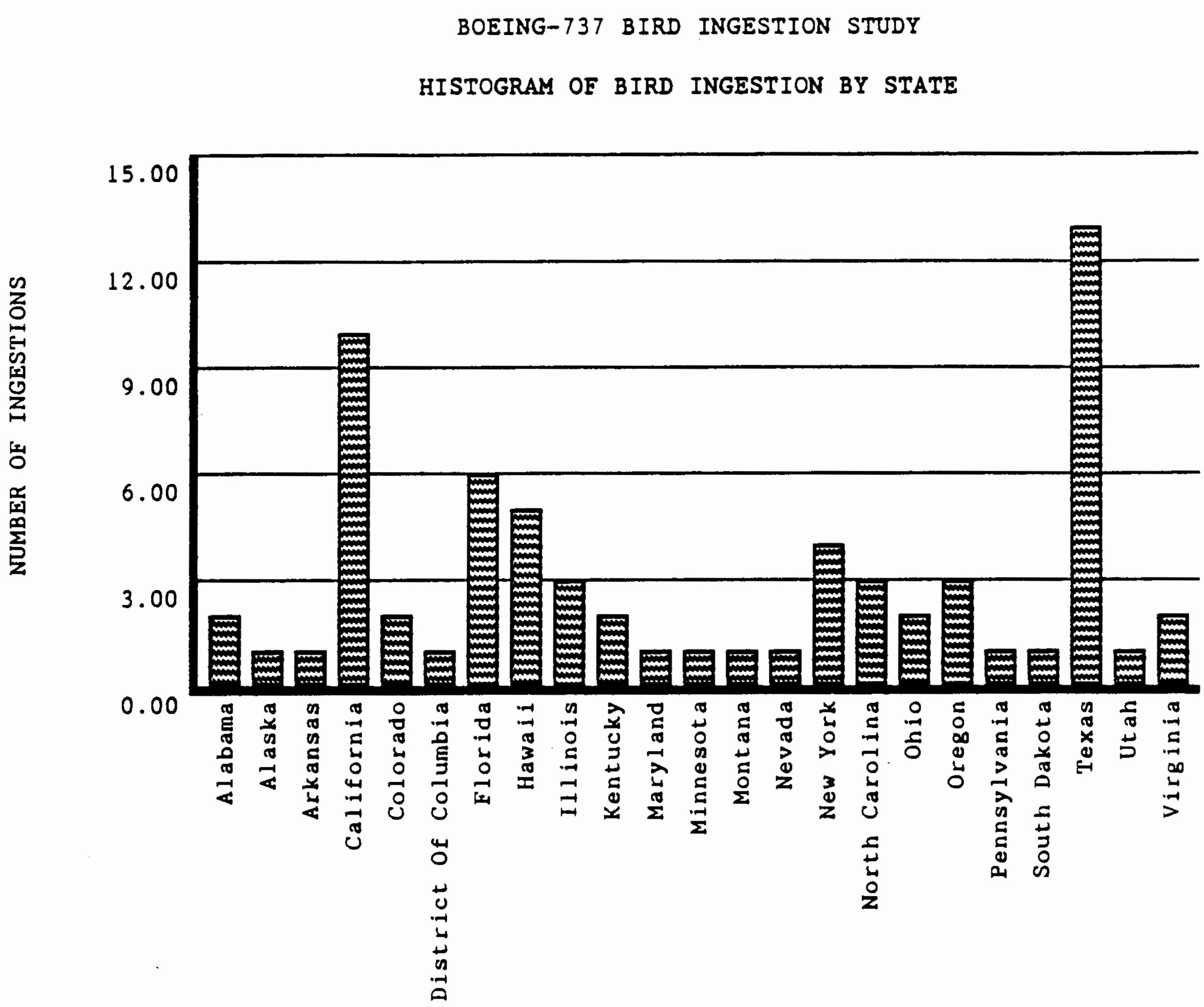

Figure 3.2 Bar Chart of Aircraft Ingestion Events by State

TABLE 3.1 TALLY OF POSITIVELY IDENTIFIED BIRD SPECIES
BROKEN DOWN BY US, FOREIGN, AND OVERALL

Latin Name	Common Name	Species Code	US	Foreign	Overall
Bubulcus ibis	Cattle egret	1I35	0	1	1
Branta canadensis	Canada goose	2J30	1	0	1
Anas platyrhynchos	Mallard	2J84	1	0	1
Pandion haliaetus	Osprey	2K1	1	0	1
Circus cyaneus	Northern marsh harrier	3K78	1	0	1
Accipiter striatus	Sharp-shinned hawk	3K105	1	0	1
Falco sparverius	American kestrel	5K26	1	0	1
Vanellus melanopterus	Black-winged plover	5N10	0	1	1
Vanellus vanellus	Gray-headed lapwing	5N20	0	2	2
Pluvialis apricaria	Eurasian golden plover	5N25	1	0	1
Charadrius vociferus	Killdeer	5N33	0	1	1
Burhinus capensis	Cape dikkop	9N4	0	1	1
Larus delawarensis	Ring-billed gull	14N12	1	0	1
Larus argentatus	Herring gull	14N14	2	0	2
Larus glaucescens	Glaucous-winged gull	14N22	1	1	2
Larus ridibundus	Common black-headed gull	14N36	0	1	1
Columba livia	Common rock dove	2P1	2	1	3
Streptopelia chinensis	Spotted dove	2P65	1	0	1
Coccyzus americanus	Yellow-billed cuckoo	2R51	1	0	1
Chordeiles minor	Nighthawk	5T5	1	0	1
Eremophila alpestris	Horned lark	17Z74	1	1	2
Sturnus vulgaris	Common starling	21Z75	1	0	1
			18	10	28

TABLE 3.2 WEIGHT DISTRIBUTION OF INGESTED BIRDS

WEIGHT RANGE (Oz)	U.S.	FOREIGN	WORLDWIDE
(0 < x <= 4)	8	3	11
(4 < x <= 8)	3	2	5
(8 < x <= 12)	0	3	3
(12 < x <= 16)	7	3	10
(16 < x <= 20)	1	0	1
⋮			
(36 < x <= 40)	3	1	4
⋮			
(52 < x <= 56)	2	0	2
⋮			
(124 < x <= 128)	1	0	1
TOTAL	25	12	37

species that were ingested. Figure 3.3 provides the same information in the form of a histogram. Most of the ingested birds that were identified in this study weighed less than 16 ounces; however 21.6 percent of the identified birds weighed more than 1 pound.

Summary statistics calculated from the raw data for the United States, foreign and worldwide bird weight distributions are presented in table 3.3. The mean, median and mode are three different concepts for the typical or average value which measures the central tendency of the distribution. The median and mode are more relevant measures of the average for the bird ingestion problem. The mean weight would be important if damage were related to the cumulative weight of all birds ingested by a single engine since the mean is based on the total weight of the ingested birds.

A pattern suggestive of a sine function is seen in figure 3.4 which is a bar chart of monthly bird ingestions for the data collection period. A cyclic pattern in aircraft ingestion events is expected since bird activity is seasonal; however, a second year of data is required to show that the periodic property in the pattern of monthly ingestion events repeats. The start of a cyclic pattern is also seen in the ingestion rate data which indicate that the trends are due to the changing bird population and not changes in air traffic activity. Time trends in bird ingestions are further investigated on a seasonal basis in the following paragraphs.

The seasonal bird ingestion rates for the northern and southern hemispheres, the United States and foreign countries, and the whole world are presented in the bar chart of figure 3.5. Here the ingestion rates are not being compared by engine type so the ingestion rate R is simply calculated as:

$$R = Ing \cdot \frac{10000}{Ops} \qquad 3.1$$

where Ing is the number of ingestions and Ops is the number of aircraft operations in the time period being considered. The rate is expressed as ingestions per 10,000 aircraft operations.

Seasonal trends were investigated using a Chi-squared goodness-of-fit (GOF) analysis. The Chi-squared value for testing the hypothesis "that the number of aircraft ingestion events does not vary with the seasons" is 22.22. The critical value for testing at the five percent level of significance is 7.81 while the 0.5 percent level is 12.8; therefore, the high value of the test statistic is a strong indication that ingestions do vary with the seasons.

The winter data were eliminated in an effort to better identify the nature of the differences between the seasons. Testing for the equality of the ingestions for spring, summer, and autumn also yields a significant difference with a test statistic of 6.05 and a five percent critical value of 5.99. After eliminating the data from the next lower season, there is no detectable difference between summer and autumn so that the data indicate that there are the fewest ingestions in the winter, followed by an increase in ingestions in the spring, with the maximum number of ingestions occurring during the summer and carrying through the autumn.

TABLE 3.3 SUMMARY STATISTICS FOR INGESTED BIRD WEIGHTS

STATISTIC	UNITED STATES (oz.)	FOREIGN (oz.)	WORLDWIDE (oz.)
MODE(S)	14	9	14
MEDIAN	14	9	10
MEAN	20.7	11.1	17.6
STANDARD DEVIATION	27.8	10.3	23.9

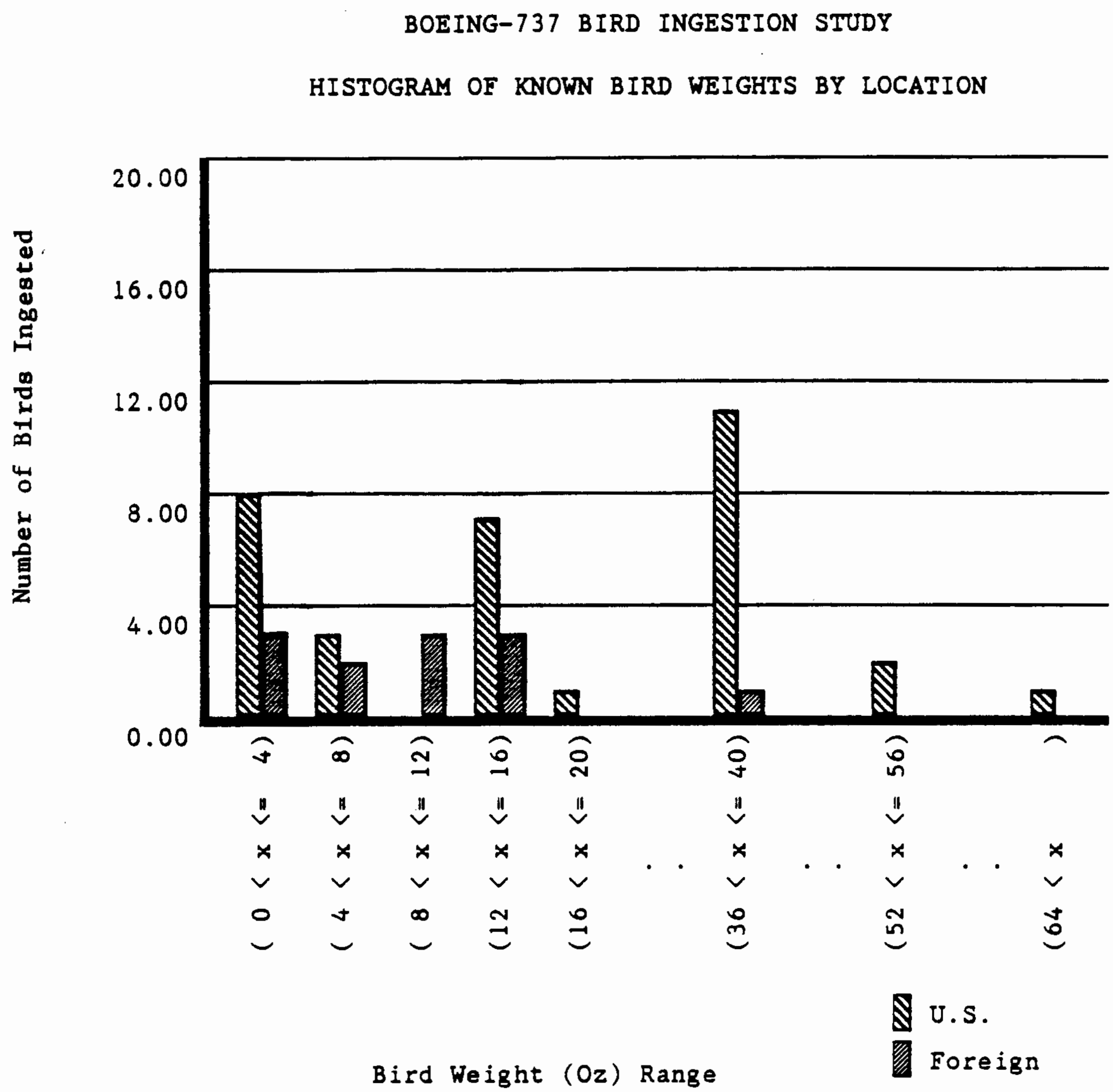

Figure 3.3 Historgram of Number of Birds Ingested by Bird Weight

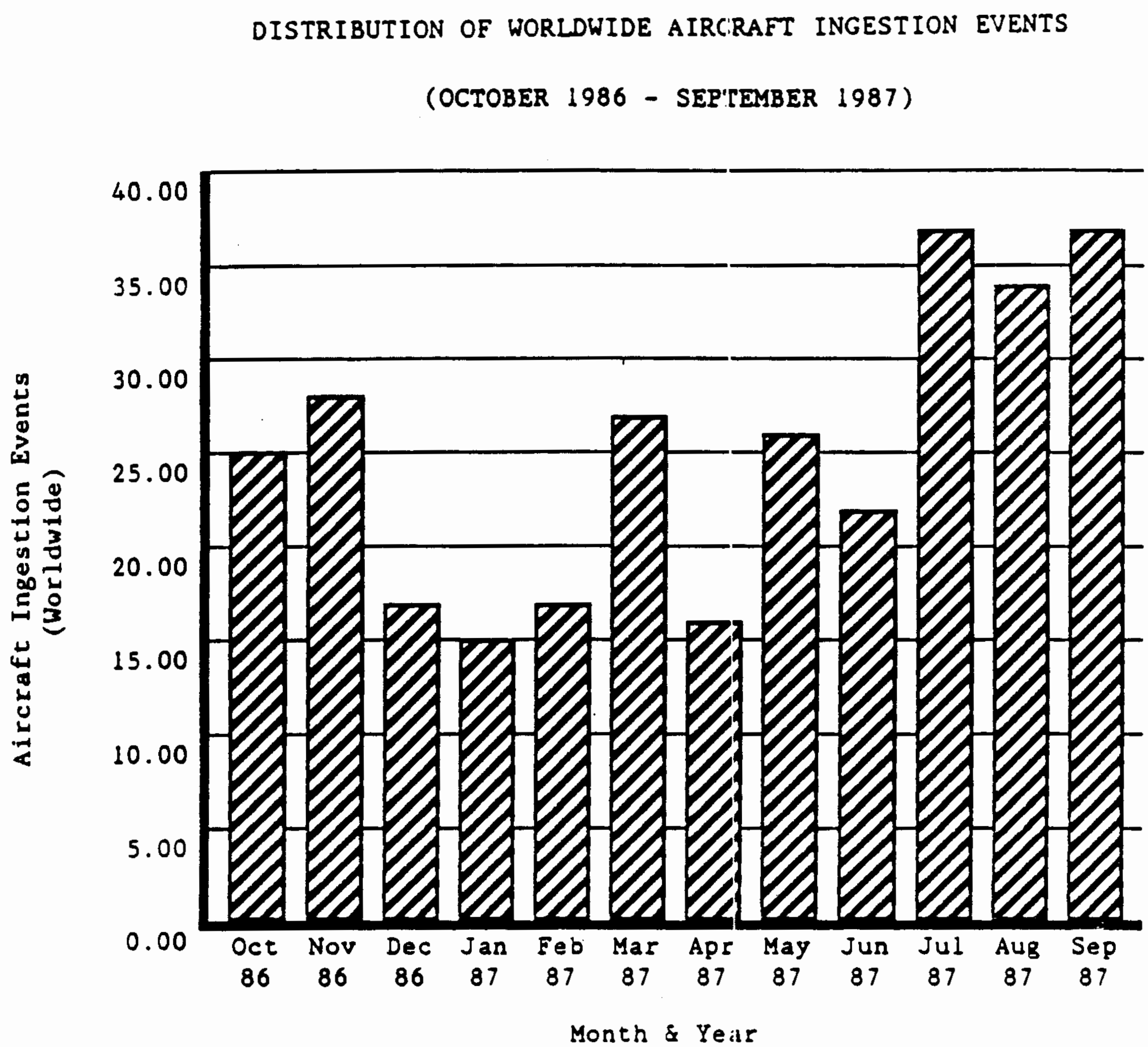

Figure 3.4 Bar Chart of Worldwide Aircraft Ingestion Events

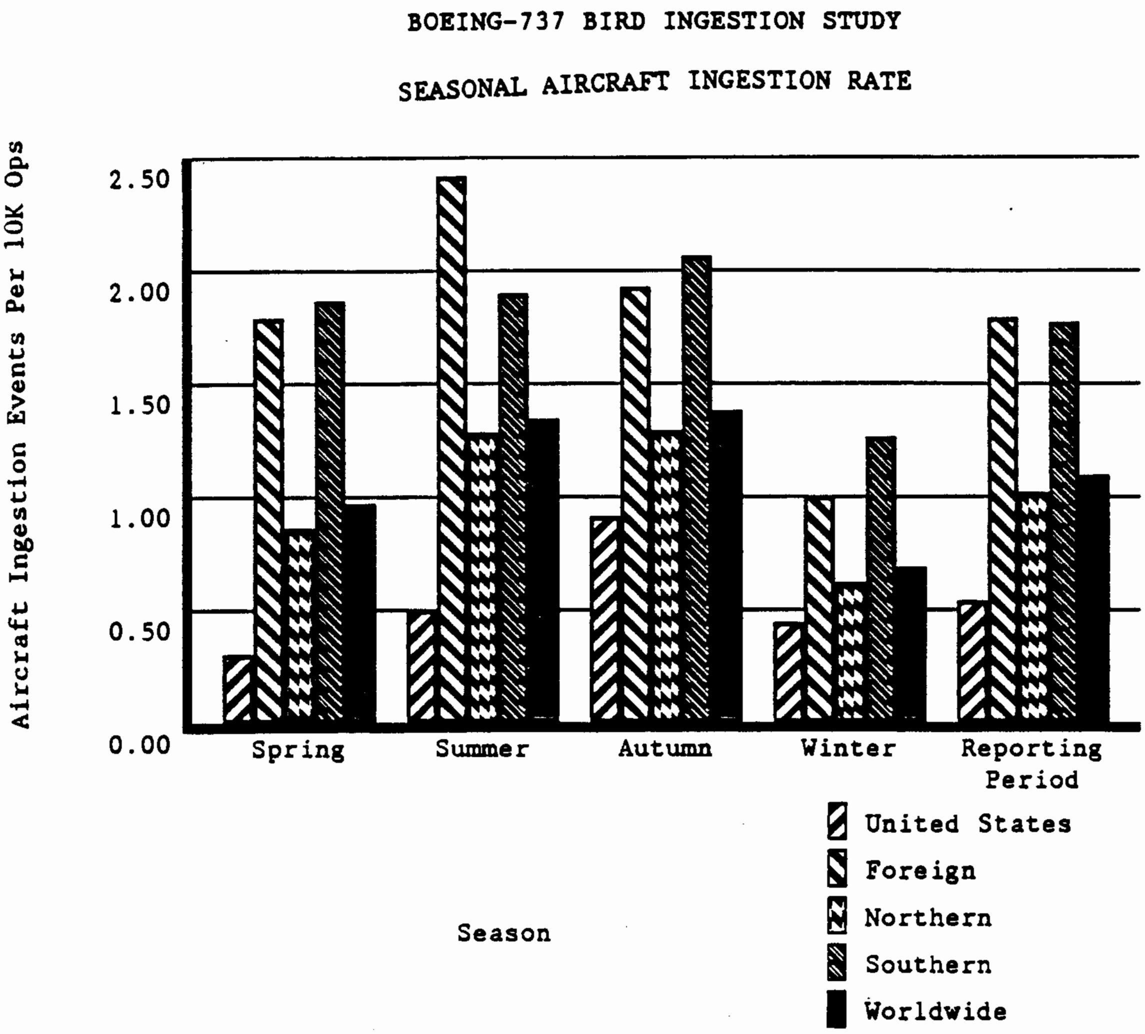

Figure 3.5 Seasonal Aircraft Ingestion Rates

The time-of-day distribution of bird ingestion events is illustrated in figure 3.6 with time of day reduced to the four basic segments of morning, mid-day, evening, and night. There is a noticeable drop in the number of ingestions at night and the Chi-squared test for equality of the four time periods indicates that they are not the same. The Chi-squared test statistic is 12.1 while the 99th percentile of the Chi-squared with three degrees of freedom distribution is 11.34.

There are two likely reasons for a drop in ingestions during the night. Birds are not generally nocturnal so that bird activity is reduced at night. Also, there are fewer flights scheduled at night. A lessened exposure due to fewer flights and fewer birds results in a reduction in the number of ingestions at night.

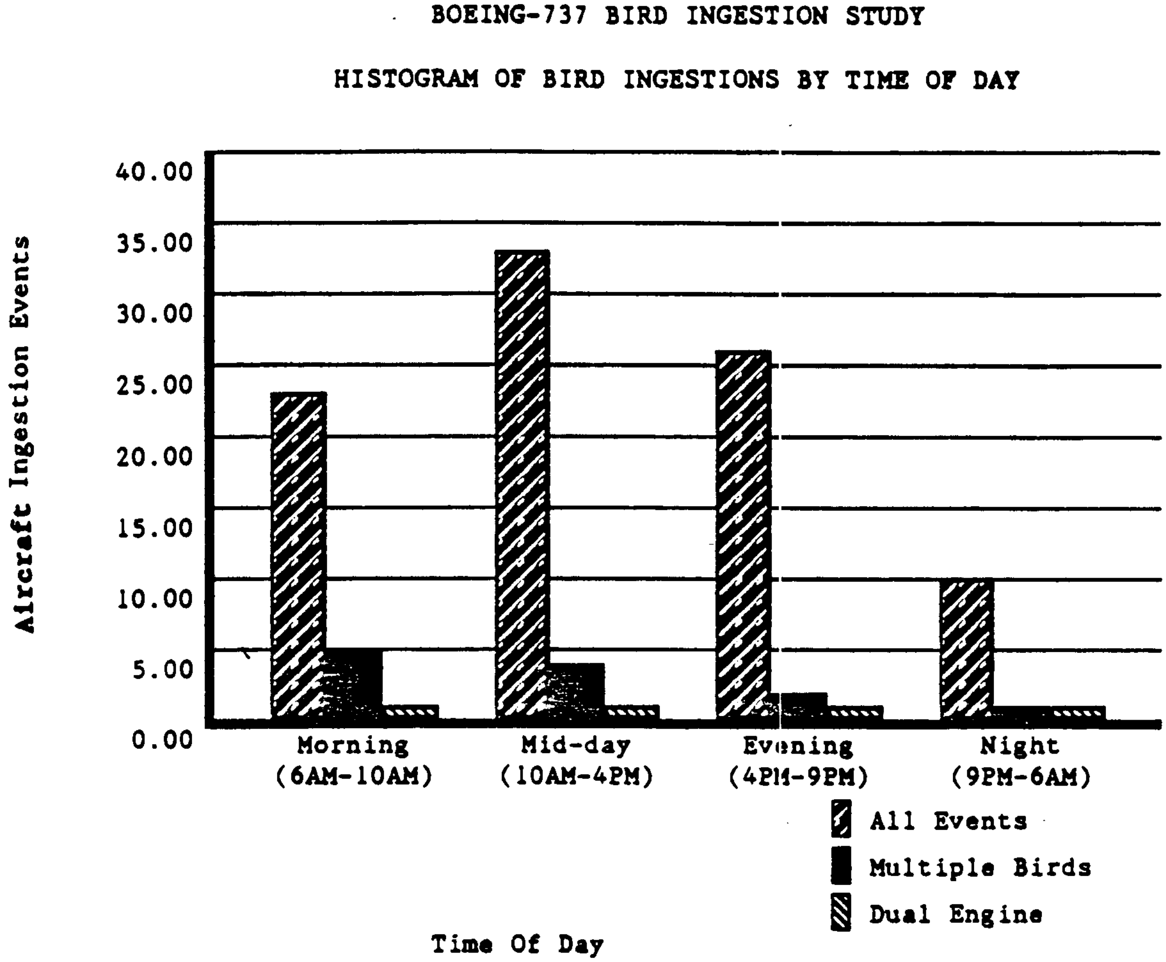

Figure 3.6 Histogram of Aircraft Ingestion Events by Time of Day

SECTION 4

INGESTION RATES

This section describes the rates at which bird ingestions occurred during the 1-year collection period covered in this report. The Poisson distribution is commonly used to describe how events are randomly scattered in time, and the bird ingestion data are shown to agree with the assumptions of a Poisson process. The first part of this section provides the estimates of the basic ingestion rates. The second part describes the Poisson distribution and how it relates to the bird ingestion events. The final parts discuss statistical analyses based on the assumption that bird ingestions follow a Poisson process.

4.1 INGESTION RATE ESTIMATES.

This section provides a general description of ingestion rates broken down by location, engine, and phase of flight. The rates are given in terms of ingestions per 10,000 aircraft operations and have been adjusted to the inlet area of the engine to allow size independent comparisons between engines. The inlet area used throughout this report is called the "fat lip area" and was specified by the Boeing Co. for each type of engine installation. A more detailed statistical analysis of ingestion rates is covered in the next section using statistical techniques for Poisson processes.

Table 4.1A lists the United States, foreign and worldwide ingestion rates for both the JT8D and the CFM56 engines as well as a composite rate for all 737 aircraft. The inlet area adjustment was done using a 10-square-foot unit area on the basis of the total inlet area of both engines to keep the rates in a reasonable range. The composite rates in each geographical region are weighted means of the inlet area adjusted rates for the individual engines and are determined as follows. The number of ingestions per 10-square-foot inlet area for each engine is projected by multiplying the rates by the number of aircraft operations. The composite rates are calculated by dividing the total projected ingestions for both engines by the total aircraft operations for the geographical region. Table 4.1B lists engine ingestion rates based on engine operations and normalized for the engine inlet area.

The ingestion rates for the CFM56 engine were calculated using reported aircraft operations for specific geographical regions. The ingestion rates for the JT8D engine were calculated using estimated aircraft operations for specific geographical regions. The details of the calculation were presented in Section 2.

Figure 4.1 shows monthly ingestion rates subdivided by engine type and adjusted for inlet area so that a comparison between engine types can be made. The adjusted monthly ingestion rate (R_{adj}) for an engine type is expressed as ingestions per 10 ft_2 per 10,000 aircraft operations is calculated as:

$$R_{adj} = Ing \cdot \frac{1440}{2IA} \cdot \frac{1000}{Ops} \qquad 4.1$$

where Ing is the number of monthly aircraft ingestion events for an engine type, IA is the inlet area (in^2) of the engine type, and Ops is the number of aircraft

TABLE 4.1A BREAKDOWN OF BIRD INGESTION RATES BY ENGINE AND LOCATION (BASED ON AIRCRAFT OPERATIONS)

ENGINE TYPE:	JT8D	CFM56	ALL ENGINES
INLET AREA:*	2234 in^2	4606 in^2	N/A
UNITED STATES			
Aircraft Ingestion Events	40	40	81
OAG Aircraft Operations	1,160,091	353,656	1,513,747
Ingestion Rate (Ing/10K Ops)	0.34	1.13	0.54
Normalized Ingestion Rate (Ing/10K Ops/10ft^2)	0.22	0.35	0.25
FOREIGN			
Aircraft Ingestion Events	173	48	221
OAG Aircraft Operations	1,057,633	174,206	1,231,839
Ingestion Rate (Ing/10K Ops)	1.64	2.76	1.79
Normalizes Ingestion Rate (Ing/10K Ops/10ft^2)	1.05	0.86	1.03
WORLDWIDE			
Aircraft Ingestion Events	213	88	302
OAG Aircraft Operations	2,217,724	527,862	2,745,586
Ingestion Rate (Ing/10K Ops)	0.96	1.67	1.10
Normalizes Ingestion Rate (Ing/10K Ops/10ft^2)	0.62	0.52	0.60

*Total Area for 2 Engines

TABLE 4.1B BREAKDOWN OF BIRD INGESTION RATES BY ENGINE AND LOCATION (BASED ON ENGINE OPERATIONS)

ENGINE TYPE:	JT8D	CFM56	ALL ENGINES
INLET AREA:*	1117 in^2	2303 in^2	N/A
UNITED STATES			
Engine Ingestion Events	43	43	87
OAG Engine Operations**	2,320,182	707,312	3,027,494
Ingestion Rate (Ing/10K Ops)	0.19	0.61	0.29
Normalized Ingestion Rate (Ing/10K Ops/10ft^2)	0.24	0.38	0.28
FOREIGN			
Engine Ingestion Events	175	52	227
OAG Engine Operations**	2,115,266	348,412	2,463,678
Ingestion Rate (Ing/10K Ops)	0.83	1.49	0.92
Normalizes Ingestion Rate (Ing/10K Ops/10ft^2)	1.07	0.93	1.05
WORLDWIDE			
Engine Ingestion Events	218	95	314
OAG Engine Operations**	4,435,448	1,055,724	5,491,174
Ingestion Rate (Ing/10K Ops)	0.49	0.90	0.57
Normalizes Ingestion Rate (Ing/10K Ops/10ft^2)	0.63	0.56	0.62

*Area for 1 Engine

** Engine Operations = 2 x Aircraft Operations

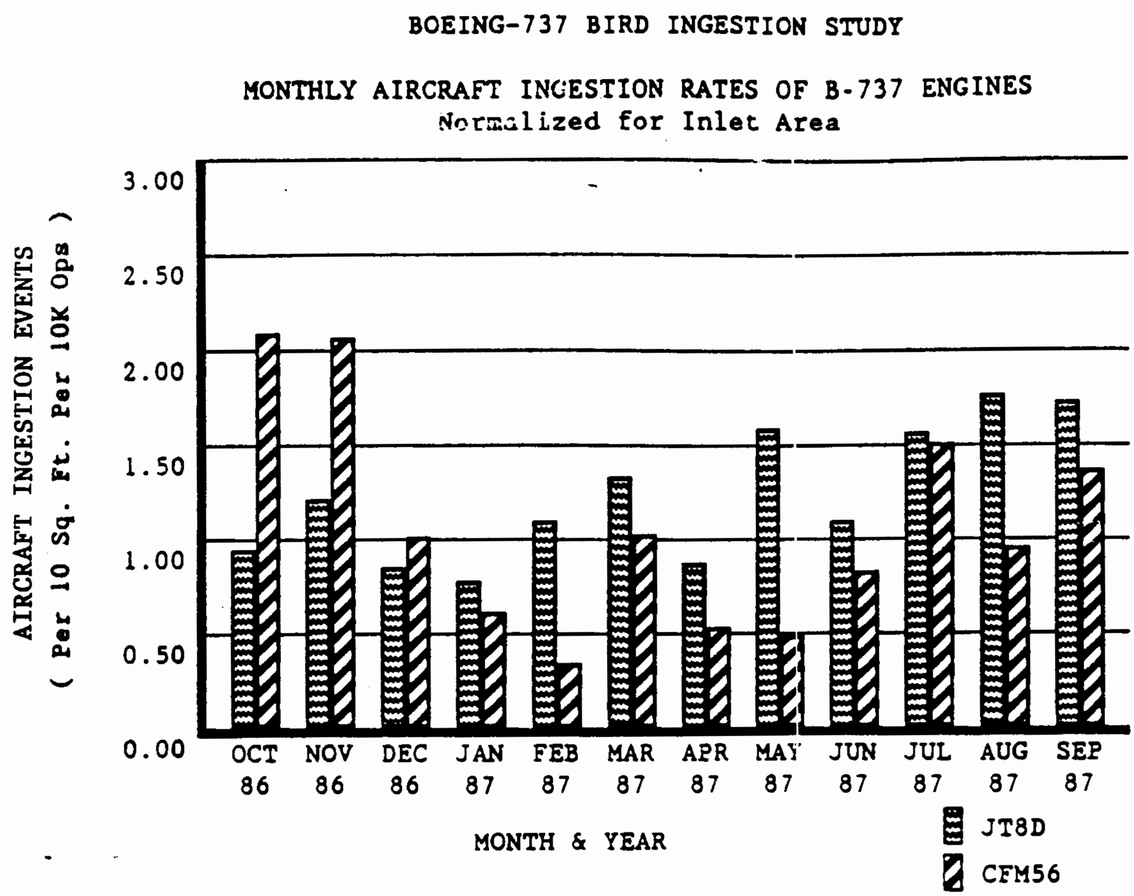

Figure 4.1 Histogram of Monthly Aircraft Ingestion Rates by Engine Type

operations for the month. Twice the engine area is used because there are two engines on each B737 aircraft. The constant 1440 is the factor for converting square inches to units of 10 square feet areas.

The phase of flight ingestion rate breakdown is presented in table 4.2A. The method used to calculate ingestion rate 1 is expressed in equation 3.1. The area adjustment used for ingestion rate 2 is implemented using equation 4.1. The highest ingestion rates were in the takeoff and landing phases followed by the climb and approach phases. There were very few ingestions during the taxi and cruise phases of flight and none were reported during descent. This pattern is typically seen in bird strike and bird ingestion studies and is indicative of the fact that airports are often located in desirable bird environs. Since birds congregate around airports there is a greater chance of striking or ingesting a bird during the phases of flight that take place close to the airports. Also, commercial airline cruise routes are well above the altitude in which birds are usually found. Table 4.2B list engine ingestion rates as a function of phase of flight. The differences in injestion rates between table 4.2A and 4.2B are due to multiple engine ingestions.

4.2 THE POISSON PROCESS.

The Poisson process is the simplest type of stochastic process which describes how events are distributed in time. The Poisson process is here taken to govern ingestion events, and the times at which these events occur are random. In a Poisson process the events are distributed somewhat evenly in time so that it appears the times at which the events occurred form a uniform distribution. This section describes some of the properties of Poisson processes that will be useful in describing bird ingestions and in testing hypotheses about bird ingestion rates.

The basis of a Poisson process is a description of the probability distribution of the number of events that occur in a given time interval. The formula for the probability of n events in an interval of length T is:

$$P(X(T)=n) = \frac{e^{-\lambda T} (\lambda T)^n}{n!} \qquad 4.2$$

The parameter λ is the mean rate at which events occur and the mean number of events in the length T time interval is λT. The time scale that will be used in this study is number of aircraft operations. Ingestion rates are typically reported in events per 10,000 aircraft operations which implies the use of aircraft operations as the time scale in a Poisson process.

One derivation of the formula for the Poisson distribution is the limiting distribution of the binomial distribution for large sample sizes. If we assume that the probability of a bird ingestion is the same from flight to flight, then the number of ingestions in a large number of flights has a binomial distribution. If the probability of ingestion is p and the number of flights is N then the probability that n ingestions occur in the N flights is:

$$P(X(N)=n) = \frac{N}{n} p^n(1-p)^{(N-n)} \qquad 4.3$$

TABLE 4.2A INGESTION RATES FOR ENGINE TYPE BY PHASE OF FLIGHT
(BASED ON AIRCRAFT OPERATIONS)

	PRATT-WHITNEY JT8D			CFMI CFM56			ALL ENGINES		
INLET* AREA	2234 in^2			4606 in^2			---		
AIRCRAFT OPERATIONS	2,217,724			527,862			2,745,586		
PHASE OF FIGHT	AIRCRAFT ING. EVENTS	INGEST RATE 1 **	INGEST RATE 2 #	AIRCRAFT ING. EVENTS	INGEST RATE 1 **	INGEST RATE 2 #	AIRCRAFT ING. EVENTS	INGEST RATE 1 **	INGEST RATE 2 ##
Taxi	1	.005	.003	2	.038	.012	3	.011	.005
Takeoff	87	.392	.253	27	.512	.160	115	.419	.235
Climb	9	.041	.025	9	.171	.053	18	.066	.031
Cruise	0	----	----	1	.019	.006	1	.004	.001
Approach	11	.050	.032	6	.114	.036	17	.062	.033
Landing	36	.162	.105	18	.341	.107	54	.197	.105
Unknown	69	.311	.201	25	.474	.148	94	.342	.190
All Phases	213	.960	.619	88	1.677	.521	302	1.100	.600

* Total Area of 2 Engines
** Ingestion Events per 10,000 Operations
\# Ingestion Events Per 10,000 Operations Per 10 ft^2
\## Function of JT8D Rate 2, CFM56 Rate 2, and Corresponding Operations

TABLE 4.2B INGESTION RATES FOR ENGINE TYPE BY PHASE OF FLIGHT
(BASED ON ENGINE OPERATIONS)

	PRATT-WHITNEY JT8D			CFMI CFM56			ALL ENGINES		
INLET AREA*	1117 in^2			2303 in^2			---		
ENGINE OPERATIONS	4,435,448			1,055,724			5,491,174		
PHASE OF FIGHT	ENGINE ING. EVENTS	INGEST RATE 1 **	INGEST RATE 2 #	ENGINE ING. EVENTS	INGEST RATE 1 **	INGEST RATE 2 #	ENGINE ING. EVENTS	INGEST RATE 1 **	INGEST RATE 2 ##
Taxi	1	.002	.003	2	.019	.012	3	.005	.005
Takeoff	90	.203	.262	29	.275	.172	120	.219	.244
Climb	9	.020	.026	9	.085	.053	18	.033	.031
Cruise	0	----	----	1	.009	.006	1	.002	.001
Approach	12	.027	.035	7	.066	.041	19	.035	.036
Landing	36	.081	.105	21	.199	.124	57	.104	.108
Unknown	70	.158	.203	26	.246	.154	96	.175	.194
All Phases	218	.491	.634	95	.900	.563	314	.572	.622

* Area of 1 Engine
** Ingestion Events per 10,000 Operations
\# Ingestion Events Per 10,000 Operations Per 10 ft^2
\## Function of JT8D Rate 2, CFM56 Rate 2, and Corresponding Operations

The binomial probabilities in equation 4.3 can be approximated by a Poisson distribution with mean Np for large values of N. That is, the single flight probability of an ingestion, p, replaces λ in equation 4.2.

An important question that can be investigated through the Poisson process model of bird ingestions is the influence of inlet area on the ingestion rates. Past studies (2,3) in bird strikes have used the assumption that the probability of a bird strike is proportional to the cross sectional area of the aircraft. Applying the same concept to engines implies that the bird ingestion rate should be proportional to the inlet area of the engine.

The inlet area effect can be incorporated into the Poisson process model by letting the parameter represent the ingestion rate per unit area. The probability of n ingestions in N operations for an engine with inlet area A is:

$$P(X(N)=n) = \frac{e^{-\lambda AN} (\lambda AN)^n}{n!} \qquad 4.4$$

4.3 VALIDITY OF THE POISSON PROCESS MODEL FOR BIRD INGESTIONS.

The applicability of the Poisson process model can be tested by analyzing the times between ingestions. The interarrival times in a Poisson process are random variables that have independent exponential distributions and the mean time between arrivals is the reciprocal of the ingestion rate. The validity of the Poisson process model can be tested by applying a goodness-of-fit (GOF) test for the exponential distribution to the times between ingestions.

The times between ingestions are measured by the number of days between aircraft ingestion events. Normally the number of aircraft operations between aircraft ingestion events would be used; however it is impossible to measure this directly. The number of days between aircraft ingestion events provides a suitable measure of the time between ingestions since the number of aircraft operations has little day-to-day variability.

The GOF test for the exponential distribution is a modified Kolmogorov-Smirnov (K-S) test comparing the observed cumulative distribution function (CDF) to the predicted exponential CDF based on the sample mean. The K-S test uses the test statistic D defined as the maximum distance between the observed and predicted cumulative distribution functions. A modification to the critical values for the test statistic is required when the predicted CDF is derived from the mean of the sample. The critical values for the modified K-S test were computed by Liliefors (4). The critical value for a .05 level of significance when the sample size, n, is larger than 30 can be approximated by $1.06/\sqrt{n}$.

The modified K-S test was run on four subgroups of the data broken down by engine and location. The four groups were (1) domestic (United States) JT8D, (2) foreign JT8D, (3) domestic CFM56, and (4) foreign CFM56. Figures 4.2 to 4.5 compare the observed and predicted cumulative distributions for each of the four groups, respectively. In each case there is a very close visual agreement between the observed and predicted CDF's.

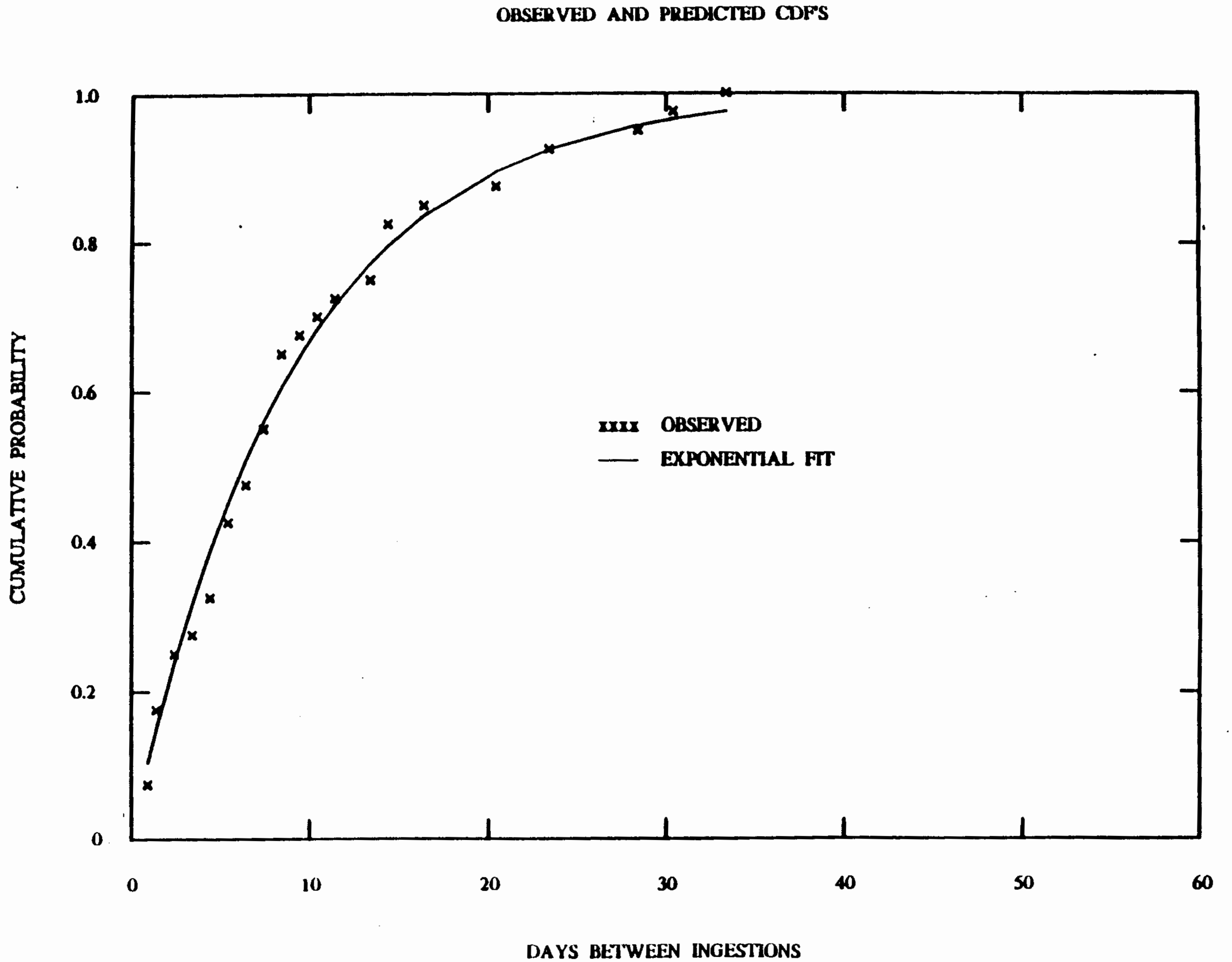

Figure 4.2 Comparison of Observed and Predicted CDFs for Domestic JT8D Aircraft Ingestion Events

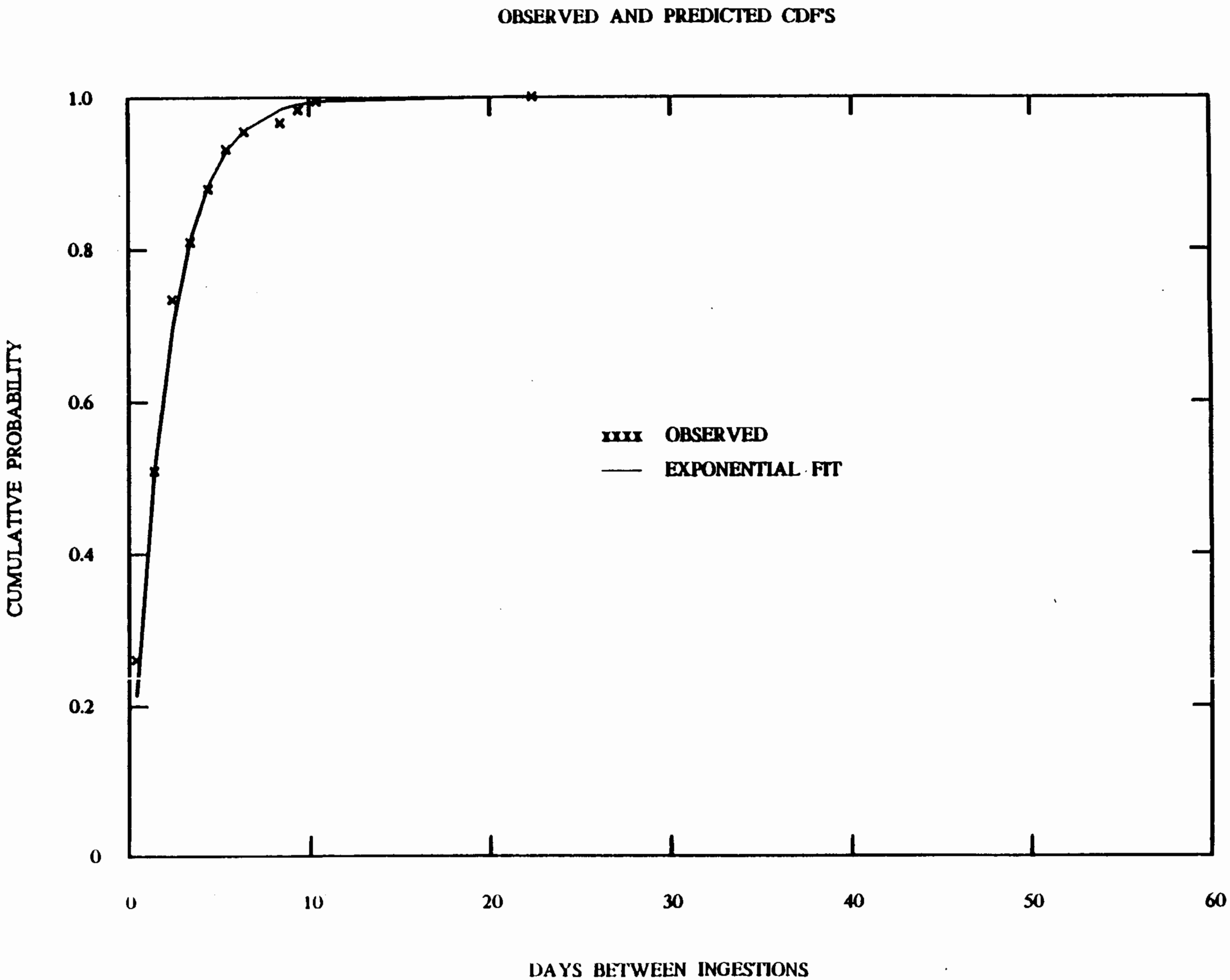

Figure 4.3 Comparison of Observed and Predicted CDFs for Foreign JT8D Aircraft Ingestion Events

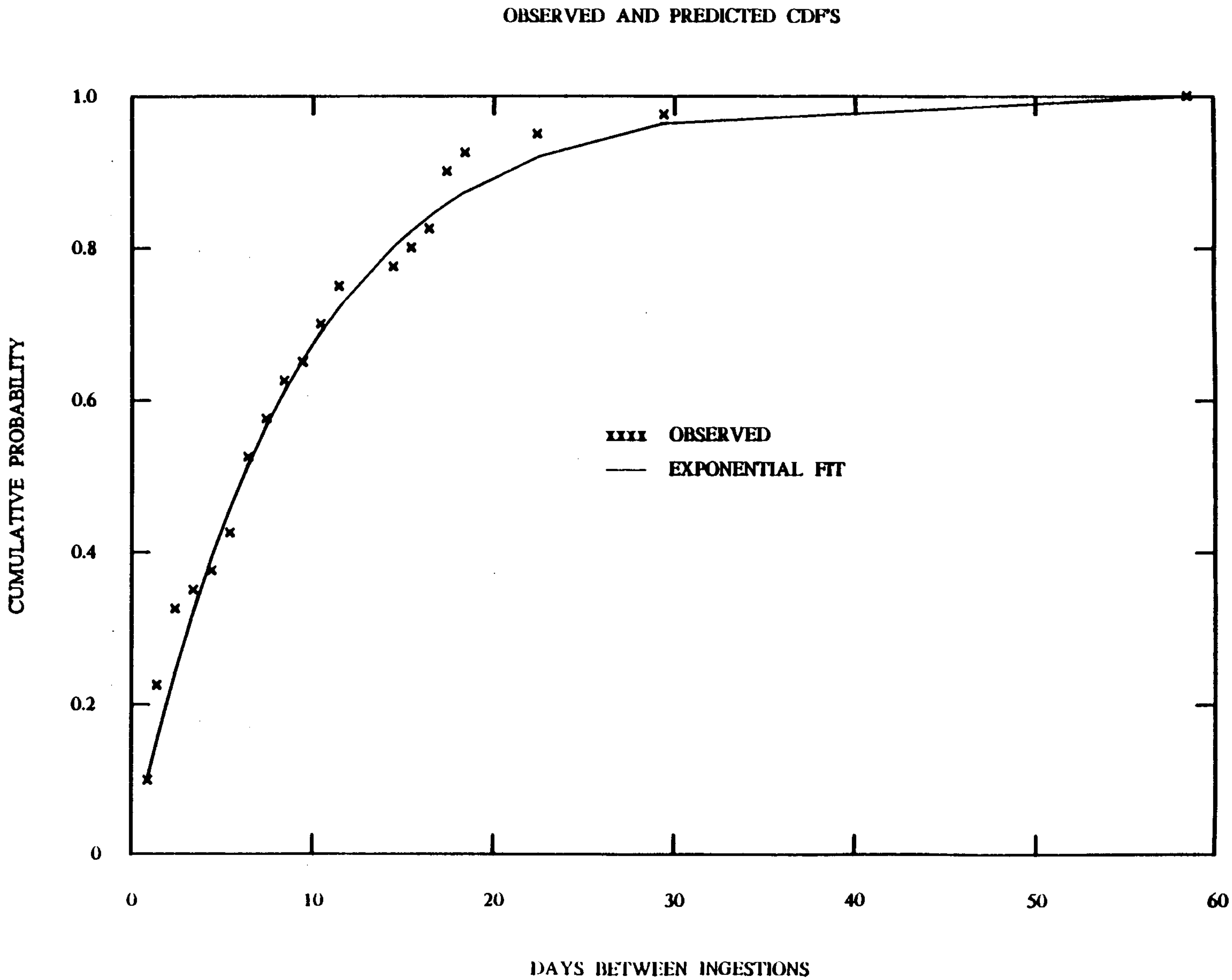

Figure 4.4 Comparison of Observed and Predicted CDFs for Domestic CFM56 Aircraft Ingestion Events

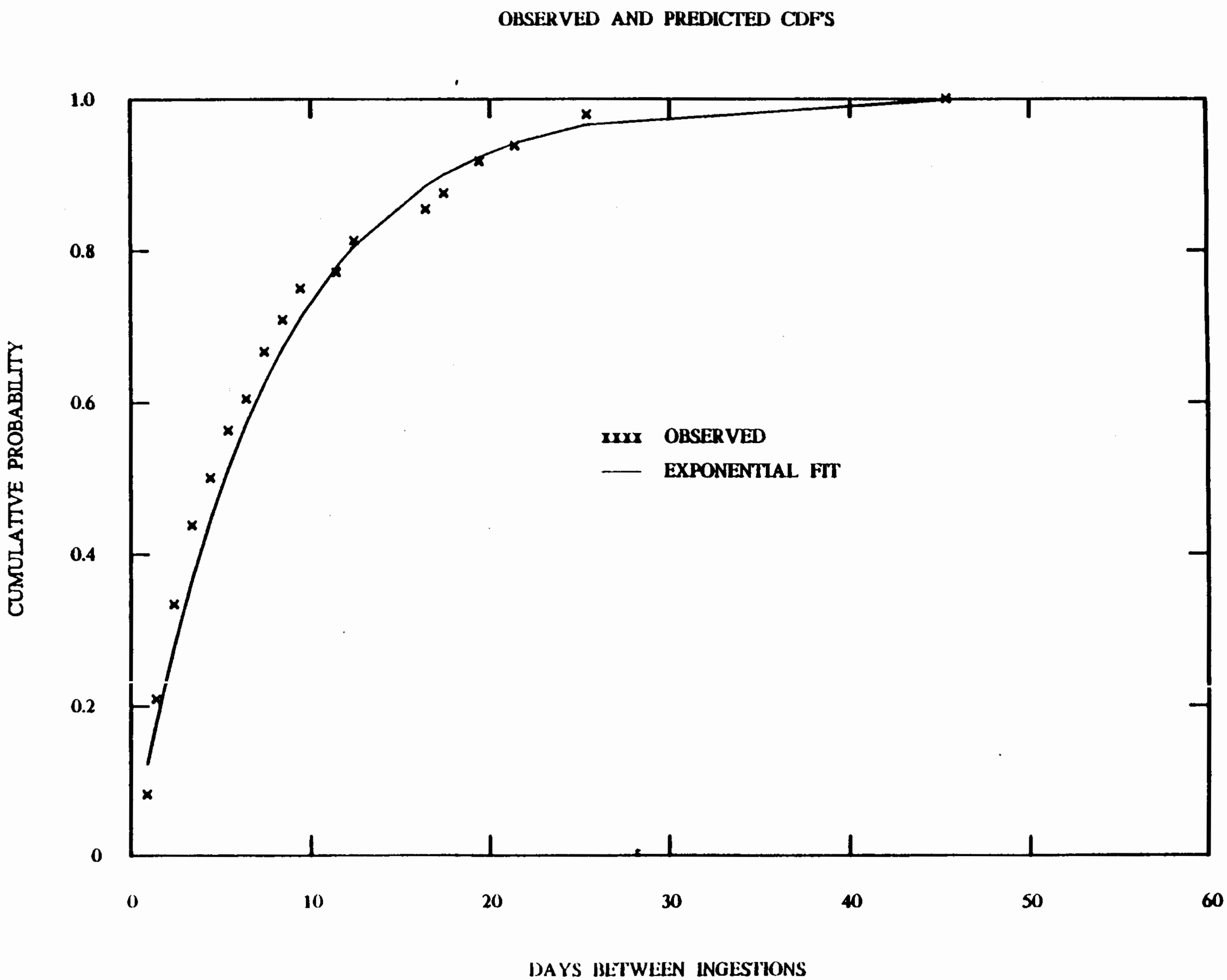

Figure 4.5 Comparison of Observed and Predicted CDFs for Foreign CFM56 Aircraft Ingestion Events

The visual similarities are verified by the statistical tests which are summarized in table 4.3. The mean time between ingestion events is given in column one, the sample size is in column two, the critical value for a five percent significance level (D^*) is in column three, and the test statistic (D) is in column four. The assumption that the times between ingestion events come from an exponential distribution cannot be rejected at the five percent level in any of the four groups. The use of a Poisson process to model bird ingestions is appropriate based on these test results.

TABLE 4.3 RESULTS OF THE EXPONENTENTIAL GOF TESTS TO VERIFY THE POISSON PROCESS

AREA	ENGINE	MEAN	SAMPLE SIZE	D^*	D
United States	JT8D	9.14	40	0.17	0.06
Contiguous US	JT8D	12.17	30	0.19	0.09
Foreign	JT8D	2.22	173	0.08	0.10
United States	CFM56	9.00	40	0.17	0.08
Contiguous US	CFM56	9.00	40	0.17	0.08
Foreign	CFM56	7.64	48	0.15	0.07

4.4 INLET AREA EFFECT ON INGESTION RATES.

One property of the Poisson process model described in Section 4.2 is that ingestion rates should be proportional to the inlet area of the engine. The size effect can be investigated in the B737 bird ingestion data by comparing the number of ingestion events of the JT8D with the number of ingestion events of the CFM56. According to equation 4.4 the total number on ingestion events during the reporting period for a given engine has a Poisson distribution with a mean that is proportional to the number of aircraft operations in the year and to the inlet area of the engine. The number of JT8D ingestion events out of the total number of ingestion events will have a Binomial distribution if the Poisson process model is valid.

The proportion of total ingestion events that occurred in JT8D engines should be:

$$P = \frac{OJ*AJ}{OJ*AJ = OC*AC} \quad , \qquad 4.5$$

where OJ and OC are the numbers of worldwide aircraft operations for and AJ and AC are the inlet areas of the JT8D and CFM56 engines, respectively. The relevant values for Equation 4.5 can be obtained from table 4.1 giving an expected proportion of JT8D ingestion events of P = 0.67. Out of 301 total ingestion events, there were 213 JT8D ingestion events so the observed proportion of JT8D ingestion events is 0.71. The test statistic to compare the observed proportion to the predicted is the standard Z statistic for the binomial distribution given by:

$$Z = (\hat{P} - P) \; / \sqrt{(P * (1-P) \;\; /N)} \; , \qquad 4.6$$

where $\hat{P}$ is the observed proportion of JT8D engines and N is the total number of aircraft ingestion events.

The Z statistic defined in equation 4.6 is used to test the null hypothesis that there is no difference between the two types of engines in ingestion rates after adjusting for area. The test statistic is computed by substituting the value 0.67 for P and 0.71 for P in equation 4.6 to give a value of 1.36. The Z value of 1.36 is not significant at the 5 percent level of significance so there is no detectable difference in ingestion rates between the JT8D and the CFM56 after adjustment for the inlet area.

A second school of thought suggests that the relationship between engine size and ingestion rate is described better as a linear function of diameter than as a linear function of area. A similar Z test can be computed by substituting diameter for area in equation 4.5. The expected proportion of JT8D ingestion events after an adjustment for diameter is P = 0.74 and the test statistic is Z = -1.50. The null hypothesis is that there is no difference in ingestion rates after adjusting for diameter and the conclusion of the test is that there is no detectable difference at the 5 percent level of significance. There are insufficient data to determine whether area or diameter is the better measure of engine size to account for differences in ingestion rates.

SECTION 5

AIRPORT BIRD INGESTION EXPERIENCE

The objective of the statistics of this section is to identify the frequency and location of bird ingestion events at airports worldwide. An aircraft ingestion event is the simultaneous ingestion of one or more birds by one or more engines of an aircraft. Most of the bird ingestion data were provided by the engine manufacturer. Airport ingestion rates are expressed in terms of aircraft ingestion events per 10,000 airport operations.

The OAG tapes indicate that there are 1,032 airports worldwide for which 5,491,172 B737 airport operations were scheduled during the reporting period. Appendix A lists the airport code, airport location, and the number of scheduled airport operations at these airports. Bird ingestion events were reported at only 137 of these airports. The OAG tapes show that there were 2,306,473 scheduled airport operations at these 137 airports. There were also bird ingestion events reported by unscheduled B737 flights at five additional airports. These five airports (Gualequaychu, China, Kosti, Sudan, Milan, Italy, Surat, India, and Jerez Dela Frontera, Spain) are included in appendix A but there are no OAG operations counts for them.

A complete summary of the airports having reported aircraft ingestion events is presented in table 5.1 as a frequency count of worldwide bird ingestion events by phase of flight. The majority of aircraft ingestion events occur during takeoff or landing. This table suggests that the threat of bird ingestion is posed primarily from birds which live near the airport and/or whose migratory path crosses over or near the airport property.

Figure 5.1 is a bar chart showing reported aircraft ingestion events at domestic airports during the reporting period. There are 44 domestic airports at which bird ingestion events have been reported. The largest number of bird ingestion events reported in the United States during the period was 4 at Dallas, Love (DAL). Of the 80 bird ingestion events reported in the United States, 14 events occurred at an unknown location and they are assigned to the airport code XUS on the bar chart.

Figure 5.2 is a bar chart showing reported aircraft ingestion events at foreign airports during the reporting period. There are 98 foreign airports at which bird ingestions have been reported. The largest number of aircraft ingestion events reported abroad during the period is eight at Frankfort, Germany (FRA). Of the 221 aircraft ingestion events reported outside of the United States, 67 events occurred at an unknown location and they are assigned to the airport code XFO on the bar chart.

Table 5.2 lists all airports worldwide which experienced three or more aircraft ingestion events during the reporting period. The table also includes the number of ingestion events, the number of OAG airport operations, and the rate of aircraft ingestion events per 10,000 airport operations. The airports are listed in descending order of airport operations.

TABLE 5.1

FREQUENCY COUNT OF AIRCRAFT INGESTION EVENTS BY AIRPORT AND PHASE OF FLIGHT

AIRPORT	AIRPORT DEFINITION	TAXI	TAKEOFF	CLIMB	CRUISE	APPROACH	LANDING	UNKNOWN	TOTAL
ADL	ADELAIDE SA AUSTRALIA		1						1
AJA	AJACCIO, CORSICA, FRANCE						1		1
AKL	AUCKLAND, NEW ZEALAND		2						2
ALB	ALBANY, NY, USA		1	1					2
ALG	ALGIERS, ALGERIA					1			1
AMS	AMSTERDAM, NETHERLANDS		1	1			1	1	4
AOR	ALOR SETAR, MALAYSIA		1						1
AUS	AUSTIN, TX, USA			1					1
BBI	BHUBANESWAR, INDIA		1						1
BEG	BELGRADE, YUGOSLAVIA							1	1
BHM	BIRMINGHAM, AL, USA			1			1		2
BHX	BIRMINGHAM, ENGLAND (UK)		2						2
BLR	BANGALORE, INDIA		1				1	1	3
BOM	BOMBAY, INDIA						1	1	2
BRS	BRISTOL, ENGLAND (UK)						1		1
BRU	BRUSSELS, BELGIUM		1	1					2
BWI	BALTIMORE, MD, USA		1						1
CCU	CALCUTTA, INDIA		1				1		2
CDG	PARIS DE GAULLE, FRANCE					1			1
CGN	COLOGNE BONN, FRG		1						1
CHC	CHRISTCHURCH, NEW ZEALAND		5				1	1	7
CLE	CLEVELAND, OH, USA		1						1
CLT	CHARLOTTE, NC, USA		1			1		1	3
CMG	CORUMBA, MATO GROSSO, BRAZIL		1						1
CNS	CAIRNS, QLD, AUSTRALIA							1	1
CPH	COPENHAGEN, DENMARK		1						1
CPT	CAPE TOWN, SOUTH AFRICA		1						1
CTU	CHENGDU, P.R. CHINA	1							1
DAB	DAYTONA BEACH, FL, USA		1						1
DAL	LOVE DALLS/FT. WORTH, TX, USA					2		2	4
DAY	DAYTON, OH, USA			1					1
DEN	STAPLETON INT'L, DENVER, CO, USA		1			1			2
DFW	DALLAS/FT WORTH, TX, USA		1						1
DUB	DUBLIN, REPUBLIC OF IRELAND					1			1
DUR	DURBAN, SOUTH AFRICA		2						2
DUS	DUESSELDORF, FRG		1				1		2
ELS	EAST LONDON, SOUTH AFRICA		2				1		3
EWR	NEWARK, NEW YORK, NY, USA		1						1
EZE	BUENOS AIRES-EZEIZA ARPT, ARGENTINA		1						1
FAT	FRESNO, CA, USA		1						1

TABLE 5.1 (continued)

FREQUENCY COUNT OF AIRCRAFT INGESTION EVENTS BY AIRPORT AND PHASE OF FLIGHT

AIRPORT	AIRPORT DEFINITION	TAXI	TAKEOFF	CLIMB	CRUISE	APPROACH	LANDING	UNKNOWN	TOTAL
FLL	FT LAUDERDALE, FL, USA		1						1
FNC	FUNCHAL - MADEIRA, PORTUGAL		1						1
FRA	FRANKFURT, FRG	1	3	1		1		2	8
GAU	GAUHATI, INDIA		1						1
GHU	GUALEGUAYCHU, ARGENTINA		1						1
GOA	GENOA, ITALY		1						1
GRZ	GRAZ, AUSTRIA						1		1
HAC	HACHIJO, JIMA ISLAND, JAPAN						1		1
HAM	HAMBURG, FRG		2						2
HOU	HOUSTON, TX, USA		1				2		3
HRL	HARLINGEN, TX, USA						1		1
HYD	HYDERABAD, INDIA		1						1
IAD	DULLES INT'L, WASHINGTON, DC, USA							1	1
IBZ	IBIZA, SPAIN						1		1
ISG	ISHIGAKI, JAPAN		1						1
ITO	HILO HAWAII, HA, US		1						1
IXB	BAGDOGRA, INDIA							1	1
JAI	JAIPUR, INDIA						1	1	2
JNB	JOHANNESBURG, SOUTH AFRICA		2						2
JRH	JORMAT, INDIA							1	1
KCH	KUCHING, SARAWAK, MALAYSIA			1					1
KGS	KOS, GREECE		1						1
KHH	KAOHSIUNG, TAIWAN						1	1	2
KHI	KARACHI, PAKISTAN						1	1	2
KMG	KUNMING, P.R. CHINA		1						1
KST	KOSTI, SUDAN					1			1
KUL	KUALA LUMPUR, MALAYSIA					1	1		2
LCA	LARNACA, CYPRUS						1		1
LEX	LEXINGTON, KY, USA		1						1
LGA	NEW YORK LA GUARDIA, NY, USA		1						1
LHE	LAHORE, PAKISTAN							1	1
LHR	LONDON HEATHROW, ENGLAND, (UK)					2			2
LIH	LIHUE, KAUAI, HA, US		2						2
LIN	MILAN LINATE, ITALY		1						1
LIT	LITTLE ROCK, AK, USA		1						1
LLW	LILONGWE, MALAWI		1						1
LNZ	LONZ, AUSTRIA		1						1
LOS	LAGOS, NIGERIA		1						1
LST	LAUNCESTON, TASMANIA, AUSTRALIA						1		1
MAD	MADRID, SPAIN		1						1

TABLE 5.1 (continued)

FREQUENCY COUNT OF AIRCRAFT INGESTION EVENTS BY AIRPORT AND PHASE OF FLIGHT

AIRPORT	AIRPORT DEFINITION	TAXI	TAKEOFF	CLIMB	CRUISE	APPROACH	LANDING	UNKNOWN	TOTAL
MAF	MIDLAND ODESSA, TX, USA		1						1
MAN	MANCHESTER, ENGLAND (UK)		3						3
MCO	ORLANDO-INT'L, FL, USA						1		1
MDT	HARRISBURG-OLMSTEAD ST, PA, USA		1						1
MDW	CHICAGO-MIDWAY, IL, USA		1						1
MEL	MELBOURNE, VICTORIA, AUSTRALIA						1		1
MIL	MILAN, ITALY		1						1
MMY	MIYAKO JIMA, JAPAN		3				2		5
MSO	MISSOULA, MT, USA						1		1
MSP	MINNEAPOLIS-ST PAUL, MN, USA		1						1
MUC	MUNICH, FRG		2			1	1		4
NCE	NICE, FRANCE						1		1
NUE	NUREMBURG, FRG			1					1
OAK	OAKLAND, SAN FRANCISCO, CA, USA		1				2		3
OGG	KAHULUI, MAUI, HA, US		2						2
OPO	OPORTO, PORTUGAL		1						1
ORD	CHICAGO-O'HARE, IL, USA		1	1					2
ORF	NORFOLK-VA. BEACH, VA, USA		1				1		2
ORY	PARIS - ORLY ARPT, FRANCE		1						1
PAT	PATNA, INDIA							1	1
PDX	PORTLAND, OR, USA			1			2		3
PEK	BEIJIN, P. R. CHINA	1					1		2
PEN	PENANG, MALAYSIA		1	1					2
PIE	TAMPA-ST. PETERSBURG, FL, USA		3						3
PLZ	PORT ELIZABETH, SOUTH AFRICA		1						1
PMR	PALMERSTON, NEW ZEALAND		1				1		2
RAP	RAPID CITY, SD, USA		1						1
RNO	RENO, NV, USA			1					1
SAT	SAN ANTONIO, TX, USA		1					1	2
SCC	PRUDHOE BAY, DEADHORSE, AS, US						1		1
SDF	LOUISVILLE, KY, USA		1						1
SFO	SAN FRANCISCO-OAKLAND, CA, USA			2					2
SJC	SAN JOSE, CA, USA		2						2
SLC	SALT LAKE CITY, UT, USA				1				1
SNA	ORANGE COUNTY, CA, USA		1						1
STR	STUTTGART, FRG						1		1
STV	SURAT, INDIA		1						1
SXR	SRINAGAR, INDIA						1		1
SYD	SYDNEY, N.S.W., AUSTRALIA			1		1			2
TFS	TENERIFFE-REINASOFIA, CANARY ISLAND			1					1

TABLE 5.1 (concluded)

FREQUENCY COUNT OF AIRCRAFT INGESTION EVENTS BY AIRPORT AND PHASE OF FLIGHT

AIRPORT	AIRPORT DEFINITION	TAXI	TAKEOFF	CLIMB	CRUISE	APPROACH	LANDING	UNKNOWN	TOTAL
TGD	TITOGRAD, YUGOSLAVIA						1		1
TLV	TEL AVIV-YAFO, ISRAEL		1						1
TNG	TANGIER, MOROCCO		1				1	1	3
TRV	TRIVANDRUM, INDIA						2	1	3
TSV	TOWNSVILLE, QLD, AUSTRALIA						1		1
TUN	TUNIS, TUNISIA						1		1
TVL	LAKE TAHOE, CA, USA			1					1
TXL	WEST BERLIN, GERMANY		1						1
UET	QUETTA, PAKISTAN							1	1
VDM	VIEDMA, ARGENTINA							1	1
VNS	VARANASI, INDIA		1					2	3
WDH	WINDHOEK, NAMIBIA						1		1
WLG	WELLINGTON, NEW ZEALAND		2						2
XRY	JEREZ DE LA FRONTERA, SPAIN					1			1
YAM	SAULT STE MARIE, ONT., CANADA		1						1
YUL	MONTREAL, QUEBEC, CANADA		1						1
YXD	EDMONTON-MUNICIPAL, ALBERTA, CANADA						1		1
YXS	PRINCE GEORGE, BC, CANADA						1		1
YYC	CALGARY, ALBERTA, CANADA						1		1
YYZ	TORONTO, ONTARIO, CANADA		1						1
ZRH	ZURICH, SWITZERLAND		1				2		3
ZTH	ZAKINTHOS, GREECE					1			1
-0-	AIRPORT UNKNOWN		9			1	3	68	81
	AIRPORTS WITH KNOWN INGESTIONS	3	115	18	1	17	54	94	302

BOEING-737 BIRD INGESTION STUDY

AIRCRAFT INGESTIONS AT DOMESTIC AIRPORTS
(OCTOBER 1986 - SEPTEMBER 1987)

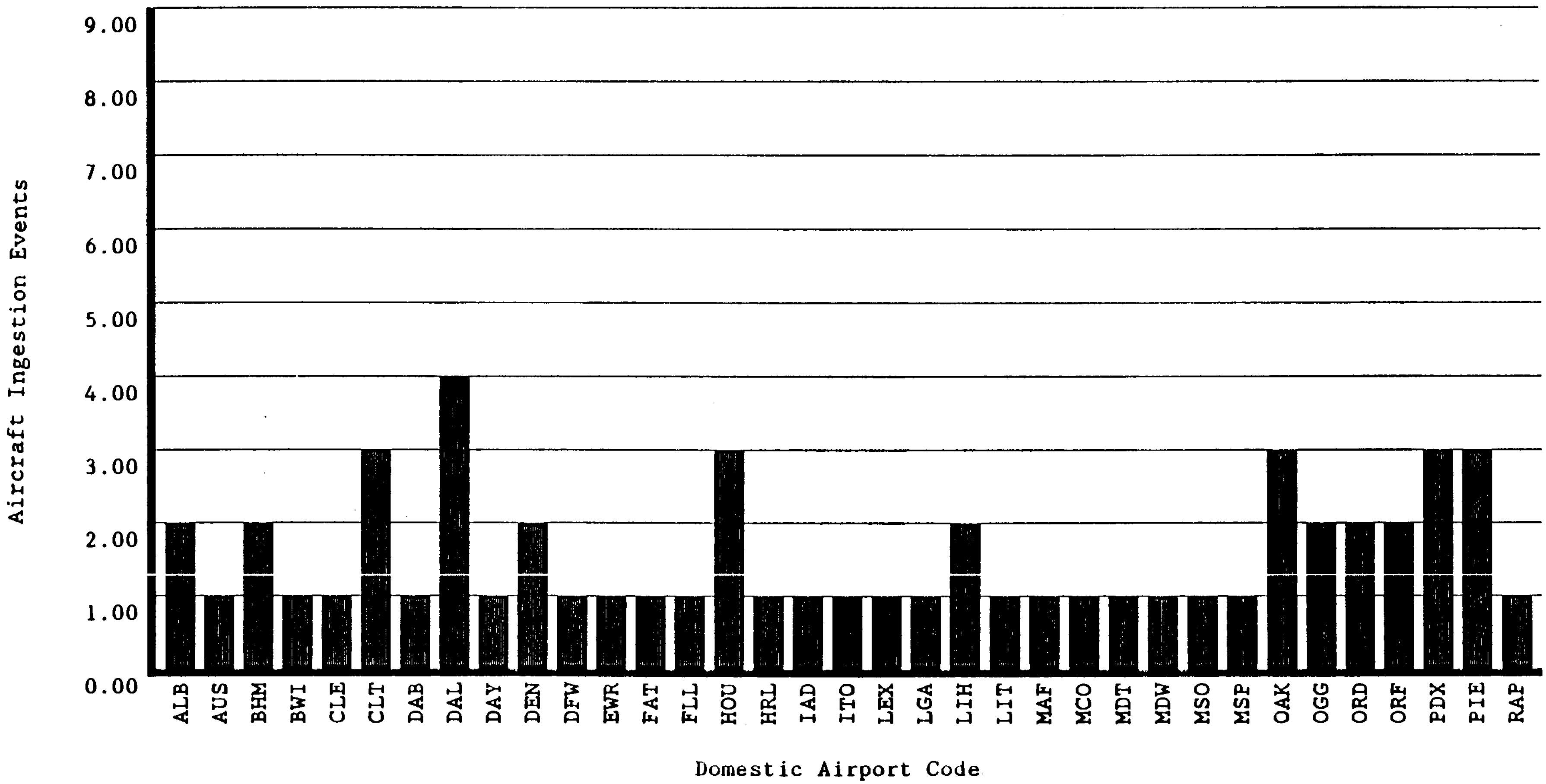

Figure 5.1 Histogram of Aircraft Ingestion Events at Domestic Airports

BOEING-737 BIRD INGESTION STUDY

AIRCRAFT INGESTIONS AT DOMESTIC AIRPORTS
(OCTOBER 1986 - SEPTEMBER 1987)

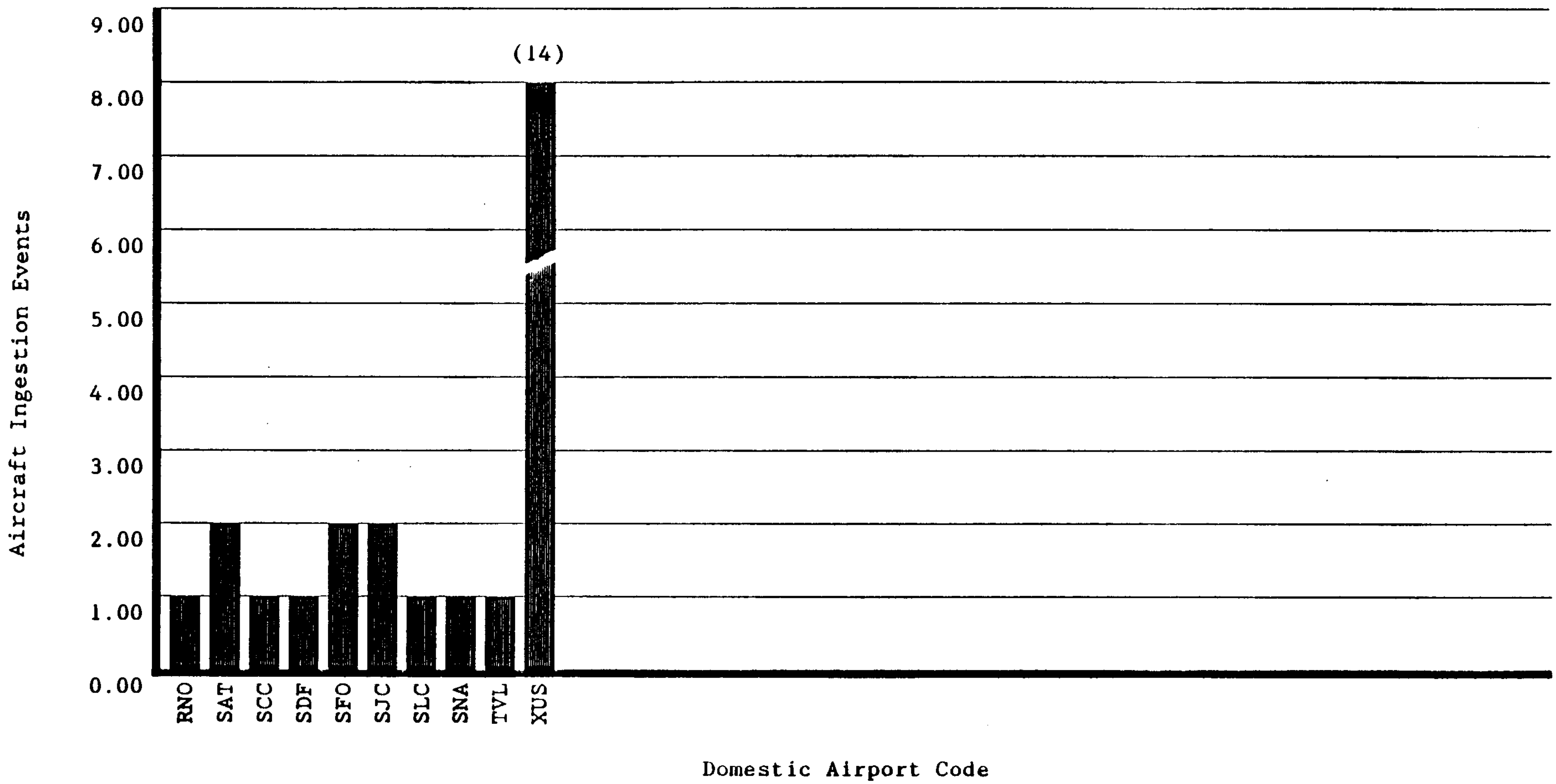

Figure 5.1 Histogram of Aircraft Ingestion Events at Domestic Airports (concluded)

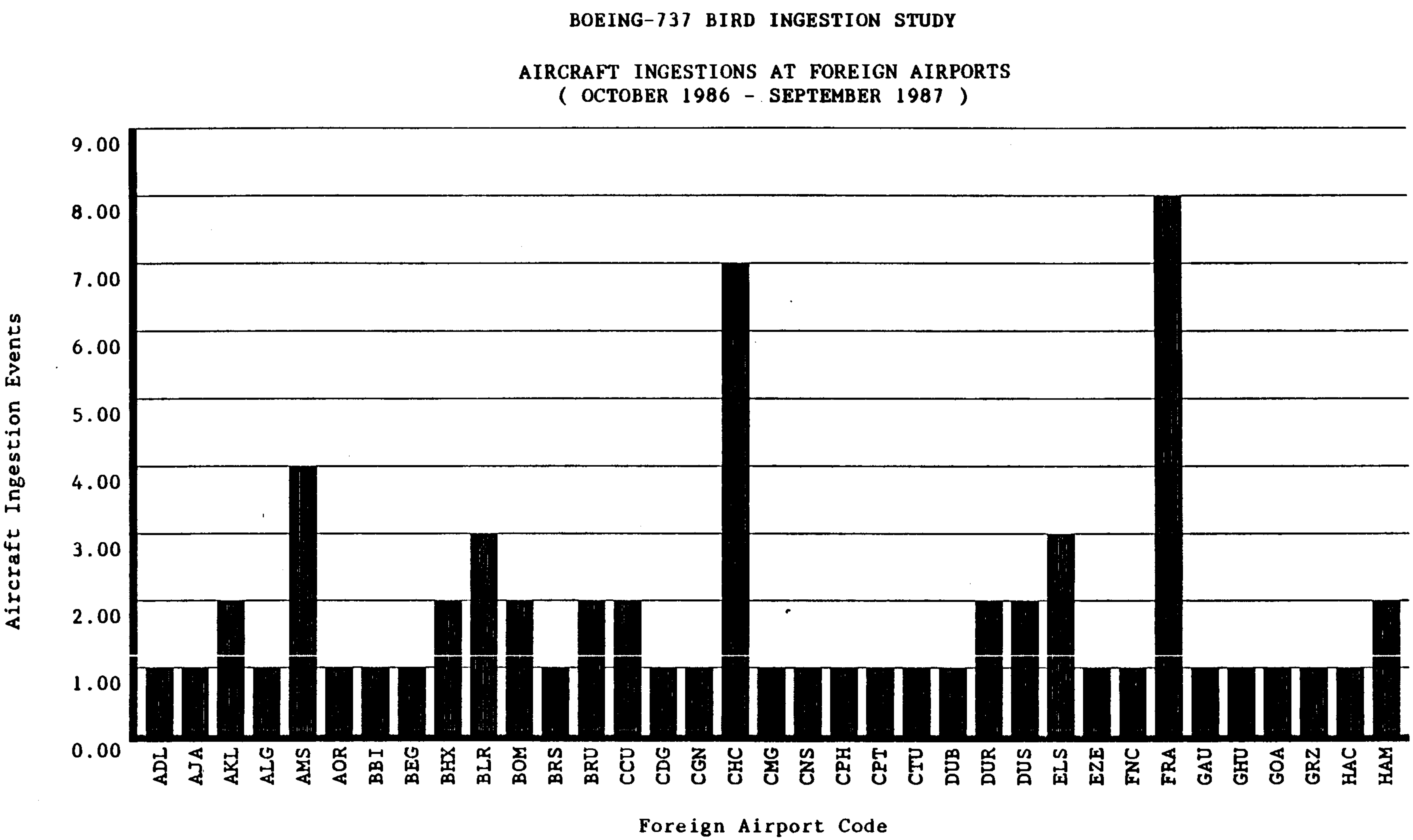

Figure 5.2 Histogram of Aircraft Ingestion Events at Foreign Airports

BOEING-737 BIRD INGESTION STUDY

AIRCRAFT INGESTIONS AT FOREIGN AIRPORTS
(OCTOBER 1986 - SEPTEMBER 1987)

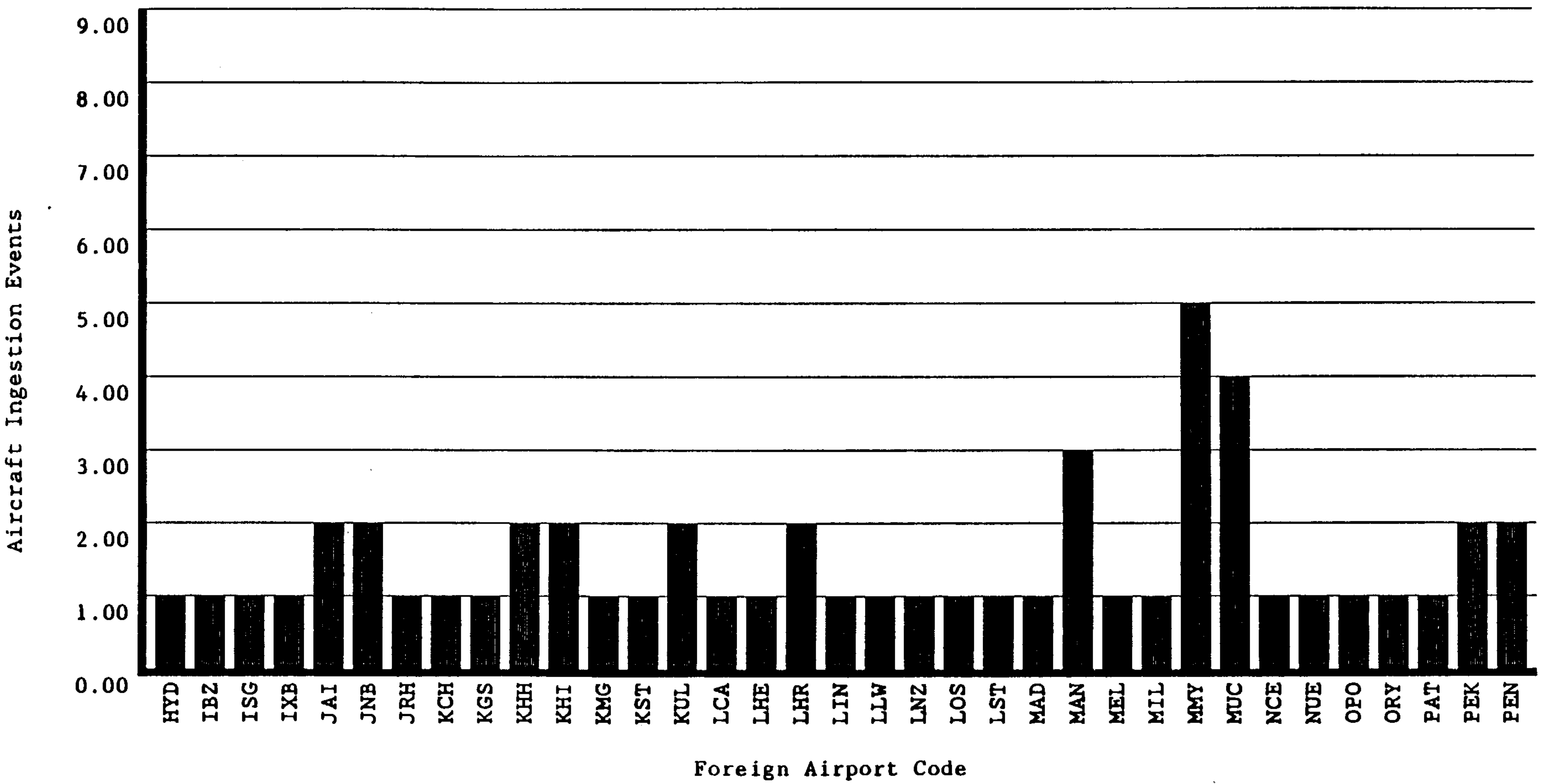

Figure 5.2 Histogram of Aircraft Ingestion Events at Foreign Airports (continued)

BOEING-737 BIRD INGESTION STUDY

AIRCRAFT INGESTIONS AT FOREIGN AIRPORTS
(OCTOBER 1986 - SEPTEMBER 1987)

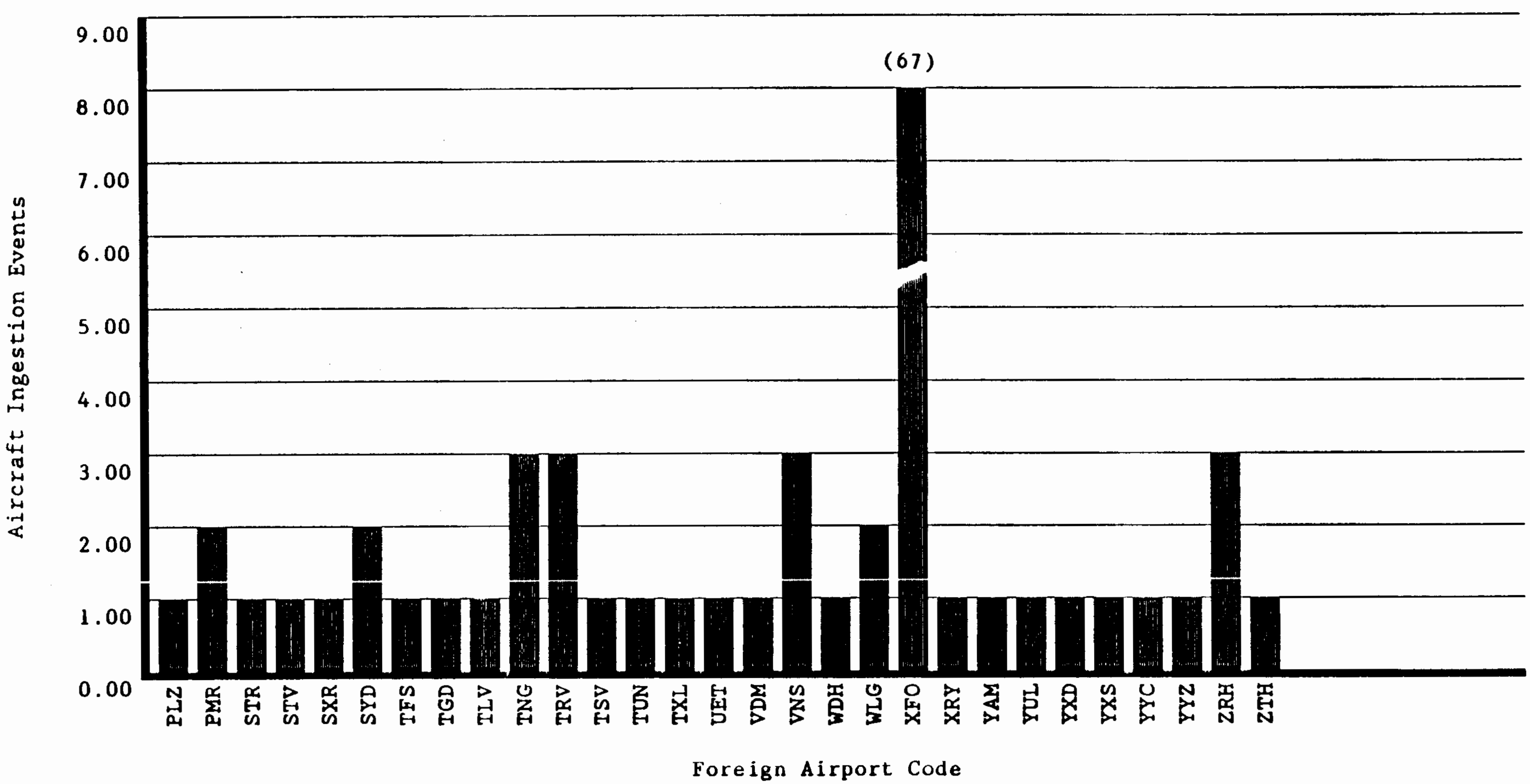

Figure 5.2 Histogram of Aircraft Ingestion Events at Foreign Airports (concluded)

TABLE 5.2 AIRPORT BIRD INGESTION RATES

(3 Or More Ingestions)

Airport Code	Airport Operations	Aircraft Ingestion Events	Ingestion Rate Events/10K Ops	Airport Location
CLT	95251	4	0.84	CHARLOTTE, NC, USA
DAL	75124	5	1.33	LOVE DALLAS/FT. WORTH, TX, USA
HOU	71429	4	1.12	HOUSTON, TX, USA
ORD	59542	3	1.01	CHICAGO-O'HARE, IL, USA
FRA	52274	8	3.06	FRANKFURT, FRG
MUC	36435	4	2.20	MUNICH, FRG
OAK	27453	3	2.19	OAKLAND, SAN FRANCISCO, CA, USA
AMS	19047	4	4.20	AMSTERDAM, NETHERLANDS
PDX	18968	3	3.16	PORTLAND, OR, USA
CHC	17095	7	8.19	CHRISTCHURCH, NEW ZEALAND
ZRH	12226	3	4.91	ZURICH, SWITZERLAND
ELS	9987	3	6.01	EAST LONDON, SOUTH AFRICA
BLR	5886	3	10.19	BANGALORE, INDIA
MAN	5780	3	10.38	MANCHESTER, ENGLAND (UK)
MMY	3606	5	27.73	MIYAKO JIMA, JAPAN
VNS	3150	3	19.05	VARANASI, INDIA
TRV	2374	3	25.27	TRIVANDRUM, INDIA
TNG	2117	3	28.34	TANGIER, MOROCCO
PIE	302	3	198.68	TAMPA-ST. PETERSBURG, FL, USA
	518046	74	2.86	

The rates of bird ingestion events per aircraft operation as summarized previously in table 4.1 are twice the rates of bird ingestion events per airport operation. The number of reported foreign bird ingestion events exceeds the number of reported domestic ingestion events by a factor of 2.7; however, the number of foreign airport operations is less than the number of domestic airport operations. The rate of reported bird ingestions per airport operation is 3.4 times higher at foreign airports than at domestic airports. This implies that either (1) there are far less birds in the environment of domestic airports, possibly due to environmental control programs, or (2) foreign airline operators are much more conscientious and cooperative in reporting bird ingestions.

SECTION 6

ENGINE DAMAGE DESCRIPTION

The type of damage incurred by well-defined bird ingestions is useful in refining bird certification test criteria that could lead to improved engine design. In general, three parameters are used to describe engine damage and failure. The first is the type of damage incurred, the second is whether or not the engine failed, and the third is a description of the crew action taken during the ingestion event. The first part of this section provides descriptions of the types of damage incurred during the study and the types of crew actions implemented as a result of the bird ingestion. The second part describes the statistical analysis of the relationship between bird weight and the likelihood of damage occurring in an ingestion. (The information about engine failures was not available at the time of this report so engine failures are not discussed here.)

6.1 ENGINE DAMAGE AND CREW ACTION DESCRIPTIONS.

The types of damage that were identified in the data base were grouped into 14 categories which are defined in table 6.1. Within the first year of data collection only 11 of the categories occurred. Tabulations of the occurrences of combinations of damage categories are presented in table 6.2. The triangular top portion of the table provides tallies of co-occurrences for all pairs of damage categories. The number in the top portion represents the number of engine ingestion events in which both the row damage and the column damage occurred. The events in which more than two types of damage occurred were also included in the tallies of the top portion of table 6.2. There were six events in which three types of damage occurred and one event with five types of damage.

There are insufficient data in the top portion of table 6.2 to make any strong statements about correlations between types of damage. There is some indication that bent and dented blades accompany broken and shingled blades and that leading edge damage is connected to shingling; however, these trends cannot be strongly substantiated because of the small amount of data. The observed trends could provide the starting point for further investigations into the damage mechanisms of bird ingestions.

The bottom half of table 6.2 provides tallies of the number of events in which each damage category was the only type of damage and the total number of events that involved each of the damage categories. Fewer than three bent and dented blades, shingled blades, and broken blades seem more likely to occur by themselves than other types of damage. When more than three blades are bent or dented there is a much higher chance that some other type of damage will also occur. As with the trends identified in the top portion of table 6.2, there is insufficient evidence to strongly substantiate these trends.

There were four types of crew action identified in connection with the aircraft ingestion events in the data base. An air turnback was performed in 36 of the events, the takeoff was aborted 19 times, a diversionary maneuver was performed four times and in one event the crew action was listed as other without specifying the type of action taken. There was no unusual crew action taken in 57 of the aircraft ingestion events for which a crew action entry was recorded,

TABLE 6.1 DEFINITION OF ENGINE DAMAGE CATEGORIES

DAMAGE CATEGORY	SEVERITY LEVEL	DAMAGE DEFINITION
TRVSFRAC	Severe	Transverse fracture - a fan blade broken or torn and/or a piece missing (includes secondary hard object damage).
CORE	Severe	Bent/broken compressor blades/vanes, blade/vane clash, blocked/disrupted airflow in low, intermediate, and high pressure compressors.
FLANGE	Severe	Flange separations.
TURBINE	Severe	Turbine damage.
BE/DE>3	Moderate	More than three fan blades bent or dented.
TORN>3	Moderate	More than three torn fan blades.
BROKEN	Moderate	Broken fan blades, leading edge and/or tip pieces missing, other blades also dented.
SPINNER	Moderate	Dented, broken, or cracked spinner (includes spinner cap).
RELEASED	Moderate	Released (walked) fan blades.
TORN<3	Mild	Three or fewer torn fan blades.
SHINGLED	Mild	Shingled (twisted) fan blades.
NACELLE	Mild	Dents and/or punctures to the engine enclosure (includes cowl).
LEAD_EDG	Mild	Leading edge distortion/curl.
BEN/DEN	Mild	One to three fan blades bent or dented.

TABLE 6.2 TYPES OF DAMAGE CAUSED BY BIRD INGESTIONS

	LEAD_EDG	BEN/DEN	BE/DE>3	TORN<3	TORN>3	BROKEN	SHINGLED	TRVSFRAC	CORE	RELEASED
BEN/DEN	1									
BE/DE>3	1	0								
TORN<3	1	1	1							
TORN>3	0	0	1	0						
BROKEN	1	5	3	1	1					
SHINGLED	6	6	5	0	0	2				
TRVSFRAC	0	2	1	0	1	2	0			
CORE	0	1	0	0	0	1	0	0		
RELEASED	0	2	1	0	1	1	1	1	0	
TURBINE	0	0	0	0	0	0	0	0	0	0

	LEAD_EDG	BEN/DEN	BE/DE>3	TORN<3	TORN>3	BROKEN	SHINGLED	TRVSFRAC	CORE	RELEASED	TURBINE
ONLY DAMAGE	5	35	4	0	0	13	26	1	3	0	1
TOTAL	14	49	13	3	1	22	43	4	4	3	1

which is about half the time. The crew action should correspond to the phase of flight in which the event occurred. No change in the flight is usually required when an ingestion occurs during a landing maneuver. The air turnbacks and aborted takeoffs would most likely occur during takeoff and climb phases since there were practically no ingestions during the cruise phase.

6.2 PROBABILITY OF DAMAGE.

One of the key questions that inspired the bird ingestion survey is the issue of what size bird should be simulated in certification testing. Two of the main issues in deciding what the certification bird size should be are (1) the likelihood of ingesting a bird of the certification size or larger and (2) the likelihood that damage will result from ingesting a bird of the certification size. The issue of bird sizes is discussed in Sections 3 and 7 while the probability of damage is the topic of this section.

The problem of relating bird weight to the probability of damage (POD) is similar to bio-assay experiments which try to predict the probability of a response as a function of dose size. The key elements of similarity are that the probability of success for a dichotomous (pass/fail) trial is related to a continuous stimulus variable. In bird ingestions the dichotomous trial is whether or not damage occurs and the stimulus variable is the weight of the ingested bird.

Linear logistic analysis is the most commonly used method of analyzing the dosage-response type of data and has been used successfully in relating the probability of transparencies breaking as a function of projectile size in dealing with the problem of propwash blown gravel breaking helicopter windshields (5). The logistic distribution function is assumed to describe the relationship between the probability of damage and the bird weight in a linear logistic analysis. The logistic distribution function is given by:

$$POD(w) = 1/\left\{1+\exp\left[-(\pi/\sqrt{3})(w-\mu)/\sigma\right]\right\} \qquad 6.1$$

where w is the bird weight, μ is the weight with a 50 percent chance of causing damage and σ is a parameter that is related to the steepness of the POD function.

The estimation of the function given in equation 6.1 has been extensively studied and the methods have been described in the literature (6,7). The method of maximum likelihood provides the best estimates for the type of data in the bird ingestion study since there are only a few ingestions at each weight. The software for estimating the parameters of equation 6.1 has been developed and extensively tested at the UDRI (8) and verified by researchers at other institutions.

The types of damage were categorized as mild, moderate or severe by the FAA. Table 6.3 itemizes the types of damage that were included in each of the severity categories. Three distinct analyses were conducted based on the severity ratings. The three analyses estimated the probability of any damage, the probability of at least moderate damage, and the probability of severe damage as a function of bias weight. Figures 6.1, 6.2, 6.3 show the estimated POD functions along with confidence bounds on the POD functions for the three analyses.

TABLE 6.3 DAMAGE SEVERITY DEFINITIONS

SEVERITY LEVEL	DAMAGE DEFINITION
SEVERE DAMAGE	Damage classified as most severe. Achieved when reported damage category is TRVSFRAC, CORE, FLANGE, or TURBINE.
MODERATE DAMAGE	Damage classified as moderately severe. Achieved when reported damage category is BE/DE>3, TORN>3, BROKEN, SPINNER, or RELEASED and no SEVERE damage has been reported.
MILD DAMAGE	Damage classified as mildly severe. Achieved when reported damage category is LEAD_EDG, BEN/DEN, TORN<3, SHINGLED, or NACELLE and no SEVERE nor MODERATE damage has been reported.

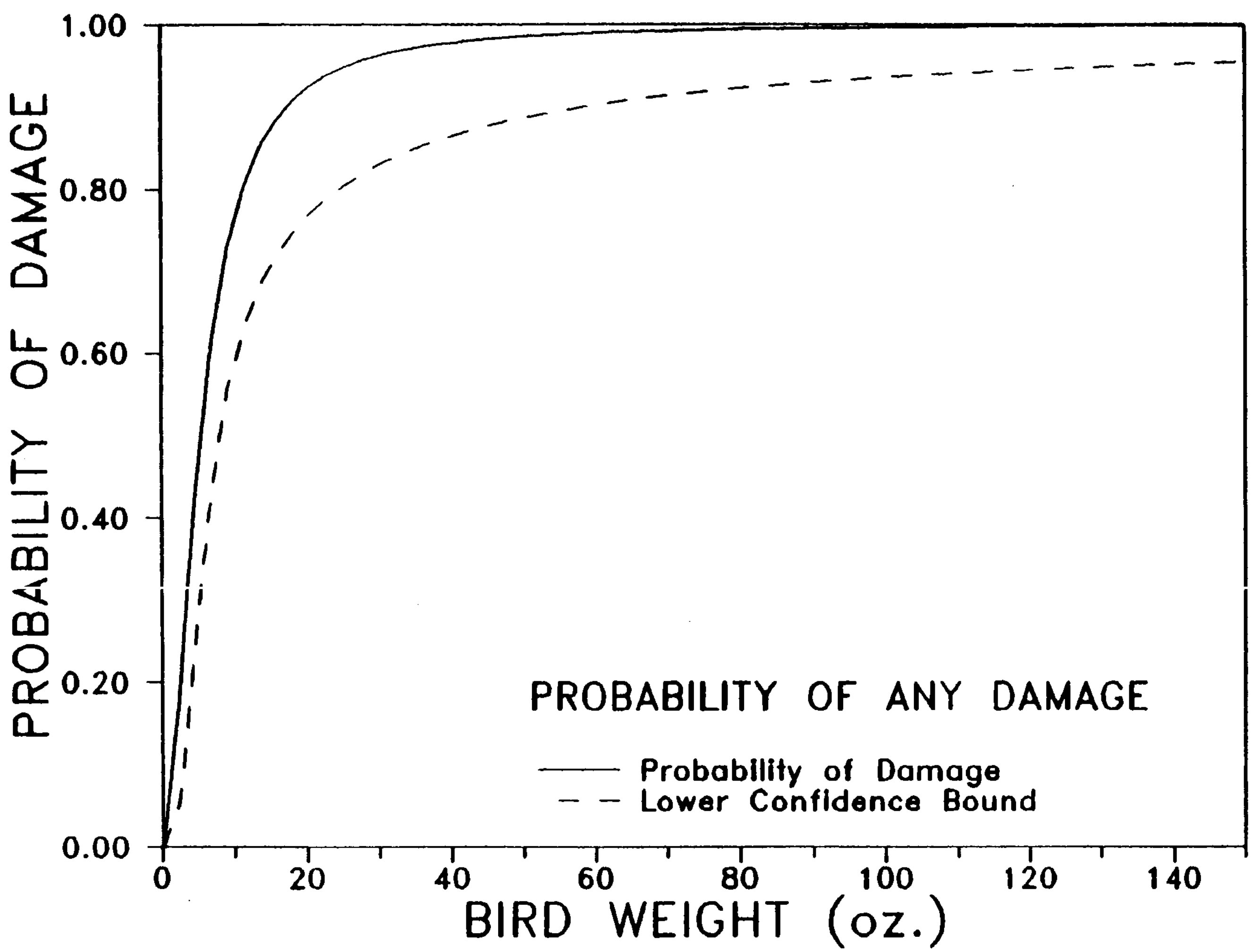

Figure 6.1 Estimated POD Function for Any Damage with the 95 Percent Confidence Bound.

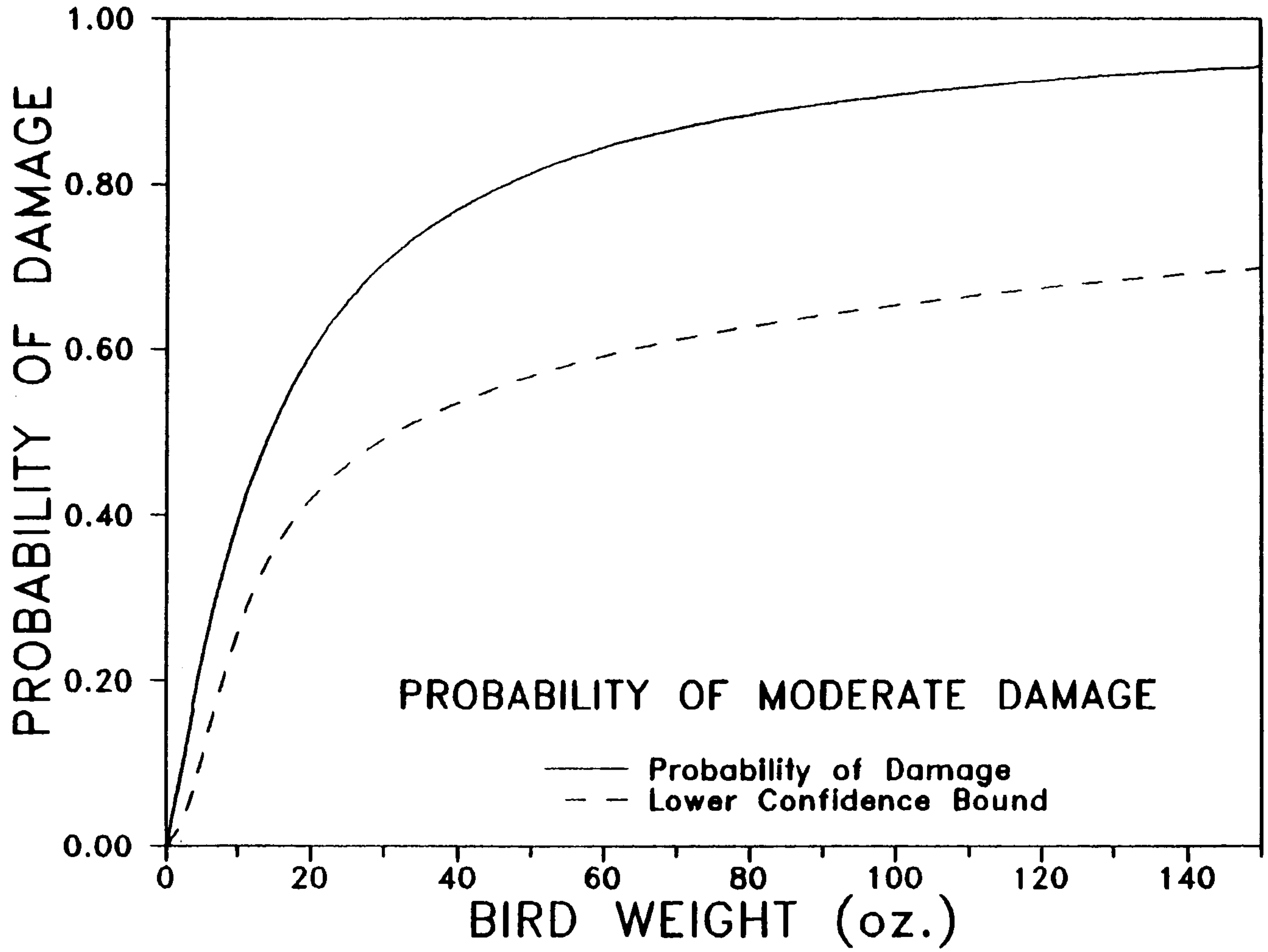

Figure 6.2 Estimated POD Function for Moderate or Worse Damage with the 95 Percent Confidence Bound.

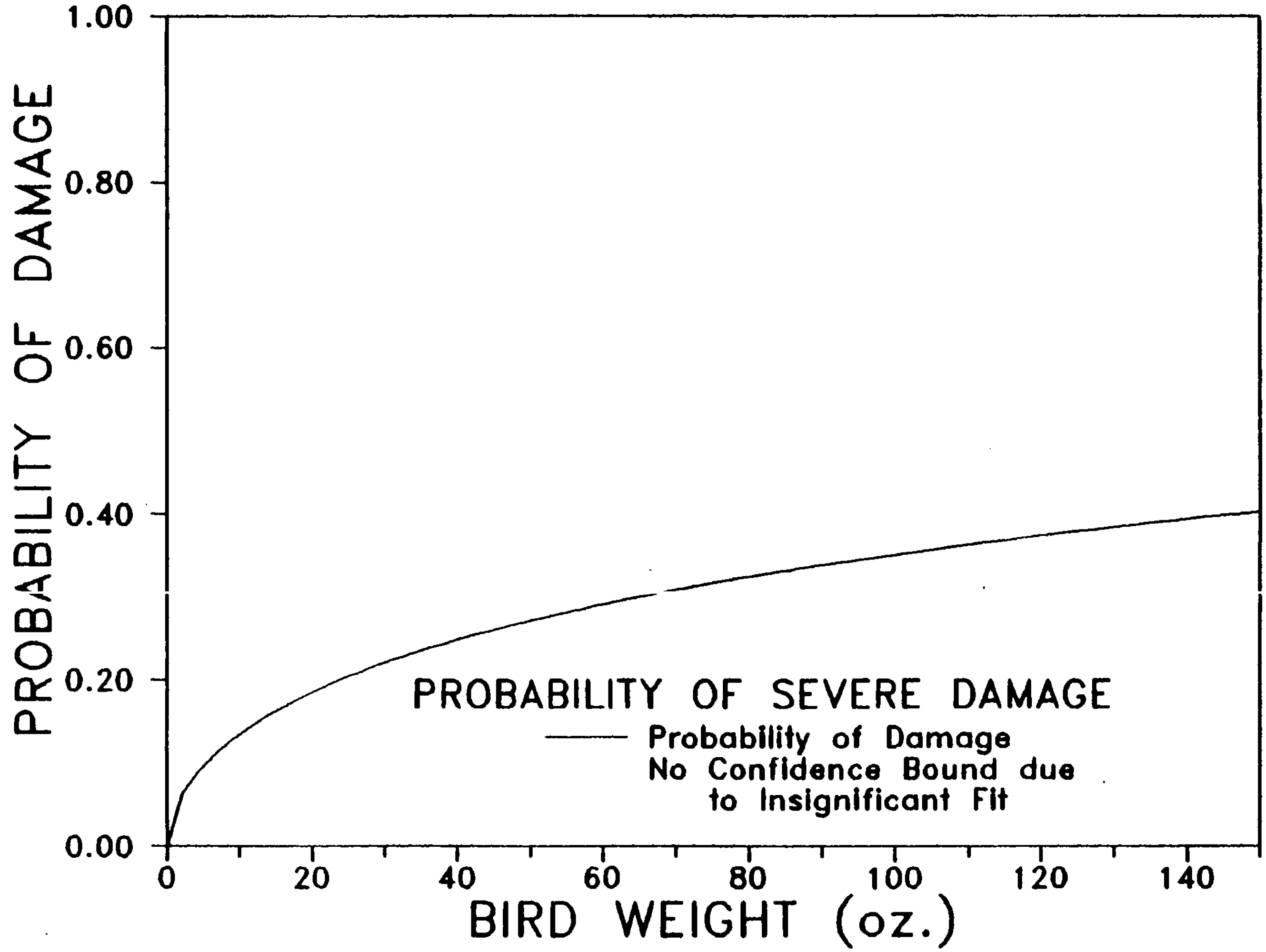

Figure 6.3 Estimated POD Function for Severe Damage.

Figure 6.1 shows the probability of any damage occurring and includes all three severity levels as positive responses. The probability of any damage occurring rises very steeply, reaching 50 percent at about 5 ounces and the curve levels off at the 95 percent level at about 30 ounces. The relationship between bird weight and the probability of any damage is very strong and results in the confidence bound being close to the mean trend curve.

The probability of moderate damage does not rise quite so steeply and a definitive weight cutoff between birds that cause damage and those that do not cause damage cannot be identified. The probability of moderate damage reaches 50 percent at 15 ounces and 90 percent at 92 ounces. The confidence bound shown in figure 6.2 is further from the mean trend than the confidence bound in figure 6.1 because the trend in the probability of moderate damage as a function of bird weight is not as strong as the trend in the probability of any damage.

The analysis of the severe damage data did not show a significant trend in the probability of damage as a function of bird weight. The estimated curve, shown in figure 6.3, shows a slight rise which means that more data might show a statistically significant trend; however, with the current data there is insufficient evidence that the probability of severe damage is related to bird weight.

The probability of damage analysis is also clouded by the poor bird identification rates. The estimated POD functions are likely to be biased toward higher POD values since there was a larger proportion of birds identified when engine damage occurred. The extent of the bias cannot be estimated accurately.

6.3 CREW ACTION AND ENGINE SHUTDOWN PROBABILITIES.

Two other factors that relate to the severity of engine damage are whether or not an unusual crew action is required and whether or not an engine was shut down as a result of the ingestion. Table 6.4 lists the conditional probabilities that an unusual crew action is required given the severity of damage that the engine incurs. The probability that an unusual crew action is required increases with the severity of engine damage as expected. The third column of table 6.4 contains the upper 95 percent confidence bound on the conditional probabilities given in column two.

The formulae for the estimates of the conditional probability of an unusual crew action given the engine damage severity are:

$$\hat{P} = \frac{C}{Ns} \qquad (6.2)$$

$$P_{CB} = \hat{P} + 1.645 \frac{\hat{P}\ (1-P)}{N_s} \qquad (6.3)$$

In equations (6.2) and (6.3), $\hat{P}$ is the estimated conditional probability of a crew action, C is the number of aircraft ingestion events in which a crew action was taken and an engine sustained the given severity level, N_s is the number of aircraft ingestion events in which an engine sustained the given severity level and P_{CB} is the upper confidence bound on the conditional probability. The constant 1.645 is derived from the cumulative normal distribution function to give a 95 percent level of confidence.

An in-flight engine shutdown occurred in eight of the 302 aircraft ingestion events; which corresponds to an estimated probability of an in-flight engine shutdown given that an ingestion has occurred of 0.027 with a 95 percent confidence bound of 0.042. The reason for the shutdown was not known in three of the events. An involuntary shutdown occurred twice, excessive vibration precipitated the shutdown twice and the engine was shut down because of the incorrect engine pressure ratio once. Inferences about the causes of in-flight shutdowns cannot be drawn because of the large proportion of shutdowns in which the cause was not identified.

TABLE 6.4 CONDITIONAL PROBABILITY OF UNUSUAL CREW ACTION (P(CA)) GIVEN THE ENGINE DAMAGE SEVERITY

Engine Damage Severity	P(CA)	Confidence Bound
No Damage	0.13	0.17
Damage	0.29	0.36
At Least Moderate Damage	0.41	0.54
Severe Damage	0.67	0.92

SECTION 7

PROBABILITY ESTIMATES

This section provides a summary of the probabilities of various bird ingestion events. The probability of an event is a measure of the likelihood that the event will occur. The probabilities in this section are calculated on a per operation basis and present similar information to the ingestion rates. The ingestion rates that were presented in Section 4 were calculated on the basis of 10,000 aircraft operations; however, it was shown in Section 4.2 that the per operation ingestion rate is equal to the probability of ingestion for a single operation. This section provides more details on the probabilities of various categories of bird ingestion events.

Table 7.1 provides the estimated probabilities and 95 percent confidence bounds for the whole B737 fleet for various aircraft ingestion events. The overall likelihood of an aircraft ingestion event in a single operation is about 1 in 10,000; and although the odds of having a bird ingestion on any one operation are very small, there are millions of B737 operations each year so that hundreds of ingestions are expected each year. Most ingestions occur during the takeoff and landing phases so that the probabilities for takeoff and climb and the approach and landing phases are relatively large. Dual engine and multiple bird ingestions are relatively rare which is reflected in the smaller probabilities for these events.

The inlet area effect on the probabilities is shown in table 7.2 which separates the probabilities by location and engine. The probabilities for the CFMI CFM56 are always larger than the corresponding probabilities for the Pratt and Whitney JT8D. The larger probabilities for the CFM56 are expected since the inlet area of the CFM56 is nearly twice the inlet area of the JT8D.

The effect of bird weight on the probabilities is estimated in tables 7.3 and 7.4. The entries in tables 7.3 and 7.4 were calculated by multiplying the overall probability for each location/engine combination by the relative frequency of each bird weight range. The relative frequencies for bird weight ranges were derived from the frequencies in table 3.2. The validity of this calculation is dependent on the randomness of bird identifications, as discussed in Section 3. Table 7.3 provides a breakdown of probability of ingestion by location and engine while table 7.4 combines the two engine types.

TABLE 7.1 INGESTION PROBABILITIES

CONDITION	INGESTION EVENTS	PROBABILITY* OF INGESTION	CONFIDENCE* BOUND
All Flights	302	11.00	12.06
Takeoff & Climb	133	4.84	5.56
Approach & Landing	71	2.59	3.15
Dual Engine / Single Bird Per Engine	9	0.33	0.57
Dual Engine / Multiple Birds	3	0.11	0.28
Multiple Birds / Single Engine	17	0.62	0.93
Moderate/Severe Damage	39	1.42	1.86

* Scaled by 10^5

TABLE 7.2 INGESTION PROBABLITIES* BY LOCATION AND ENGINE TYPE

	JT8D ENGINE						CFM56 ENGINE					
	UNITED STATES		FOREIGN		WORLDWIDE		UNITED STATES		FOREIGN		WORLDWIDE	
Aircraft Operations:	1,160,091		1,057,633		2,217,724		353,656		174,206		527,862	
Condition Under Consideration	Ing Evt	Ingestion Prob'lity	Ing Evt	Ingestion Prob'lity	Ing Evt	Ingestion Prob'lity	Ing Evt	Ingestion Prob'lity	Ing Evt	Ingestion Prob'lity	Ing Evt	Ingestion Prob'lity
All Flights	40	3.45	173	16.36	213	9.60	40	11.31	48	27.55	88	16.67
Takeoff And Climb Phases	26	2.24	70	6.62	96	4.33	20	5.66	16	9.18	36	6.82
Approach And Landing Phases	9	0.76	38	3.59	47	2.12	8	2.26	16	9.18	24	4.55
Dual Engine - Single Bird Events	1	0.09	2	0.19	3	0.14	2	0.58	4	2.30	6	1.14
Multiple Birds - Single Engine Events	0	---	12	1.13	12	0.54	1	0.28	4	2.30	5	0.95
Multiple Birds - Dual Engine Events	2	0.17	0	---	2	0.09	1	0.28	0	---	1	0.19
Moderate Or Severe Damage	14	1.21	19	1.80	33	1.49	2	0.57	4	2.30	6	1.14

*Ingestion probabilities scaled by 10^5

TABLE 7.3

PROBABILITIES OF INGESTION* AS A FUNCTION OF BIRD WEIGHT BY LOCATION AND ENGINE TYPE

	JT8D ENGINE			CFM56 ENGINE		
	US	FOREIGN	WORLDWIDE	US	FOREIGN	WORLDWIDE
Aircraft Ops:	1,160,091	1,057,633	2,217,724	353,656	174,206	527,862
Bird Wt Range (Oz.)	Prob. of Ingestion	Prob. of Ingestion	Prob. of Ingestion	Prob. of Ingestion	Prob. of Ingestion	Prob. of Ingestion
($0 < x \leq 4$)	0.41	4.09	1.54	8.48	6.89	9.72
($4 < x \leq 8$)	0.41	2.04	1.15	1.41	6.89	2.78
($8 < x \leq 12$)	---	2.04	0.38	---	13.78	2.78
($12 < x \leq 16$)	1.42	6.13	3.84	---	---	---
($16 < x \leq 20$)	0.20	---	0.38	---	---	---
⋮						
($36 < x \leq 40$)	0.41	2.04	1.15	1.41	---	1.39
⋮						
($52 < x \leq 56$)	0.41	---	0.77	---	---	---
⋮						
($124 < x \leq 128$)	0.20	---	0.38	---	---	---
All Events	3.45	16.36	9.60	11.31	27.55	16.67

* Ingestion probabilities scaled by 10^5

TABLE 7.4 PROBABILITIES OF INGESTION* AS A FUNCTION OF BIRD WEIGHT BY LOCATION

	BOEING-737 COMMERCIAL FLEET		
	UNITED STATES	FOREIGN	WORLDWIDE
Aircraft Operations:	1,513,747	1,231,839	2,745,586
Bird Weight Range (Ounces)	Probability Of Ingestion	Probability Of Ingestion	Probability Of Ingestion
(0 < x <= 4)	1.69	4.49	3.26
(4 < x <= 8)	0.63	2.99	1.48
(8 < x <= 12)	---	4.49	0.89
(12 < x <= 16)	1.48	4.49	2.96
(16 < x <= 20)	0.21	---	0.30
.			
.			
(36 < x <= 40)	0.63	1.50	1.19
.			
.			
(52 < x <= 56)	0.42	---	0.59
.			
.			
(124 < x <= 128)	0.21	---	0.30

*Ingestion probabilities scaled by 10^5

SECTION 8

CONCLUSIONS

The main goal of this bird ingestion investigation is to provide data to better define the nature and extent of the bird ingestion threat. The job of collecting information on bird ingestions is extremely difficult because of the large number of organizations that must cooperate to collect complete and accurate bird ingestion data. The sparsity of information that was collected makes it very difficult to draw strong inferences about the nature of the bird ingestion threat. This section summarizes conclusions from the first year's data for the B737 aircraft.

Bird Descriptions

Gulls, doves, and lapwings are most often ingested.

There is a better identification rate when the engine is damaged.

Ingestions are seasonal and less likely at night.

Ingestion Rates

Ingestion events can be modeled as a Poisson process.

It appears that ingestion rates are proportional to either the inlet area or diameter of the engine (i.e. there is no statistically significant difference between the ingestion rates of the JT8D and the CFM56 after adjusting for inlet area or diameter.)

Airport Experiences

More bird ingestions were reported at foreign airports than at United States airports and the ingestion rates for foreign operations were higher than for United States operations.

The 19 airports that reported three or more ingestions represented 14 percent of the airports that experienced ingestions and accounted for 25 percent of all ingestion events.

Engine Damage

Some types of engine damage are correlated with other types of damage.

There is some evidence that the probability of any damage increases with the weight of the bird that is ingested; however, there is insufficient data to establish a weight relationship to severe damage.

Unusual crew actions are more likely when more severe damage is inflicted on an engine.

Required in-flight engine shutdowns occur in less than five percent of all ingestion events.

Probabilities of Ingestion

Bird ingestions are more likely during the take-off and landing phases of an aircraft operation.

SECTION 9

REFERENCES

1. Frings, G., "A Study of Bird Ingestions into Large High Bypass Ratio Turbine Aircraft Engines," DOT/FAA/CT-84/13, Department of Transportation, Federal Aviation Administration, September 1984.

2. Berens, A.P., West, B.W., and Turella, M.A., "On a Probabilistic Model for Evaluating the Birdstrike Threat to Aircraft Crew Enclosures," UDR-TR-78-124, University of Dayton Research Institute, Dayton, OH, November 1978.

3. Skinn, D.A. and Berens, A.P., "Bird Avoidance Model (BAM) Phase I Report: Feasibility Demonstration," UDR-TR-80-122, University of Dayton Research Institute, Dayton, OH, November 1980.

4. Liliefors, H.W., "On the Kilmogorov-Smirnov Test for the Exponential Distribution with Mean Unknown," Journal of the American Statistical Assoc., Vol. 64, March 1969, pp. 387-389.

5. Bertke, R.S. and Hovey, P.W., "Glass/Acrylic Coupon Impact Testing," UDR-TR-82-145, University of Dayton Research Institute, Dayton, OH, November 1982.

6. Cox, D.R., "The Analysis of Binary Data," Department of Mathematics Imperial College, Methuen & Co., Ltd., London, England, 1970.

7. Fienberg, S.E., "The Analysis of Cross-Classified Categorical Data," IBSN 0-262-06063-9, MIT Press, 1977.

8. Berens, A.P., Hovey, P.W., Donahue, R.M., and Craport, W.M., "User's Manual for Probability of Detection Software System (POD/SS)," UDR-TR-88-12, University of Dayton Research Institute, Dayton, OH, January 1988.

SECTION 10

GLOSSARY

Term	Definition of Term
Engine Ingestion Event	Process whereby one or more birds pass through the engine inlet during engine operation.
Ingested Bird	A bird having experienced the process of engine ingestion event.
Aircraft Ingestion Event	Simultaneous ingestion of one or more birds into one or more engines of an aircraft.
Airport Operation	Takeoff (departure) from an airport or a landing (arrival) at an airport.
Aircraft Operation	A nonstop aircraft flight from one airport to another. (Includes time from taxi-out from departure airport through taxi-in at arrival airport.)
Engine Operation	The participation of each engine of an aircraft in an aircraft operation (e.g., a twin engine aircraft would, ideally, experience two engine operations for each aircraft operation).
Ingestion Rate	The number of aircraft or engine ingestion events per flight event. Flight event refers to aircraft, engine or airport operation. The components of ingestion rate are specified when used in the report. The influence of engine inlet area is not considered.
Normalized Ingestion Rate	Ingestion rate adjusted to a given nominal area. Allows statistical comparison of ingestion rates of engines with different inlet areas.

APPENDIX A

AIRPORTS WITH SCHEDULED BOEING-737 FLIGHTS
AND/OR REPORTED BIRD INGESTION EVENTS

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
AAE	ANNABA, ALGERIA	N	NO	-0-	2393
AAY	AL GHAYDAH, YEMEN	N	NO	-0-	210
ABE	ALLENTOWN, PA, USA	N	YES	PA	370
ABJ	ABIDJAN, COTE D'IVORE (IVORY COAST)	N	NO	-0-	1620
ABQ	ALBUQUERQUE, NM, USA	N	YES	NM	41942
ABS	ABU SIMBEL, ARAB REP OF EGYPT	N	NO	-0-	3366
ABT	AL BAHA, SAUDI ARABIA	N	NO	-0-	1148
ABV	ABUJA, NIGERIA	N	NO	-0-	1240
ABZ	ABERDEEN, SCOTLAND	N	NO	-0-	1519
ACA	ACAPULCO, MEXICO	N	NO	-0-	126
ACC	ACCRA, GHANA	N	NO	-0-	486
ACE	LANZAROTE, CANARY ISLANDS	N	NO	-0-	76
ACV	EUREKA ARCATA, CA, USA	N	YES	CA	2616
ADD	ADDIS ABABA, ETHIOPIA	N	NO	-0-	148
ADE	ADEN, YEMEN	N	NO	-0-	1346
ADL	ADELAIDE SA AUSTRALIA	S	NO	-0-	4738
ADQ	KODIAK, AS, US	N	NO	AS	2290
ADZ	SAN ANDRES ISLAND, COLOMBIA	N	NO	-0-	526
AEP	BUENOS AIRES - NEWBERY, ARGENTINA	S	NO	-0-	23291
AES	AALESUND, NORWAY	N	NO	-0-	8988
AGA	AGADOR, MOROCCO	N	NO	-0-	601
AGP	MALAGA, SPAIN	N	NO	-0-	2434
AGR	AGRA, INDIA	N	NO	-0-	1980
AGS	AUGUSTA, GA, USA	N	YES	GA	1579
AHB	ABHA, SAUDI ARABIA	N	NO	-0-	2026
AHU	AL HOCEIMA, MOROCCO	N	NO	-0-	292
AJA	AJACCIO, CORSICA, FRANCE	N	NO	-0-	59
AJF	JOUF, SAUDI ARABIA	N	NO	-0-	1128
AJU	ARACAJU, BRAZIL	S	NO	-0-	1460
AKL	AUCKLAND, NEW ZEALAND	S	NO	-0-	16985
AKN	KING SALMON, AS, US	N	NO	AS	1444
AKR	AKURE, NIGERIA	N	NO	-0-	238
ALB	ALBANY, NY, USA	N	YES	NY	4461
ALC	ALICANTE, SPAIN	N	NO	-0-	148
ALG	ALGIERS, ALGERIA	N	NO	-0-	14258
ALY	ALEXANDRIA, ARA REP OF EGYPT	N	NO	-0-	2104
AMA	AMARILLO, TX, USA	N	YES	TX	12811
AMD	AHMEDABAD, INDIA	N	NO	-0-	5932
AMM	AMMAN, JORDAN	N	NO	-0-	2131
AMS	AMSTERDAM, NETHERLANDS	N	NO	-0-	19047
ANC	ANCHORAGE, AS, US	N	NO	AS	18977
ANF	ANTOFAGASTA, CHILE	S	NO	-0-	1434
ANI	ANIAK, AS, US	N	NO	AS	460
ANR	ANTWERP, BELGIUM	N	NO	-0-	540
ANU	ANTIGUA, WEST INDIES	N	NO	-0-	18
AOR	ALOR SETAR, MALAYSIA	N	NO	-0-	1886
APL	NAMPULA, MOZAMBIQUE	S	NO	-0-	1144
APW	APIA, WESTERN SAMOA	S	NO	-0-	858
AQI	QAISUMAH, SAUDI ARABIA	N	NO	-0-	494
ARI	ARICA, CHILE	S	NO	-0-	970
ARN	STOCKHOLM ARLANDA, SWEDEN	N	NO	-0-	7556
ASP	ALICE SPRINGS, N.T., AUSTRALIA	S	NO	-0-	1816
ASU	ASUNCION, PARAGUAY	S	NO	-0-	498
ASW	ASWAN, ARAB REP OF EGYPT	N	NO	-0-	4968
ATH	ATHENS, GREECE	N	NO	-0-	24758
ATL	ATLANTA, GA, USA	N	YES	GA	42143
ATM	ALTAMIRA, BRAZIL	S	NO	-0-	416
ATQ	AMRITSAR, INDIA	N	NO	-0-	1846
AUA	ARUBA, ARUBA	N	NO	-0-	50
AUH	ABU DHABI, U. A. EMIRATES	N	NO	-0-	4023
AUS	AUSTIN, TX, USA	N	YES	TX	33326
AUX	ARAGUAINA, BRAZIL	S	NO	-0-	244
AVL	ASHEVILLE, NC, USA	N	YES	NC	1298
AVP	WILKES-BARRE/SCRANTON, PA, USA	N	YES	PA	114

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
AXD	ALEXANDROUPOLIS, GREECE	N	NO	-0-	908
AXT	AKITA, JAPAN	N	NO	-0-	591
AYT	ANTALYA, TURKEY	N	NO	-0-	52
AZO	KALAMAZOO, MI, USA	N	YES	MI	2800
AZR	ADRAR, ALGERIA	N	NO	-0-	818
BAH	BAHRAIN, BAHRAIN	N	NO	-0-	11933
BAQ	BARRANQUILLA, COLOMBIA	N	NO	-0-	105
BBI	BHUBANESWAR, INDIA	N	NO	-0-	2086
BCN	BARCELONA, SPAIN	N	NO	-0-	4166
BDH	BANDAR LENGEH, IRAN	N	NO	-0-	1460
BDL	HARTFORD, CN, USA	N	YES	CN	15001
BDQ	VADODARA, INDIA	N	NO	-0-	1925
BDT	BADO LITE, ZAIRE	N	NO	-0-	208
BEG	BELGRADE, YUGOSLAVIA	N	NO	-0-	10759
BEL	BELEM, BRAZIL	S	NO	-0-	5505
BET	BETHEL, AS, US	N	NO	AS	3190
BEW	BEIRA, MOZAMBIQUE	S	NO	-0-	1304
BFL	BAKESFIELD, CA, USA	N	YES	CA	2742
BFN	BLOEMFONTEIN, SOUTH AFRICA	S	NO	-0-	3954
BFS	BELFAST, N. IRELAND	N	NO	-0-	1570
BGF	BANGUI, CEN. AFRICAN REPUBLIC	N	NO	-0-	272
BGI	BARBADOS, BARBADOS	N	NO	-0-	52
BGO	BERGEN, NORWAY	N	NO	-0-	12038
BHH	BISHA, SAUDI ARABIA	N	NO	-0-	1740
BHI	BAHIA BLANCA, ARGENTINA	S	NO	-0-	2162
BHJ	BHUJ, INDIA	N	NO	-0-	730
BHM	BIRMINGHAM, AL, USA	N	YES	AL	6048
BHO	BHOPAL, INDIA	N	NO	-0-	1828
BHU	BHAVNAGAR, INDIA	N	NO	-0-	730
BHX	BIRMINGHAM, ENGLAND (UK)	N	NO	-0-	2307
BIA	BASTIA, CORSICA, FRANCE	N	NO	-0-	234
BIL	BILLINGS, MT, USA	N	YES	MT	7285
BIO	BILBAO, SPAIN	N	NO	-0-	622
BIQ	BIARRITZ, FRANCE	N	NO	-0-	52
BIS	BISMARCK, ND, USA	N	YES	ND	3396
BJL	BANJUL, GAMBIA	N	NO	-0-	472
BJM	BUJUMBURA, BURUNDI	S	NO	-0-	245
BKI	KOTA KINABALU, SABAH, MALAYSIA	N	NO	-0-	8699
BKK	BANGKOK, THAILAND	N	NO	-0-	7329
BKO	BAMAKO, MALI	N	NO	-0-	50
BKY	BUKAVU, ZAIRE	S	NO	-0-	104
BLL	BILLUND, DENMARK	N	NO	-0-	2177
BLQ	BOLOGNA, ITALY	N	NO	-0-	310
BLR	BANGALORE, INDIA	N	NO	-0-	5886
BNA	NASHVILLE, TN, USA	N	YES	TN	17920
BND	BANDAR ABBAS, IRAN	N	NO	-0-	1460
BNE	BRISBANE, QLD, AUSTRALIA	S	NO	-0-	12830
BNI	BENIN CITY, NIGERIA	N	NO	-0-	2127
BOD	BORDEAUX, FRANCE	N	NO	-0-	688
BOI	BOISE, ID, USA	N	YES	ID	5399
BOM	BOMBAY, INDIA	N	NO	-0-	16848
BOO	BODO, NORWAY	N	NO	-0-	2868
BOS	BOSTON, MA, USA	N	YES	MA	30820
BRC	SAN CARLOS DE BARILOCHE, ARGENTINA	S	NO	-0-	1663
BRE	BREMEN, FED REP OF GERMANY	N	NO	-0-	4526
BRS	BRISTOL, ENGLAND (UK)	N	NO	-0-	2
BRU	BRUSSELS, BELGIUM	N	NO	-0-	31942
BRW	BARROW, AS, US	N	NO	AS	1897
BSB	BRASILIA, BRAZIL	S	NO	-0-	22788
BSL	BASEL/MULHOUSE, SWITZERLAND	N	NO	-0-	554
BTM	BUTTE, MT, USA	N	YES	MT	1460
BTR	BATON ROUGE, LA, USA	N	YES	LA	2944
BTV	BURLINGTON, VT, USA	N	YES	VT	2544
BUD	BUDAPEST, HUNGARY	N	NO	-0-	1660

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
BUF	BUFFALO, NY, USA	N	YES	NY	17704
BUQ	BULAWAYO, ZIMBABWE	S	NO	-0-	1834
BUR	BURBANK, CA, USA	N	YES	CA	11187
BUX	BUNA, ZAIRE	N	NO	-0-	210
BUZ	BUSHEHR, IRAN	N	NO	-0-	88
BVB	BOA VISTA, BRAZIL	N	NO	-0-	1314
BWI	BALTIMORE, MD, USA	N	YES	MD	54435
BWN	BASERI BEGAWAN, BRUNEI DARUSSALAM	N	NO	-0-	2951
BXO	BISSAU, GUINEA BISSAU	N	NO	-0-	20
BZE	BELIZE CITY, BELIZE	N	NO	-0-	3647
BZN	BOZEMAN, MT, USA	N	YES	MT	5200
BZV	BRAZZAVILE, PEOP REP OF CONGO	S	NO	-0-	1406
CAB	CABINDA, ANGOLA	S	NO	-0-	1042
CAE	COLUMBIA, SC, USA	N	YES	SC	8213
CAI	CAIRO, ARAB REP OF EGYPT	N	NO	-0-	8057
CAK	AKRON/CANTON, OH, USA	N	YES	OH	2241
CAN	GUANGZHOU, P. R. CHINA	N	NO	-0-	13955
CAS	CASABLANCA, MOROCCO	N	NO	-0-	-0-
CAY	CAYENNE, FRENCH GUIANA	N	NO	-0-	208
CBD	CAR NICOBAR, INDIA	N	NO	-0-	40
CBH	BECHAR, ALGERIA	N	NO	-0-	1455
CBQ	CALABAR, NIGERIA	N	NO	-0-	1935
CBR	CANBERRA, A.C.T, AUTSTRALIA	S	NO	-0-	5600
CCP	CONCEPCION, CHILE	S	NO	-0-	1184
CCU	CALCUTTA, INDIA	N	NO	-0-	10798
CDG	PARIS DE GAULLE, FRANCE	N	NO	-0-	25514
CDV	CORDOVA, AS, US	N	NO	AS	1514
CEO	WACO KUNGO, ANGOLA	S	NO	-0-	10
CFU	CORFU, GREECE	N	NO	-0-	746
CGB	CUIABA MATO GROSSO, BRAZIL	S	NO	-0-	9184
CGH	SAO PAULO-CONGONHAS, BRAZIL	S	NO	-0-	1082
CGK	JAKARTA-SOEKARNO, INDONESIA	S	NO	-0-	626
CGN	COLOGNE BONN, FRG	N	NO	-0-	18161
CGO	ZHENGZHOU, P. R. CHINA	N	NO	-0-	208
CGQ	CHANGCHUN, P. R. CHINA	N	NO	-0-	62
CGR	CAMPO GRANDE, BRAZIL	S	NO	-0-	6770
CHA	CHATTANOOGA, TN, USA	N	YES	TN	1618
CHC	CHRISTCHURCH, NEW ZEALAND	S	NO	-0-	17095
CHO	CHARLOTTESVILLE, VA, USA	N	YES	VA	1814
CHQ	CHANIA, CRETE, GREECE	N	NO	-0-	856
CHS	CHARLESTON, SC, USA	N	YES	SC	7219
CID	CEDAR RAPIDS/IOWA CITY, IO, USA	N	YES	IO	3800
CIX	CHICLAYO, PERU	S	NO	-0-	286
CJB	COIMBATORE, INDIA	N	NO	-0-	1528
CJC	CALAMA, CHILE	S	NO	-0-	626
CKG	CHONGQING, P. R. CHINA	N	NO	-0-	714
CKS	CARAJAS, BRAZIL	S	NO	-0-	417
CKY	CONAKRY, GUINEA	N	NO	-0-	550
CLE	CLEVELAND, OH, USA	N	YES	OH	24028
CLT	CHARLOTTE, NC, USA	N	YES	NC	95251
CMB	COLOMBO, SRI LANKA	N	NO	-0-	3021
CMG	CORUMBA, MATO GROSSO, BRAZIL	S	NO	-0-	1460
CMH	COLUMBUS, OH, USA	N	YES	OH	8004
CMI	CHAMPAIGN, IL, USA	N	YES	IL	2186
CMN	MOHAMEDV, CASABLANCA, MOROCCO	N	NO	-0-	4767
CNF	BELO HORIZONTE-CONFINS, BRAZIL	S	NO	-0-	19683
CNQ	CORRIENTES, ARGENTINA	S	NO	-0-	1100
CNS	CAIRNS, QLD, AUSTRALIA	S	NO	-0-	4850
CNX	CHIANG MAI, THAILAND	N	NO	-0-	728
COK	COCHIN, INDIA	N	NO	-0-	5457
COO	COTONOU, BENIN	N	NO	-0-	1120
COR	CORDOBA, ARGENTINA	S	NO	-0-	6772
COS	COLORADO SPRINGS, CO, USA	N	YES	CO	8004
CPH	COPENHAGEN, DENMARK	N	NO	-0-	11419

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
CPQ	CAMPINAS, BRAZIL	S	NO	-0-	1056
CPR	CASPER, WY, USA	N	YES	WY	4230
CPT	CAPE TOWN, SOUTH AFRICA	S	NO	-0-	8545
CPV	CAMPINA GRANDE, BRAZIL	S	NO	-0-	626
CRD	COMODORO RIVADAVIA, ARGENTINA	S	NO	-0-	2553
CRP	CORPUS CHRISTI, TX, USA	N	YES	TX	5584
CRW	CHARLESTON, WV, USA	N	YES	WV	4478
CTA	CATANIA, ITALY	N	NO	-0-	252
CTC	CATAMARCA, ARGENTINA	S	NO	-0-	778
CTG	CARTAGENA, COLOMBIA	N	NO	-0-	105
CTS	SAPPORO-CHITOSE, JAPAN	N	NO	-0-	1398
CTU	CHENGDU, P.R. CHINA	N	NO	-0-	2138
CUN	CANCUM, MEXICO	N	NO	-0-	634
CUR	CURACAO, NETH ANTILLES	N	NO	-0-	20
CVG	CINCINNATI, OH, USA	N	YES	OH	14496
CWB	CURITIBA, PARANA, BRAZIL	S	NO	-0-	6532
CXI	CHRISTMAS ISLAND, REP OF KIRIBATI	N	NO	-0-	106
CYI	CHIAYI, TAIWAN	N	NO	-0-	730
CZL	CONSTANTINE, ALGERIA	N	NO	-0-	3352
CZS	CRUZEIRO DO SUL, ACRE, BRAZIL	S	NO	-0-	344
CZX	CHANGZHOU, P. R. CHINA	N	NO	-0-	208
DAB	DAYTONA BEACH, FL, USA	N	YES	FL	3532
DAC	DHAKA, BANGLADESH	N	NO	-0-	934
DAL	LOVE DALLS/FT. WORTH, TX, USA	N	YES	TX	75124
DAM	DAMASCUS, SYRIA	N	NO	-0-	523
DAR	DAR ES SALAAM, TANZANIA	S	NO	-0-	3407
DAY	DAYTON, OH, USA	N	YES	OH	37652
DBV	DUBROVNIK, YUGOSLAVIA	N	NO	-0-	1806
DCA	NATIONAL, WASHINGTON, DC, USA	N	YES	DC	22108
DEC	DECATUR, IL, USA	N	YES	IL	0
DEL	DELHI, INDIA	N	NO	-0-	15987
DEN	STAPLETON INT'L, DENVER, CO, USA	N	YES	CO	112673
DFW	DALLAS/FT WORTH, TX, USA	N	YES	TX	51130
DHA	DHAHRAN, SAUDI ARABIA	N	NO	-0-	7902
DIB	DIBRUGARH, INDIA	N	NO	-0-	816
DIE	ANTSIRANANA, MADAGASCAR	S	NO	-0-	610
DIR	DIRE DAWA, ETHIOPIA	N	NO	-0-	38
DJE	DJERBA, TUNISIA	N	NO	-0-	547
DJG	DJANET, ALGERIA	N	NO	-0-	466
DKR	DAKAR, SENEGAL	N	NO	-0-	467
DLA	DOUALA, REP OF CAMEROON	N	NO	-0-	5262
DLG	DILLINGHAM, AS,US	N	NO	AS	1444
DOD	DODOMA, TANZANIA	S	NO	-0-	16
DOH	DOHA, QATAR	N	NO	-0-	8859
DPS	DENPASAR, INDONESIA	S	NO	-0-	104
DRO	DURANGO, CO, USA	N	YES	CO	2233
DRW	DARWIN, N.T., AUSTRALIA	S	NO	-0-	1107
DSM	DES MOINES, IO, USA	N	YES	IO	7748
DTW	WAYNE CO, DETROIT, MI, USA	N	YES	MI	16765
DUB	DUBLIN, REPUBLIC OF IRELAND	N	NO	-0-	19308
DUD	DUNEDIN, NEW ZEALAND	S	NO	-0-	4145
DUR	DURBAN, SOUTH AFRICA	S	NO	-0-	6925
DUS	DUESSELDORF, FRG	N	NO	-0-	30119
DUT	DUTCH HARBOR, AS, US	N	NO	AS	828
DXB	DUBAI, U. A. EMIRATES	N	NO	-0-	3134
EAM	NEJRAN, SAUDI ARABIA	N	NO	-0-	2392
EBB	ENTEBBE KAMPALA, UGANDA	N	NO	-0-	39
EBD	EL OBEID, SUDAN	N	NO	-0-	632
EBJ	ESBJERG, DENMARK	N	NO	-0-	482
EDI	EDINBURGH, SCOTLAND	N	NO	-0-	1040
EFL	KEFALONIA, GREECE	N	NO	-0-	780
EJH	WEDJH, SAUDI ARABIA	N	NO	-0-	784
ELG	EL GOLEA, ALGERIA	N	NO	-0-	416
ELP	EL PASO, TX, USA	N	YES	TX	38902

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
ELQ	GASSIM, SAUDI ARABIA	N	NO	-0-	4652
ELS	EAST LONDON, SOUTH AFRICA	S	NO	-0-	9987
ELU	EL OUED, ALGERIA	N	NO	-0-	288
EMA	EAST MIDLANDS, ENGLAND	N	NO	-0-	291
ENU	ENUGU, NIGERIA	N	NO	-0-	3138
EQS	ESQUEL, ARGENTINA	S	NO	-0-	1116
ERI	ERIE, PA, USA	N	YES	PA	1772
ESR	EL SALVADOR, CHILE	S	NO	-0-	836
ETH	ELAT, ISRAEL	N	NO	-0-	4
EUG	EUGENE, OR, USA	N	YES	OR	3493
EUN	LAAYOUNE, MOROCCO	N	NO	-0-	244
EVE	EVENES, NORWAY	N	NO	-0-	1520
EVV	EVANSVILLE, IN, USA	N	YES	IN	2468
EWR	NEWARK, NEW YORK, NY, USA	N	YES	NY	78323
EZE	BUENOS AIRES-EZEIZA ARPT, ARGENTINA	S	NO	-0-	424
FAE	FAROE ISLANDS, DENMARK	N	NO	-0-	756
FAI	FAIRBANKS, AS, US	N	NO	AS	3674
FAO	FARO, PORTUGAL	N	NO	-0-	1069
FAR	FARGO, ND, USA	N	YES	ND	1561
FAT	FRESNO, CA, USA	N	YES	CA	9993
FAY	FAYETTEVILLE, NC, USA	N	YES	NC	3260
FBM	LUBUMBASHI, ZAIRE	S	NO	-0-	282
FBU	FORNEBU, OSLO, NORWAY	N	NO	-0-	11420
FCA	KALISPELL GLACIER NAT'L OK, MT, USA	N	YES	MT	1460
FCO	DA VINCI, ROME, ITALY	N	NO	-0-	4538
FEZ	FEZ, MOROCCO	N	NO	-0-	146
FIH	KINSHASA, ZAIRE	S	NO	-0-	2324
FKI	KISANGANI, ZAIRE	N	NO	-0-	1170
FLL	FT LAUDERDALE, FL, USA	N	YES	FL	12566
FLN	FLORIANOPOLIS, BRAZIL	S	NO	-0-	4180
FMA	FORMOSA, ARGENTINA	S	NO	-0-	682
FMI	KALEMIE, ZAIRE	S	NO	-0-	524
FNA	FREETOWN, SIERRA LEONE	N	NO	-0-	112
FNC	FUNCHAL - MADEIRA, PORTUGAL	N	NO	-0-	3737
FNT	FLINT, MI, USA	N	YES	MI	2186
FOC	FUZHOU, P. R. CHINA	N	NO	-0-	534
FOE	FORBES, TOPEKA, KA, USA	N	YES	KA	1407
FOR	FORTALEZA, CEARA, BRAZIL	S	NO	-0-	4798
FPO	FREEPORT, BAHAMAS	N	NO	-0-	2666
FRA	FRANKFURT, FRG	N	NO	-0-	52274
FSD	SIOUX FALLS, SD, USA	N	YES	SD	6410
FTU	FT DAUPHIN, MADAGASCAR	S	NO	-0-	332
FUK	FUKUOKA, JAPAN	N	NO	-0-	730
FWA	FT WAYNE, IN, USA	N	YES	IN	2580
GAJ	YAMAGATA, HONSHU, JAPAN	N	NO	-0-	1154
GAU	GAUHATI, INDIA	N	NO	-0-	3934
GBE	GABORONE, BOTSWANA	S	NO	-0-	527
GEG	SPOKANE, WA, USA	N	YES	WA	8549
GHA	GHARDAIA, ALGERIA	N	NO	-0-	1014
GHB	GOVERNORS HARBOUR, BAHAMAS	N	NO	-0-	36
GHU	GUALEGUAYCHU, ARGENTINA	S	NO	-0-	-0-
GIB	GIBRALTAR, GIBRALTAR	N	NO	-0-	1788
GIG	RIO DE JANEIRO INT'L, BRAZIL	S	NO	-0-	27048
GIZ	GIZAN, SAUDI ARABIA	N	NO	-0-	5781
GJT	GRAND JUNCTION, CO, USA	N	YES	CO	2416
GLA	GLASGLOW, SCOTLAND	N	NO	-0-	687
GMA	GEMENA, ZAIRE	N	NO	-0-	312
GOA	GENOA, ITALY	N	NO	-0-	292
GOI	GOA, INDIA	N	NO	-0-	1798
GOM	GOMA, ZAIRE	S	NO	-0-	104
GOP	GORAKHPUR, INDIA	N	NO	-0-	486
GOT	GOTHENBURG, SWEDEN	N	NO	-0-	3846
GOU	GAROUA, REP OF CAMEROON	N	NO	-0-	1954
GOV	GOVE, N.T., AUSTRALIA	S	NO	-0-	314

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
GRB	GREEN BAY, WI, USA	N	YES	WI	605
GRJ	GEORGE, SOUTH AFRICA	S	NO	-0-	2178
GRR	GRAND RAPIDS, MI, USA	N	YES	MI	4831
GRU	SAO PAULO-GUARULMOS, BRAZIL	S	NO	-0-	41061
GRZ	GRAZ, AUSTRIA	N	NO	-0-	619
GSO	GREENSBORO/HPT/WIN-SALEM, NC, USA	N	YES	NC	18586
GSP	GREENVILLE/SPARTANBURG, SC, USA	N	YES	SC	1508
GTF	GREAT FALLS, MT, USA	N	YES	MT	4356
GUA	GUATELMALA CITY, GUATEMALA	N	NO	-0-	1667
GUM	GUAM, GUAM	N	NO	-0-	289
GVA	GENEVA, SWITZERLAND	N	NO	-0-	10594
GWL	GWALIOR, INDIZ	N	NO	-0-	1460
GWT	GALWAY, IRELAND	N	NO	-0-	130
GXF	SEIYUN, YEMEN	N	NO	-0-	26
GXG	NEGAGE, ANGOLA	S	NO	-0-	382
GYE	GUAYAQUIL,ECUADOR	S	NO	-0-	1609
GYN	GOIANIA, BRAZIL	S	NO	-0-	7891
HAC	HACHIJO, JIMA ISLAND, JAPAN	N	NO	-0-	834
HAH	MORONI-HAHAYA, COMOROS	S	NO	-0-	266
HAJ	HANOVER, FED REP OF GERMANY	N	NO	-0-	8844
HAK	HAIKOU, P. R. CHINA	N	NO	-0-	770
HAM	HAMBURG, FRG	N	NO	-0-	25535
HAN	HANOI, SOC REP OF VIETNAM	N	NO	-0-	152
HAS	HAIL, SAUDI ARABIA	N	NO	-0-	3642
HBA	HOBART, TASMANIA, AUSTRALIA	S	NO	-0-	3785
HBT	HAFR ALBAPIN, SAUDI ARABIA	N	NO	-0-	140
HDY	HAT YAI, THAILAND	N	NO	-0-	3094
HEL	HELSINKI, FINLAND	N	NO	-0-	2797
HER	HERAKLION, GREECE	N	NO	-0-	1780
HGH	HANGZHOU, P. R. CHINA	N	NO	-0-	1390
HIR	HONIARA, GUADALCANAL, SOLOMON IS.	S	NO	-0-	436
HJR	HIROSHIMA, JAPAN	N	NO	-0-	1460
HKD	HAKODATE, JAPAN	N	NO	-0-	1030
HKG	HONG KONG, HONG KONG	N	NO	-0-	2792
HKT	PHUKET, THAILAND	N	NO	-0-	1932
HLN	HELENA, MT, USA	N	YES	MT	2046
HLZ	HAMILTON, NEW ZEALAND	S	NO	-0-	627
HME	HASSI MESSAOUD, ALGERIA	N	NO	-0-	256
HND	TOKYO-HANEDA, JAPAN	N	NO	-0-	14398
HNL	HONOLULU, OAHU, HA, USA	N	NO	HA	51139
HOD	HODEIDAH, YEMEN	N	NO	-0-	86
HOF	HOFUF, SAUDI ARABIA	N	NO	-0-	992
HOR	HORTA FAIAL ISLAND, PORTUGAL	N	NO	-0-	92
HOU	HOUSTON, TX, USA	N	YES	TX	71429
HPN	WHITE PLAINS, NY, USA	N	YES	NY	2159
HRB	HARBIN, MANCHURIA, P. R. CHINA	N	NO	-0-	210
HRE	HARARE, ZIMBABWE	S	NO	-0-	3314
HRG	HORGHADA, ARAB REP OF EGYPT	N	NO	-0-	760
HRL	HARLINGEN, TX, USA	N	YES	TX	7446
HSV	HUNTSVILLE/DECATUR, AL, USA	N	YES	AL	1817
HTI	HAMILTON ISLAND, QLD, AUSTRALIA	S	NO	-0-	1351
HTS	HUNTINGTON, WV, USA	N	YES	WV	1152
HUN	HUALIEN, TAIWAN	N	NO	-0-	6508
HYD	HYDERABAD, INDIA	N	NO	-0-	2103
IAD	DULLES INT'L, WASHINGTON, DC, USA	N	YES	DC	84839
IAH	HOUSTON INTERCONT, TX, USA	N	YES	TX	35485
IAM	IN AMENAS, ALGERIA	N	NO	-0-	408
IBA	IBADAN, NIGERIA	N	NO	-0-	1382
IBZ	IBIZA, SPAIN	N	NO	-0-	124
ICT	WICHITA, KA, USA	N	YES	KA	10698
IDA	IDAHO FALLS, ID, USA	N	YES	ID	2190
IDR	INDORE, INDIA	N	NO	-0-	1460
IFN	ISFAHAN, IRAN	N	NO	-0-	2256
IGL	IZMIR-CIGLI, TURKEY	N	NO	-0-	26

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
IGR	IGUAZU, ARGENTINA	S	NO	-0-	986
IGU	IGUASSU FALLS, BRAZIL	S	NO	-0-	1776
ILG	PHILADELPHIA-WILMINGTON, PA, USA	N	YES	PA	440
ILM	WILMINGTON, NC, USA	N	YES	NC	6254
ILR	ILORIN, NIGERIA	N	NO	-0-	1568
IMF	IMPHAL, INDIA	N	NO	-0-	1460
IMP	IMPERATRIZ, BRAZIL	S	NO	-0-	1186
IND	INDIANAPOLIS, IN, USA	N	YES	IN	12290
INI	NIS, YUGOSLAVIA	N	NO	-0-	57
INU	NAURU, REP OF NAURU	S	NO	-0-	889
INZ	IN SALAH, ALGERIA	N	NO	-0-	586
IOA	IOANNINA, GREECE	N	NO	-0-	1354
IOS	ILHEUS, BRAZIL	S	NO	-0-	2920
IQQ	IQUIQUE, CHILE	S	NO	-0-	1460
IQT	IQUTOS, PERU	S	NO	-0-	210
IRJ	LA RIOJA, ARGENTINA	S	NO	-0-	860
IRP	ISIRO, ZAIRE	N	NO	-0-	104
ISA	MOUNT ISA, QLD, AUSTRALIA	S	NO	-0-	546
ISB	ISLAMABAD RAWALPINDI, PAKISTAN	N	NO	-0-	3663
ISG	ISHIGAKI, JAPAN	N	NO	-0-	6936
ISO	KINSTON, NC, USA	N	YES	NC	2024
ISP	LONG ISLAND MACARTHUR, NY, USA	N	YES	NY	5816
IST	ISTANBUL, TURKEY	N	NO	-0-	2551
ITH	ITHICA, NY, USA	N	YES	NY	182
ITO	HILO HAWAII, HA, US	N	NO	HA	8568
IUE	NIUE ISLAND, NIUE	S	NO	-0-	127
IVC	INVERCARGILL, NEW ZEALAND	S	NO	-0-	2069
IXA	AGARTALA, INDIA	N	NO	-0-	1976
IXB	BAGDOGRA, INDIA	N	NO	-0-	2366
IXC	CHANDIGAR, INDIA	N	NO	-0-	1460
IXD	ALLAHABAD, INDIA	N	NO	-0-	392
IXE	MANGALORE, INDIA	N	NO	-0-	2370
IXJ	JAMMU, INDIA	N	NO	-0-	1650
IXL	LEH, INDIA	N	NO	-0-	574
IXM	MADURAI, INDIA	N	NO	-0-	1200
IXR	RANCHI, INDIA	N	NO	-0-	1460
IXS	SILOHAR, INDIA	N	NO	-0-	1748
IXU	AURANGABAD, INDIA	N	NO	-0-	1820
IXZ	PORT BLAIR ANDAMAN ISLAND, INDIA	N	NO	-0-	706
JAC	JACKSON, WY, USA	N	YES	WY	2325
JAI	JAIPUR, INDIA	N	NO	-0-	4068
JAN	JACKSON, MS, USA	N	YES	MS	3392
JAX	JACKSONVILLE, FL, USA	N	YES	FL	10211
JDH	JODHPUR, INDIA	N	NO	-0-	2920
JDO	JUAZEIRO DO NORTE CEARAH, BRAZIL	S	NO	-0-	626
JED	JEDDAH, SAUDI ARABIA	N	NO	-0-	19745
JER	JERSEY CHANNEL ISLANDS, UK	N	NO	-0-	1263
JFK	KENNEDY, NEW YORK, NY, USA	N	YES	NY	13217
JGA	JAMNAGAR, INDIA	N	NO	-0-	730
JHB	JOHOR BAHRU, MALAYSIA	N	NO	-0-	4018
JIB	DJIBOUTI, DJIBOUTI	N	NO	-0-	508
JKH	CHIOS, GREECE	N	NO	-0-	1858
JNB	JOHANNESBURG, SOUTH AFRICA	S	NO	-0-	13746
JNU	JUNEAU, AS, US	N	NO	AS	2255
JOI	JOINVILLE, BRAZIL	S	NO	-0-	626
JOS	JOS, NIGERIA	N	NO	-0-	2596
JPA	JOAO PESSOA, BRAZIL	S	NO	-0-	1460
JRH	JORMAT, INDIA	N	NO	-0-	694
JRO	KILIMANJARO, TANZANIA	S	NO	-0-	1667
JSI	SKIATHOS, GREECE	N	NO	-0-	412
JTR	SANTORINI, THIRA ISLAND, GREECE	N	NO	-0-	1126
JUB	JUBA, SUDAN	N	NO	-0-	38
JUJ	JUJUY, ARGENTINA	S	NO	-0-	600
KAD	KADUNA, NIGERIA	N	NO	-0-	3896

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
KAN	KANO, NIGERIA	N	NO	-0-	700
KBL	KABUL, AFGHANISTAN	N	NO	-0-	208
KBR	KOTA BHARU, MALAYSIA	N	NO	-0-	3024
KCH	KUCHING, SARAWAK, MALAYSIA	N	NO	-0-	5337
KCZ	KOCHI, JAPAN	N	NO	-0-	1522
KDU	SKARDU, PAKISTAN	N	NO	-0-	190
KEF	REYKJAVIK-KEFLAVIK, ICELAND	N	NO	-0-	561
KER	KERMAN, IRAN	N	NO	-0-	532
KGA	KANANGA, ZAIRE	S	NO	-0-	420
KGL	KIGALI, RWANDA	S	NO	-0-	22
KGS	KOS, GREECE	N	NO	-0-	550
KHH	KAOHSIUNG, TAIWAN	N	NO	-0-	14596
KHI	KARACHI, PAKISTAN	N	NO	-0-	7384
KHN	NANCHANG KIANGSI, P. R. CHINA	N	NO	-0-	228
KIJ	NIIGATA, JAPAN	N	NO	-0-	2190
KIM	KIMBERLEY, SOUTH AFRICA	S	NO	-0-	3888
KIN	KINGSTON, JAMAICA	N	NO	-0-	338
KKC	KHON KAEN, THAILAND	N	NO	-0-	2264
KLX	KALAMATA, GREECE	N	NO	-0-	782
KMG	KUNMING, P.R. CHINA	N	NO	-0-	2448
KMI	MIYAZAKI, JAPAN	N	NO	-0-	4686
KMP	KEETMANSHOOP, NAMIBIA	S	NO	-0-	174
KMQ	KOMATSU, JAPAN	N	NO	-0-	730
KND	KINDU, ZAIRE	S	NO	-0-	480
KNU	KANPUR, INDIA	N	NO	-0-	1372
KOA	KONA, HA, US	N	NO	HA	11308
KOJ	KAGOSHIMA, JAPAN	N	NO	-0-	843
KRS	KRISTIANSAND, NORWAY	N	NO	-0-	7646
KRT	KHARTOUM, SUDAN	N	NO	-0-	1921
KSA	KOSRAE, CAROLINE ISLANDS	N	NO	-0-	10
KSM	ST MARY'S, AS, US	N	NO	AS	420
KST	KOSTI, SUDAN	N	NO	-0-	-0-
KSU	KRISTIANSUND, NORWAY	N	NO	-0-	2128
KTM	KATHMANDU, NEPAL	N	NO	-0-	2240
KTN	KETCHIKAN, AS, US	N	NO	AS	1460
KUA	KUANTAN, MALAYSIA	N	NO	-0-	426
KUH	KUSHIRO, JAPAN	N	NO	-0-	1336
KUL	KUALA LUMPUR, MALAYSIA	N	NO	-0-	21147
KVA	KAVALA, GREECE	N	NO	-0-	1242
KWE	GUIYANG, P. R. CHINA	N	NO	-0-	684
KWI	KUWAIT, KUWAIT	N	NO	-0-	3659
KWL	GUILIN, P. R. CHINA	N	NO	-0-	3855
LAD	LUANDA, ANGOLA	S	NO	-0-	5680
LAN	LANSING, MI, USA	N	YES	MI	1120
LAS	LAS VEGAS, NV, USA	N	YES	NV	82033
LAX	LOS ANGELES, CA, USA	N	YES	CA	113329
LBB	LUBBOCK, TX, USA	N	YES	TX	13600
LBU	LABUAN SABAH, MALAYSIA	N	NO	-0-	2398
LBV	LIBREVILLE, GABON	N	NO	-0-	1553
LCA	LARNACA, CYPRUS	N	NO	-0-	1352
LCE	LA CEIBA, HONDURAS	N	NO	-0-	380
LDE	LOURDES/TARBES, FRANCE	N	NO	-0-	8
LDI	LINDI, TANZANIA	S	NO	-0-	10
LED	LENINGRAD, U.S.S.R.	N	NO	-0-	198
LEI	ALMERIA, SPAIN	N	NO	-0-	100
LEJ	LEIPZIG, GDR	N	NO	-0-	16
LEX	LEXINGTON, KY, USA	N	YES	KY	3916
LFW	LOME, TOGO	N	NO	-0-	985
LGA	NEW YORK LA GUARDIA, NY, USA	N	YES	NY	32068
LGB	LONG BEACH, CA, USA	N	YES	CA	1299
LGW	LONDON-GATWICK, ENGLAND	N	NO	-0-	13117
LHE	LAHORE, PAKISTAN	N	NO	-0-	7188
LHR	LONDON HEATHROW, ENGLAND, (UK)	N	NO	-0-	69405
LIH	LIHUE, KAUAI, HA, US	N	NO	HA	17365

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
LIL	LILLE, FRANCE	N	NO	-0-	214
LIM	LIMA, PERU	S	NO	-0-	1460
LIN	MILAN LINATE, ITALY	N	NO	-0-	7588
LIS	LISBON, PORTUGAL	N	NO	-0-	10558
LIT	LITTLE ROCK, AK, USA	N	YES	AK	10791
LJA	LODJA, ZAIRE	S	NO	-0-	106
LJU	LJUBLJANA, YUGOSLAVIA	N	NO	-0-	1741
LKO	LUCKNOW, INDIA	N	NO	-0-	4396
LLW	LILONGWE, MALAWI	S	NO	-0-	752
LMT	KLAMATH FALLS, OR, USA	N	YES	OR	1218
LNK	LINCOLN, NB, USA	N	YES	NB	5816
LNZ	LONZ, AUSTRIA	N	NO	-0-	768
LOS	LAGOS, NIGERIA	N	NO	-0-	16716
LPA	GRAN CANARIA, CANARY ISLANDS	N	NO	-0-	293
LPB	LA PAZ, BOLIVIA	S	NO	-0-	136
LPL	LIVERPOOL, ENGLAND	N	NO	-0-	30
LST	LAUNCESTON, TASMANIA, AUSTRALIA	S	NO	-0-	4721
LTN	LONDON-LUTON INT'L, ENGLAND	N	NO	-0-	192
LUN	LUSAKA, ZAMBIA	S	NO	-0-	2302
LUO	LUENA, ANGOLA	S	NO	-0-	434
LUQ	SAN LUIS, ARGENTINA	S	NO	-0-	196
LUX	LUXEMBOURG, LUXEMBOURG	N	NO	-0-	2615
LXR	LUXOR, ARAB REP OF EGYPT	N	NO	-0-	2161
LXS	LEMNOS, GREECE	N	NO	-0-	1040
LYH	LYNCHBURG, VA, USA	N	YES	VA	1824
LYP	FAISALABAD, PAKISTAN	N	NO	-0-	790
LYR	LONGYEARBYEN, NORWAY	N	NO	-0-	14
LYS	LYON, FRANCE	N	NO	-0-	5223
MAA	MADRAS, INDIA	N	NO	-0-	7714
MAB	MARABA, BRAZIL	S	NO	-0-	470
MAD	MADRID, SPAIN	N	NO	-0-	6813
MAF	MIDLAND ODESSA, TX, USA	N	YES	TX	16021
MAH	MAHON, MENORCA, SPAIN	N	NO	-0-	84
MAJ	MAJURO, MARSHALL ISLAND	N	NO	-0-	92
MAN	MANCHESTER, ENGLAND (UK)	N	NO	-0-	5780
MAO	MANAUS, BRAZIL	S	NO	-0-	6627
MBJ	MONTEGO BAY, JAMAICA	N	NO	-0-	218
MBS	SAGINAW, MI, USA	N	YES	MI	794
MBX	MARIBOR, YUGOSLAVIA	N	NO	-0-	0
MCI	KANSIS CITY, MO, USA	N	YES	MO	26453
MCO	ORLANDO-INT'L, FL, USA	N	YES	FL	23551
MCP	MACAPA, AMAPA, BRAZIL	N	NO	-0-	1888
MCT	MUSCAT, OMAN	N	NO	-0-	4409
MCY	MAROOCHYDORE, QLD, AUSTRALIA	S	NO	-0-	104
MCZ	MACEIO, ALAGOAS, BRAZIL	S	NO	-0-	978
MDE	MEDELLIN, COLOMBIA	N	NO	-0-	312
MDI	MAKURDI, NIGERIA	N	NO	-0-	730
MDK	MBANDAKA, ZAIRE	N	NO	-0-	416
MDQ	MAR DEL PLATA, ARGENTINA	S	NO	-0-	2964
MDT	HARRISBURG-OLMSTEAD ST, PA, USA	N	YES	PA	3784
MDW	CHICAGO-MIDWAY, IL, USA	N	YES	IL	33077
MDZ	MENDOZA, ARGENTINA	S	NO	-0-	1578
MED	MEDINA, SAUDI ARABIA	N	NO	-0-	4698
MEG	MALANGE, ANGOLA	S	NO	-0-	740
MEL	MELBOURNE, VICTORIA, AUSTRALIA	S	NO	-0-	17124
MEM	MEMPHIS, TN, USA	N	YES	TN	8599
MES	MEDAN, INDONESIA	N	NO	-0-	730
MEX	MEXICO CITY, MEXICO	N	NO	-0-	4170
MFE	MC ALLEN, TX, USA	N	YES	TX	288
MFR	MEDFOR, OR, USA	N	YES	OR	3529
MFU	MFUWE, ZAMBIA	S	NO	-0-	34
MGA	MANAGUA, NICARAGUA	N	NO	-0-	3212
MGM	MONTGOMERY, AL, USA	N	YES	AL	148
MGQ	MOGADISHU, SOMALIA	N	NO	-0-	94

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
MHD	MASHAD, IRAN	N	NO	-0-	516
MIA	MIAMI, FL, USA	N	YES	FL	28033
MIL	MILAN, ITALY	N	NO	-0-	-0-
MIR	MONASTIR, TUNISIA	N	NO	-0-	488
MIU	MAIDUGURI, NIGERIA	N	NO	-0-	887
MJM	MBUJI-MAYI, ZAIRE	S	NO	-0-	364
MJN	MAJUNGA, MADAGASCAR	S	NO	-0-	402
MJT	MYTILENE, GREECE	N	NO	-0-	2852
MKE	MILWAUKEE, WI, USA	N	YES	WI	1056
MKY	MALACCA, MALAYSIA	S	NO	-0-	2109
MLA	MALTA, MEDITERRANEAN SEA	N	NO	-0-	2882
MLB	MELBOURNE, FL, USA	N	YES	FL	958
MLE	MALE, MALDIVES	N	NO	-0-	356
MLH	MULHOUSE/BASEL, FRANCE	N	NO	-0-	1
MLI	MOLINE, IL, USA	N	YES	IL	1947
MLU	MONROE, LA, USA	N	YES	LA	3670
MMY	MIYAKO JIMA, JAPAN	N	NO	-0-	3606
MNL	MANILA, PHILIPPINES	N	NO	-0-	1232
MOB	MOBILE AL/PASCAGOULA, MS, USA	N	YES	AL	3013
MOC	MONTES CLAROS, BRAZIL	S	NO	-0-	416
MOL	MOLDE, NORWAY	N	NO	-0-	2129
MOQ	MORONDAVA, MADAGASCAR	S	NO	-0-	112
MOT	MINOT, ND, USA	N	YES	ND	737
MPL	MONTPELLIER, FRANCE	N	NO	-0-	52
MPM	MAPUTO, MOZAMBIQUE	S	NO	-0-	2248
MRS	MARSEILLE, FRANCE	N	NO	-0-	3381
MRU	MAURITIUS, MAURITIUS	S	NO	-0-	321
MRY	MONTEREY, CA, USA	N	YES	CA	3559
MSN	MADISON, WI, USA	N	YES	WI	1695
MSO	MISSOULA, MT, USA	N	YES	MT	3537
MSP	MINNEAPOLIS-ST PAUL, MN, USA	N	YES	MN	8120
MSR	MUENSTER, FRG	N	NO	-0-	4
MSY	NEW ORLEANS, LA, USA	N	YES	LA	25950
MSZ	NAMIBE, ANGOLA	S	NO	-0-	228
MTS	MANZINI, SWAZILAND	S	NO	-0-	96
MTY	MONTERREY, MEXICO	N	NO	-0-	0
MUC	MUNICH, FRG	N	NO	-0-	36435
MUX	MULTAN, PAKISTAN	N	NO	-0-	2488
MUZ	MUSOMA, TANZANIA	S	NO	-0-	8
MVB	FRANCEVILLE, GABON	N	NO	-0-	1
MVD	MONTEVIDEO, URUGUAY	S	NO	-0-	4977
MVR	MAROUA, REP OF CAMEROON	N	NO	-0-	1190
MWZ	MWANZA, TANZANIA	S	NO	-0-	79
MXP	MILAN-MALPENSA, ITALY	N	NO	-0-	4
MYJ	MATSUYAMA, SHIKIKU, JAPAN	N	NO	-0-	290
MYR	MYRTLE BEACH, SC, USA	N	YES	SC	4864
MYW	MTWARA, TANZANIA	S	NO	-0-	370
MYY	MIRI, SARAWAK, MALAYSIA	N	NO	-0-	3024
MZG	MAKUNG, TAIWAN	N	NO	-0-	8877
MZT	MAZATLAN, MEXICO	N	NO	-0-	976
NAG	NAGPUR, INDIA	N	NO	-0-	2756
NAN	NADI, FIJI	S	NO	-0-	1373
NAP	NAPLES, ITALY	N	NO	-0-	739
NAS	NASSAU, BAHAMAS	N	NO	-0-	7440
NAT	NATAL, BRAZIL	S	NO	-0-	4380
NBO	NAIROBI, KENYA	S	NO	-0-	1051
NCE	NICE, FRANCE	N	NO	-0-	3675
NCL	NEWCASTLE, ENGLAND	N	NO	-0-	1825
NDD	SUMBE, ANGOLA	S	NO	-0-	10
NDJ	N'DJAMENA, CHAD	N	NO	-0-	18
NGE	N'GAOUNDERE, REP OF CAMEROON	N	NO	-0-	1006
NGO	NAGOYA, JAPAN	N	NO	-0-	5577
NIM	NIAMEY, NIGER	N	NO	-0-	62
NKC	NOUAKCHOTT, MAURITANIA	N	NO	-0-	110

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
NKG	NANJING, P. R. CHINA	N	NO	-0-	2476
NLA	NDOLA, ZAMBIA	S	NO	-0-	701
NLK	NORFOLK ISLAND, PACIFIC OCEAN	S	NO	-0-	420
NNG	NANNING, P. R. CHINA	N	NO	-0-	1157
NOS	NOSSIBE, MADAGASCAR	S	NO	-0-	508
NOU	NOUMEA, NEW CALEDONIA	S	NO	-0-	219
NOV	HUAMBO, ANGOLA	S	NO	-0-	520
NQN	NEUQUEN, ARGENTINA	S	NO	-0-	1876
NUE	NUREMBURG, FRG	N	NO	-0-	3516
NVT	NAVEGANTES, BRAZIL	S	NO	-0-	2608
OAJ	JACKSONVILLE, NC, USA	N	YES	NC	2428
OAK	OAKLAND, SAN FRANCISCO, CA, USA	N	YES	CA	27453
ODE	ODENSE, DENMARK	N	NO	-0-	567
OGG	KAHULUI, MAUI, HA, US	N	NO	HA	27942
OGX	OUARGLA, ALGERIA	N	NO	-0-	836
OHD	OHRID, YUGOSLAVIA	N	NO	-0-	292
OIT	OITA, JAPAN	N	NO	-0-	854
OKA	OKINAWA, RYUKYU IS, JAPAN	N	NO	-0-	11818
OKC	OKLAHOMA CITY, OK, USA	N	YES	OK	25165
OLB	OLBIA, ITALY	N	NO	-0-	40
OMA	OMAHA, NB, USA	N	YES	NB	10800
OME	NOME, AS, US	N	NO	AS	2272
ONT	ONTARIO, CA, USA	N	YES	CA	33033
OOL	GOLD COAST, QLD, AUSTRALIA	S	NO	-0-	2812
OPO	OPORTO, PORTUGAL	N	NO	-0-	3349
ORD	CHICAGO-O'HARE, IL, USA	N	YES	IL	59542
ORF	NORFOLK-VA. BEACH, VA, USA	N	YES	VA	24618
ORH	WORCESTER, MA, USA	N	YES	MA	719
ORK	CORK, IRELAND	N	NO	-0-	2942
ORN	ORAN, ALGERIA	N	NO	-0-	4524
ORY	PARIS - ORLY ARPT, FRANCE	N	NO	-0-	6940
OSA	OSAKA, JAPAN	N	NO	-0-	1792
OSL	OSLO, NORWAY	N	NO	-0-	14168
OSM	MOSUL, IRAQ	N	NO	-0-	312
OTP	BUCHAREST-OTOPENI, ROMANIA	N	NO	-0-	487
OTZ	KOTZEBUE, AS, US	N	NO	AS	2082
OUA	OUAGADOUGOU, BURKINA FASO	N	NO	-0-	14
OUD	OUJDA, MOROCCO	N	NO	-0-	402
OUE	OUESSO, PEOP REP OF CONGO	N	NO	-0-	258
OZZ	OUARAZATE, MOROCCO	N	NO	-0-	161
PAT	PATNA, INDIA	N	NO	-0-	4973
PBI	WEST PALM BEACH, FL, USA	N	YES	FL	10310
PBM	PARAMARIBO, REP OF SURINAME	N	NO	-0-	104
PCL	PUCALLPA, PERU	S	NO	-0-	586
PDL	PONTA DELGADA, PORTUGAL (AZORES)	N	NO	-0-	886
PDP	PUNTA DEL ESTE, URUGUAY	S	NO	-0-	2332
PDX	PORTLAND, OR, USA	N	YES	OR	18968
PEK	BEIJIN, P. R. CHINA	N	NO	-0-	9169
PEN	PENANG, MALAYSIA	N	NO	-0-	9062
PER	PERTH, WA, AUSTRALIA	S	NO	-0-	1178
PEW	PESHAWAR, PAKISTAN	N	NO	-0-	418
PHC	PORT HARCOURT, NIGERIA	N	NO	-0-	208
PHE	PORT HEDLAND, WA, AUSTRALIA	S	NO	-0-	130
PHL	PHILADELPHIA/WILMINGTON, PA, USA	N	YES	PA	34184
PHS	PHITSANULOK, THAILAND	N	NO	-0-	1460
PHX	PHOENIX, AZ, USA	N	YES	AZ	163588
PIA	PEORIA, IL, USA	N	YES	IL	389
PIE	TAMPA-ST. PETERSBURG, FL, USA	N	YES	FL	302
PIK	GLASGOW-PRESTWICK, SCOTLAND	N	NO	-0-	52
PIT	PITTSBURGH, PA, USA	N	YES	PA	69413
PIU	PIURA, PERU	S	NO	-0-	1068
PLZ	PORT ELIZABETH, SOUTH AFRICA	S	NO	-0-	12531
PMA	PEMBA ISLAND, TANZANIA	S	NO	-0-	8
PMC	PUERTO MONTT, CHILE	S	NO	-0-	1400

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
PME	PORTSMOUTH, UK	N	NO	-0-	-0-
PMI	PALMA MALLORCA ISLAND, SPAIN	N	NO	-0-	2449
PMR	PALMERSTON, NEW ZEALAND	S	NO	-0-	2592
PNQ	POONA, INDIA	N	NO	-0-	842
PNR	POINTE NOIRE, PEOP REP OF CONGO	S	NO	-0-	1265
PNS	PENSACOLA, FL, USA	N	YES	FL	2180
PNZ	PETROLINA, BRAZIL	S	NO	-0-	720
POA	PORTO ALEGRE, BRAZIL	S	NO	-0-	8156
POG	PORT GENTIL, GABON	S	NO	-0-	18
POL	PEMBA, MOZAMBIQUE	S	NO	-0-	260
POS	PORT OF SPAIN, TRINIDAD/TOBAGO	N	NO	-0-	52
PPG	PAGO PAGO, SAMOA	S	NO	-0-	434
PPP	PROSERPINE, QLD, AUSTRALIA	S	NO	-0-	437
PRG	PRAGUE, CZECHOSLOVAKIA	N	NO	-0-	1231
PSA	PISA, ITALY	N	NO	-0-	1082
PSC	PASCO, WA, USA	N	YES	WA	864
PSG	PETERSBURG, AS, US	N	NO	AS	1460
PSI	PASNI, PAKISTAN	N	NO	-0-	208
PSP	PALM SPRINGS, CA, USA	N	YES	CA	3083
PSS	POSADAG, ARGENTINA	S	NO	-0-	938
PTY	PANAMA CITY, PANAMA	N	NO	-0-	2683
PUB	PUEBLO, CO, USA	N	YES	CO	2569
PUQ	PUNTA ARENAS, CHILE	S	NO	-0-	760
PUY	PULA, YUGOSLAVIA	N	NO	-0-	76
PVD	PROVIDENCE, RI, USA	N	YES	RI	5358
PVH	PORTO VELHO, BRAZIL	S	NO	-0-	4700
PVR	PUERTO VALLARTA, MEXICO	N	NO	-0-	880
PWM	PORTLAND, ME, USA	N	YES	ME	2450
PXO	PORTO SANTO, PORTUGAL (MADEIRA)	N	NO	-0-	58
PZU	PORT SUDAN, SUDAN	N	NO	-0-	925
QTV	TREVISO, ITALY	N	NO	-0-	-0-
RAE	ARAR, SAUDI ARABIA	N	NO	-0-	1662
RAH	RAFHA, SAUDI ARABIA	N	NO	-0-	166
RAJ	RAJKOT, INDIA	N	NO	-0-	730
RAK	MARRAKECH, MOROCCO	N	NO	-0-	529
RAP	RAPID CITY, SD, USA	N	YES	SD	4703
RAR	RAROTONGA, COOK ISLAND, S. PACIFIC	S	NO	-0-	152
RAS	RASHT, IRAN	N	NO	-0-	540
RBR	RIO BRANCO, BRAZIL	S	NO	-0-	3614
RCU	RIO CUARTO, ARGENTINA	S	NO	-0-	552
RDD	REDDING, CA, USA	N	YES	CA	3151
RDU	RALEIGH-DURHAM, NC, USA	N	YES	NC	23607
REC	RECIFE, BRAZIL	S	NO	-0-	8974
REL	TRELEW, ARGENTINA	S	NO	-0-	2448
RES	RESISTENCIA, ARGENTINA	S	NO	-0-	730
RGA	RIO GRANDE, ARGENTINA	S	NO	-0-	1628
RGL	RIO GALLEGOS, ARGENTINA	S	NO	-0-	3170
RHO	RHODES, GREECE	N	NO	-0-	728
RIC	RICHMOND, VA, USA	N	YES	VA	8252
RIJ	RIOJA, PERU	S	NO	-0-	338
RIY	RIYAN, YEMEN	N	NO	-0-	560
RJK	RIJEKA, YUGOSLAVIA	N	NO	-0-	76
RKT	RAS AL KHAIMAH, U. A. EMIRATES	N	NO	-0-	236
RNN	RONNE, DENMARK	N	NO	-0-	298
RNO	RENO, NV, USA	N	YES	NV	25150
ROA	ROANOKE, VA, USA	N	YES	VA	3910
ROB	MONROVIA ROBERTS, LIBERIA	N	NO	-0-	320
ROC	ROCHESTER, NY, USA	N	YES	NY	13533
ROK	ROCKHAMPTON, QLD, AUSTRALIA	S	NO	-0-	3570
ROR	KOROR, PALAU ISLAND, PACIFIC OCEAN	N	NO	-0-	132
ROS	ROSARIO, ARGENTINA	S	NO	-0-	1704
RPR	RAIPUR, INDIA	N	NO	-0-	1460
RRS	ROROS, NORWAY	N	NO	-0-	782
RSW	FORT MYERS REGIONAL, FL, USA	N	YES	FL	2486

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
RUH	RIYADH, SAUDI ARABIA	N	NO	-0-	21799
RUN	REUNION ISLAND, INDIAN OCEAN	S	NO	-0-	436
SAB	SABA, NETH. ANTILLES	N	NO	-0-	-0-
SAH	SANAA, YEMEN	N	NO	-0-	1580
SAL	SAN SALVADOR, EL SALVADOR	N	NO	-0-	6574
SAN	SAN DIEGO, CA, USA	N	YES	CA	36109
SAO	SAO PAULO, BRAZIL	S	NO	-0-	-0-
SAP	SAN PEDRO, SULA, HONDURAS	N	NO	-0-	3411
SAT	SAN ANTONIO, TX, USA	N	YES	TX	31907
SAV	SAVANNAH, GA, USA	N	YES	GA	5077
SBA	SANTA BARBARA, CA, USA	N	YES	CA	2895
SBN	SOUTH BEND, IN, USA	N	YES	IN	1496
SCC	PRUDHOE BAY, DEADHORSE, AS, US	N	NO	AS	3834
SCK	STOCKTON,CA, USA	N	YES	CA	787
SCL	SANTIAGO, CHILE	S	NO	-0-	3733
SCN	SAARBRUECKEN, FRG	N	NO	-0-	-0-
SDA	BAGHDAD-SADDAM, IRAQ	N	NO	-0-	2599
SDD	LUBANGO, ANGOLA	S	NO	-0-	862
SDE	SANTIAGO DEL ESTERO, ARGENTINA	S	NO	-0-	910
SDF	LOUISVILLE, KY, USA	N	YES	KY	11936
SDJ	SENDAI, JAPAN	N	NO	-0-	2796
SDK	SANDAKAN, SABAH, MALAYSIA	N	NO	-0-	2190
SEA	SEATTLE/TACOMA, WA, USA	N	YES	WA	27059
SFA	SFAX, TUNISIA	N	NO	-0-	186
SFN	SANTA FE, ARGENTINA	S	NO	-0-	624
SFO	SAN FRANCISCO-OAKLAND, CA, USA	N	YES	CA	82408
SGF	SPRINGFIELD, MO, USA	N	YES	MO	3704
SHA	SHANGHAI, P. R. CHINA	N	NO	-0-	1678
SHE	SHENYANG, P. R. CHINA	N	NO	-0-	208
SHJ	SHARJAH, U. A. EMIRATES	N	NO	-0-	2588
SHV	SHREVEPORT, LA, USA	N	YES	LA	3098
SHW	SHARURAH, SAUDI ARABIA	N	NO	-0-	730
SIA	XI AN, P. R. CHINA	N	NO	-0-	848
SID	SAL, CAPE VERDE ISLAND	N	NO	-0-	10
SIN	SINGAPORE, SINGAPORE	N	NO	-0-	6631
SIT	SITKA, AS, US	N	NO	AS	778
SJC	SAN JOSE, CA, USA	N	YES	CA	37310
SJJ	SARAJEVO, YUGOSLAVIA	N	NO	-0-	174
SJO	SAN JOSE, COST RICA	N	NO	-0-	3317
SKG	THESSALONIKI, GREECE	N	NO	-0-	1987
SKO	SOKOTO, NIGERIA	N	NO	-0-	1182
SKP	SKOPJE, YUGOSLAVIA	N	NO	-0-	210
SKS	SKRYDSTRUP, DENMARK	N	NO	-0-	45
SKZ	SUKKUR, PAKISTAN	N	NO	-0-	566
SLA	SALTA, ARGENTINA	S	NO	-0-	1934
SLC	SALT LAKE CITY, UT, USA	N	YES	UT	77961
SLL	SALALAH, OMAN	N	NO	-0-	882
SLZ	SAO LUIZ, MARANHAO, BRAZIL	S	NO	-0-	3629
SMF	SACRAMENTO, CA, USA	N	YES	CA	18876
SMI	SAMOS ISLAND, GREECE	N	NO	-0-	1678
SNA	ORANGE COUNTY, CA, USA	N	YES	CA	24680
SNN	SHANNON, IRELAND	N	NO	-0-	1999
SNO	SAKON NAKHON, THAILAND	N	NO	-0-	566
SOF	SOFIA, BULGARIA	N	NO	-0-	671
SPP	MENONGUE, ANGOLA	S	NO	-0-	224
SPU	SPLIT, YUGOSLAVIA	N	NO	-0-	1592
SRQ	SARASOTA/BRADENTON, FL, USA	N	YES	FL	657
SSA	SALVADOR, BRAZIL	S	NO	-0-	9230
SSG	MALABO, EQUATORIAL GUINEA	N	NO	-0-	126
STL	ST LOUIS, MO, USA	N	YES	MO	20660
STM	SANTAREM, BRAZIL	S	NO	-0-	3318
STR	STUTTGART, FRG	N	NO	-0-	18747
STT	ST THOMAS, VIRGIN ISLANDS	N	NO	-0-	748
STV	SURAT, INDIA	N	NO	-0-	-0-

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
STX	ST CROIX, VIRGIN ISLANDS	N	NO	-0-	730
SUV	SUVA, FIJI	S	NO	-0-	650
SUX	SIOUX CITY, IO, USA	N	YES	IO	1536
SVB	SAMBAVA, MADAGASCAR	S	NO	-0-	274
SVG	STAVANGER, NORWAY	N	NO	-0-	16946
SVO	MOSCOW-SHEREMETYE, U.S.S.R.	N	NO	-0-	864
SVP	KUITO, ANGOLA	S	NO	-0-	422
SXB	STRASBOURG, FRANCE	N	NO	-0-	76
SXF	BERLIN, GDR	N	NO	-0-	86
SXR	SRINAGAR, INDIA	N	NO	-0-	2123
SYD	SYDNEY, N.S.W., AUSTRALIA	S	NO	-0-	16325
SYR	SYRACUSE, NY, USA	N	YES	NY	10961
SYZ	SHIRAZ, IRAN	N	NO	-0-	3868
SZG	SALZBURG, AUSTRIA	N	NO	-0-	648
TAI	TAIZ, YEMEN	N	NO	-0-	820
TBO	TABORA, TANZANIA	S	NO	-0-	36
TBP	TUMBES, PERU	S	NO	-0-	404
TBT	TABATINGA, BRAZIL	S	NO	-0-	764
TBU	TONGATAPU, TONGA ISLAND, PACIFIC	S	NO	-0-	667
TBZ	TABRIZ, IRAN	N	NO	-0-	214
TEE	TBESSA, ALGERIA	N	NO	-0-	652
TER	TERCEIRA, PORTUGAL (AZORES)	N	NO	-0-	87
TET	TETE, MOZAMBIQUE	S	NO	-0-	364
TEZ	TEZPUR, INDIA	N	NO	-0-	728
TFF	TEFE, BRAZIL	S	NO	-0-	246
TFS	TENERIFFE-REINASOFIA, CANARY ISLAND	N	NO	-0-	244
TGD	TITOGRAD, YUGOSLAVIA	N	NO	-0-	616
TGG	KUALA, TERENGGANU, MALAYSIA	N	NO	-0-	438
TGT	TANGA, TANZANIA	S	NO	-0-	26
TGU	TEGUCIGALPA, HONDURAS	N	NO	-0-	3746
THE	TERESINA, PIAUI, BRAZIL	S	NO	-0-	2920
THR	TEHRAN, IRAN	N	NO	-0-	4370
TIA	TIRANA, ALBANIA	N	NO	-0-	104
TIF	TAIF, SAUDI ARABIA	N	NO	-0-	1484
TIN	TINDOUF, ALGERIA	N	NO	-0-	1006
TIP	TRIPOLI, LIBYA	N	NO	-0-	287
TIV	TIVAT, YUGOSLAVIA	N	NO	-0-	188
TKQ	KIGOMA, TANZANIA	S	NO	-0-	18
TLE	TULEAR, MADAGASCAR	S	NO	-0-	490
TLH	TALLAHASSEE, FL, USA	N	YES	FL	0
TLM	TILIMSEN, ALGERIA	N	NO	-0-	1046
TLS	TOULOUSE, FRANCE	N	NO	-0-	1152
TLV	TEL AVIV-YAFO, ISRAEL	N	NO	-0-	2334
TMM	TAMATAVE, MADAGASCAR	S	NO	-0-	150
TMR	TAMANRASSET, ALGERIA	N	NO	-0-	1228
TMS	SAO TOME ISLAND, SAO TOME ISLAND	N	NO	-0-	124
TNG	TANGIER, MOROCCO	N	NO	-0-	2117
TNN	TAINAN, TAIWAN	N	NO	-0-	3324
TNR	ANTANANARIVO, MADAGASCAR	S	NO	-0-	1953
TOE	TOZEUR, TUNISIA	N	NO	-0-	86
TOL	TOLEDO, OH, USA	N	YES	OH	1724
TOS	TROMSO, NORWAY	N	NO	-0-	2080
TOY	TOYAMA, JAPAN	N	NO	-0-	1522
TPA	TAMPA/ST PETERSBURG, FL, USA	N	YES	FL	19425
TPP	TARAPOTO, PERU	S	NO	-0-	656
TRD	TRONDHEIM, NORWAY	N	NO	-0-	11039
TRI	TRI-CITY AIRPORT, TN, USA	N	YES	TN	2166
TRN	TURIN, ITALY	N	NO	-0-	932
TRU	TRUJILLO, PERU	S	NO	-0-	28
TRV	TRIVANDRUM, INDIA	N	NO	-0-	2374
TRW	TARAWA, REP OF KIRIBATI	N	NO	-0-	106
TRZ	TIRUCHIRAPALLY, INDIA	N	NO	-0-	2318
TSA	TAIPEI-SUNG SHAN, TAIWAN	N	NO	-0-	22439
TSN	TIANJIN, P. R. CHINA	N	NO	-0-	954

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
TSV	TOWNSVILLE, QLD, AUSTRALIA	S	NO	-0-	6252
TTJ	TOTTORI, JAPAN	N	NO	-0-	1460
TTT	TAITUNG, TAIWAN	N	NO	-0-	1488
TUC	TUCUMAN, ARGENTINA	S	NO	-0-	2409
TUL	TULSA, OK, USA	N	YES	OK	30215
TUN	TUNIS, TUNISIA	N	NO	-0-	5129
TUR	TUCURUI, BRAZIL	S	NO	-0-	419
TUS	TUCSON, AZ, USA	N	YES	AZ	14844
TUU	TABUK, SAUDI ARABIA	N	NO	-0-	4152
TVL	LAKE TAHOE, CA, USA	N	YES	CA	2274
TWU	TAWAU, SABAH, MALAYSIA	N	NO	-0-	2920
TXL	WEST BERLIN, GERMANY	N	NO	-0-	17484
TYL	TALARA, PERU	S	NO	-0-	12
TYN	TAIYUAN, P. R. CHINA	N	NO	-0-	104
TYS	KNOXVILLE, TN, USA	N	YES	TN	4917
UAQ	SAN JUAN, ARGENTINA	S	NO	-0-	546
UBA	UBERABA, BRAZIL	S	NO	-0-	1186
UBJ	UBE, JAPAN	N	NO	-0-	2496
UBP	UBON PATCHATHANI, THAILAND	N	NO	-0-	730
UDI	UBERLANDIA, BRAZIL	S	NO	-0-	1186
UDR	UDAIPUR, INDIA	N	NO	-0-	1460
UEL	QUELIMANE, MOZAMBIQUE	S	NO	-0-	418
UET	QUETTA, PAKISTAN	N	NO	-0-	832
UIO	QUITO, ECUADOR	S	NO	-0-	1609
UNK	UNALAKLEET, AS, US	N	NO	AS	4
URT	SURAT THANI, THAILAND	N	NO	-0-	798
URY	GURAYAT, SAUDI ARABIA	N	NO	-0-	740
USH	USHUAIA, ARGENTINA	S	NO	-0-	1804
UTH	UDON, THANI, THAILAND	N	NO	-0-	738
UTN	UPINGTON, SOUTH AFRICA	S	NO	-0-	882
UVL	NEW VALLEY, ARAB REP OF EGYPT	N	NO	-0-	315
VCE	VALVERDE, CANARY ISLANDS	N	NO	-0-	1729
VCP	SAO PAULO - VIRACOPOS, BRAZIL	S	NO	-0-	104
VDM	VIEDMA, ARGENTINA	S	NO	-0-	416
VFA	VICTORIA FALL, ZIMBABWE	S	NO	-0-	610
VHC	SAURIMO, ANGOLA	S	NO	-0-	252
VIE	VIENNA, AUSTRIA	N	NO	-0-	5820
VIL	DAKHLA, MOROCCO	N	NO	-0-	8
VIX	VITORIA, ESPIRITO SANTO, BRAZIL	S	NO	-0-	2878
VLC	VALENCIA, SPAIN	N	NO	-0-	206
VLG	VILLA GESELL, ARGENTINA	S	NO	-0-	154
VLI	PORT VILA, VANUATU	S	NO	-0-	251
VNS	VARANASI, INDIA	N	NO	-0-	3150
VTZ	VISHAKHAPATNAM, INDIA	N	NO	-0-	1722
VVI	SANTA CRUZ, VIRU VIRU, BOLIVIA	S	NO	-0-	104
VXC	LICHINGA, MOZAMBIQUE	S	NO	-0-	312
WAW	WARSAW, POLAND	N	NO	-0-	1027
WDH	WINDHOEK, NAMIBIA	S	NO	-0-	1862
WLG	WELLINGTON, NEW ZEALAND	S	NO	-0-	17828
WRG	WRANGELL, AS, US	N	NO	AS	1460
WUH	WUHAN, P. R. CHINA	N	NO	-0-	2002
XMN	XIAMEN, P. R. CHINA	N	NO	-0-	2254
XRY	JEREZ DE LA FRONTERA, SPAIN	N	NO	-0-	-0-
YAK	YAKUTAT, AS, US	N	NO	AS	1460
YAM	SAULT STE MARIE, ONT., CANADA	N	NO	-0-	3540
YAO	YAOUNDE, REP OF CAMEROON	N	NO	-0-	4147
YBC	BAIE COMEAU, QUEBEC, CANADA	N	NO	-0-	276
YBG	SAGUENAY, QUE, CANADA	N	NO	-0-	520
YBR	BRANDON, MAN, CANADA	N	NO	-0-	1252
YCB	CAMBRIDGE BAY, NWT, CANADA	N	NO	-0-	239
YCG	CASTLEGAR, BC, CANADA	N	NO	-0-	626
YCH	CHATHAM, NB, CANADA	N	NO	-0-	626
YCL	CHARLO, NB, CANADA	N	NO	-0-	626
YDF	DEER LAKE, NFLD, CANADA	N	NO	-0-	2855

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
YDQ	DAWSON CREEK, BC, CANADA	N	NO	-0-	626
YEG	EDMONTON, ALTA, CANADA	N	NO	-0-	11693
YEV	INUVIK, NWT, CANADA	N	NO	-0-	745
YFB	IQALUIT, NWT, CANADA	N	NO	-0-	1769
YFC	FREDERICTON, NB, CANADA	N	NO	-0-	1342
YFO	FLIN FLON, MAN, CANADA	N	NO	-0-	420
YGJ	YONAGO, JAPAN	N	NO	-0-	2190
YGL	LA GRANDE, QUE, CANADA	N	NO	-0-	1044
YGW	KUUJJUARAPIK, QUE, CANADA	N	NO	-0-	522
YGX	GILLAM, MAN, CANADA	N	NO	-0-	832
YHD	DRYDEN, ONT, CANADA	N	NO	-0-	2699
YHY	HAY RIVER, NWT, CANADA	N	NO	-0-	1252
YHZ	HALIFAX, NS, CANADA	N	NO	-0-	14221
YJT	STEPHENVILLE, NFLD, CANADA	N	NO	-0-	144
YKA	KAMLOOPS, BC, CANADA	N	NO	-0-	2650
YLW	KELOWNA, BC, CANADA	N	NO	-0-	8790
YMM	FT MCMURRAY, ALTA, CANADA	N	NO	-0-	1148
YMS	YURIMAGUAS, PERU	S	NO	-0-	210
YMX	MONTREAL MIRABEL, QUE, CANADA	N	NO	-0-	569
YNB	YANBU, SAUDI ARABIA	N	NO	-0-	2513
YNG	YOUNGSTOWN, OH, USA	N	YES	OH	330
YOL	YOLA, NIGERIA	N	NO	-0-	1279
YOW	OTTAWA, ONT, CANADA	N	NO	-0-	10695
YPR	PRINCE RUPERT, BC, CANADA	N	NO	-0-	1436
YQB	QUEBEC, QUE, CANADA	N	NO	-0-	1356
YQD	THE PAS, MAN, CANADA	N	NO	-0-	630
YQG	WINDSOR, ONT, CANADA	N	NO	-0-	2351
YQH	WATSON LAKE, YT, CANADA	N	NO	-0-	335
YQR	REGINA, SASK, CANADA	N	NO	-0-	3925
YQT	THUNDER BAY, ONT, CANADA	N	NO	-0-	6659
YQU	GRANDE PRAIRIE, ALBA, CANADA	N	NO	-0-	1568
YQX	GANDER, NFLD, CANADA	N	NO	-0-	748
YQY	SYDNEY, NS, CANADA	N	NO	-0-	1846
YQZ	QUESNEL, BC, CANADA	N	NO	-0-	442
YRB	RESOLUTE, NT, CANADA	N	NO	-0-	417
YSB	SUBDURY, ONT, CANADA	N	NO	-0-	1092
YSJ	SAINT JOHN, NB, CANADA	N	NO	-0-	1358
YSM	FT SMITH, NWT, CANADA	N	NO	-0-	1252
YSR	NANISIVIK NWT, CANADA	N	NO	-0-	208
YTH	THOMPSON, MAN, CANADA	N	NO	-0-	1006
YUL	MONTREAL, QUEBEC, CANADA	N	NO	-0-	19081
YUM	YUMA, AZ, USA	N	YES	AZ	31
YUX	HALL BEACH, NWT, CANADA	N	NO	-0-	210
YVO	VAL D'OR, QUE, CANADA	N	NO	-0-	1887
YVP	FT CHIMO, QUE, CANADA	N	NO	-0-	1178
YVQ	NORMAN WELLS, NWT, CANADA	N	NO	-0-	1133
YVR	VANCOUVER, BC, CANADA	N	NO	-0-	38426
YWG	WINNIPEG, MAN, CANADA	N	NO	-0-	13898
YWK	WABUSH, NFLD, CANADA	N	NO	-0-	964
YWL	WILLIAMS LAKE, BC, CANADA	N	NO	-0-	442
YXC	CRANBROOK, BC, CANADA	N	NO	-0-	2712
YXD	EDMONTON—MUNICIPAL, ALBERTA, CANADA	N	NO	-0-	10271
YXE	SASKATOON, SASK, CANADA	N	NO	-0-	3934
YXJ	FT ST JOHN, BC, CANADA	N	NO	-0-	3958
YXS	PRINCE GEORGE, BC, CANADA	N	NO	-0-	5052
YXT	TERRACE, BC, CANADA	N	NO	-0-	1790
YXU	LONDON, ONT, CANADA	N	NO	-0-	422
YXY	WHITEHORSE, YT, CANADA	N	NO	-0-	1479
YYC	CALGARY, ALBERTA, CANADA	N	NO	-0-	33327
YYD	SMITHERS, BC, CANADA	N	NO	-0-	904
YYE	FT NELSON, BC, CANADA	N	NO	-0-	962
YYF	PENTICTON, BC, CANADA	N	NO	-0-	2964
YYG	CHARLOTTETOWN, PEI, CANADA	N	NO	-0-	1699
YYJ	VICTORIA, BC, CANADA	N	NO	-0-	871

AIRPORT	APTDEF	HEMISPHR	CONUS	ABBR	STGFY87
YYL	LYNN LAKE, MAN, CANADA	N	NO	-0-	32
YYQ	CHURCHILL, MAN, CANADA	N	NO	-0-	412
YYR	GOOSE BAY, NFLD, CANADA	N	NO	-0-	1733
YYT	ST JOHNS, NFLD, CANADA	N	NO	-0-	4331
YYY	MONT JOLI, QUE, CANADA	N	NO	-0-	276
YYZ	TORONTO, ONTARIO, CANADA	N	NO	-0-	44100
YZF	YELLOWKNIFE, NWT, CANADA	N	NO	-0-	3253
YZP	SANDSPIT, BC, CANADA	N	NO	-0-	774
YZT	PORT HARDY, BC, CANADA	N	NO	-0-	708
YZV	SETP-ILES, QUE, CANADA	N	NO	-0-	603
ZAD	ZADAR, YUGOSLAVIA	N	NO	-0-	52
ZAG	ZAGREB, YUGOSLAVIA	N	NO	-0-	6743
ZAH	ZAHEDAN, IRAN	N	NO	-0-	88
ZHA	ZHANGJIANG, P. R. CHINA	N	NO	-0-	416
ZIH	IXTAPA/ZIHUATANEJO, MEXICO	N	NO	-0-	44
ZNZ	ZANZIBAR, TANZANIA	S	NO	-0-	1098
ZRH	ZURICH, SWITZERLAND	N	NO	-0-	12226
ZTH	ZAKINTHOS, GREECE	N	NO	-0-	676
ZUM	CHURCHILL FALLS, NFLD, CANADA	N	NO	-0-	216

APPENDIX B

CONTENTS OF FAA BIRD INGESTION DATA BASE
BOEING 737 AIRPLANE
OCTOBER 1986 - SEPTEMBER 1987

This appendix presents the contents of the Boeing 737 bird ingestion data base maintained by the FAA. The appendix presents actual data extracted from the FAA data base and used in this report. When the null symbol -0- appears in any data position it indicates that the data are unknown. The data base contents are described below:

COLUMN	DESCRIPTION OF COLUMN CONTENTS
EDATE	Date(mm/dd/yyyy) of ingestion event.
EVT#	FAA ingestion event sequence number reflecting order in which events were entered into the FAA bird ingestion data base.
ENG_POS	Engine position of engine ingesting bird. Since each engine ingestion event has a unique record in the data base, duplicate event numbers indicate multiple engine ingestion events. This column provides record uniqueness in such cases. 1 - left engine of 737 airplane 2 - right engine of 737 airplane
ETIME	Local time of bird ingestion.
SIGN_EVT	Significant event factors. AIRWRTHY - engine related airworthiness effects INV POS LOSS - involuntary power loss MULT BIRDS - multiple birds in 1 engine MULT ENG - multiple engine ingestion (1 bird in each engine) MULT ENG-BIRDS - multiple engine ingestion and 1 or both engines sustained multiple bird ingestion TRVS FRAC - transverse fan blade fracture OTHER - other significant factor, may be reported in narrative remarks NONE - no significant factor noted
AIRCRAFT	737 aircraft type.
POF	Phase of flight during which bird ingestion occurred. (TAXI;TAKEOFF;CLIMB;CRUISE;DESCENT;LANDING;UNKNOWN)
ALTITUDE	Altitude (ft. AGL) at time of bird ingestion.
SPEED	Air speed (knots) at time of bird ingestion.
FL_RULES	Flight rules in effect at time of bird ingestion. IFR - instrument flight rules VFR - visual flight rules UNK - unknown

LT_COND Light conditions at time of bird ingestion.
(DARK;LIGHT;DAWN;DUSK;etc.)

WEATHER Weather conditions at time of bird ingestion.

CREW_AC Crew action taken in response to bird ingestion.
ATO - aborted takeoff
ATB - air turnback
DIV - diversion
UNK - unknown
NONE - no crew action taken
N/A - not applicable
OTHER - some action taken, may be specified in narrative remarks

CREW_AL Indicates whether crew alerted to presence of birds at time of bird ingestion.
(YES;NO;UNKNOWN)

BIRD_SEE Indicates whether ingested bird(s) seen prior to ingestion
NO - not seen
YES - seen
SEVERAL - 2 to 10 birds observed
FLOCK - more than 10 birds observed

BIRD_NAM Common bird name. Trailing asterisk (*) implies bird not positively identified as such.

BIRD_SPE Species of positively identified bird. Alphanumeric identification code which conforms to Edward's† convention.

#_BIRDS Number of birds ingested. A (-2) implies more than one bird but the exact count is unknown.

WT_OZ_1 Weight (oz.) of first ingested bird.

CTY_PRS Scheduled city pairs of aircraft operation.
(from code:to code) 3 letter city airport code.
Reference AIRPORT column in Appendix A.

AIRPORT Airport at which bird ingestion event occurred.
3 letter city airport code. Reference AIRPORT column in Appendix A.

LOCALE Nearest town, state, country, etc.

US_INCID Indicates whether bird ingestion occurred within United States boundaries.
(YES;NO)

†Edwards, E.P., "A Coded List of Birds of the World," IBSN:911882-04-9, 1974.

*U.S. GOVERNMENT PRINTING OFFICE: 1990-704-061/20008

APPENDIX B

CONTENTS OF FAA BIRD INGESTION DATA BASE - BOEING 737 AIRPLANE
OCTOBER 1986 - SEPTEMBER 1987

This appendix presents the contents of small engine bird ingestion data base maintained by the FAA. The appendix presents actual data extracted from the FAA database and used in this report. When the null symbol -0- appears in any data position it indicates that the data are unknown. The data base contents are described below:

COLUMN	DESCRIPTION OF COLUMN CONTENTS
EDATE	Date (mm/dd/yyyy) of ingestion event.
EVT#	FAA ingestion event sequence number reflecting order in which events were entered into the FAA bird ingestion data base.
ENG_POS	Engine position of engine ingesting bird. Since each engine ingestion event has a unique record in the data base, duplicate event numbers indicate multiple engine ingestion events. This column provides record uniqueness in such cases. 1 - left engine of 737 airplane 2 - right engine of 737 airplane
ETIME	Local time of bird ingestion.
SIGN_EVT	Significant event factors. AIRWRTHY - engine related airworthiness effects INV POS LOSS - involuntary power loss MULT BIRDS - multiple birds in 1 engine MULT ENG - multiple engine ingestion (1 bird in each engine) MULT ENG-BIRDS - multiple engine ingestion and 1 or both engines sustained multiple bird ingestion TRVS FRAC - transverse fan blade fracture OTHER - other significant factor, may be reported in narrative remarks NONE - no significant factor noted
AIRCRAFT	737 aircraft type.
POF	Phase of flight during which bird ingestion occurred. (TAXI;TAKEOFF;CLIMB;CRUISE;DESCENT;LANDING;UNKNOWN)
ALTITUDE	Altitude (ft. AGL) at time of bird ingestion.
SPEED	Air speed (kn) at time of bird ingestion.
FL_RULES	Flight rules in effect at time of bird ingestion. IFR - instrument flight rules VFR - visual flight rules UNK - unknown

LT_COND Light conditions at time of bird ingestion.
(DARK;LIGHT;DAWN;DUSK;etc.)

WEATHER Weather conditions at time of bird ingestion.

CREW_AC Crew action taken in response to bird ingestion.
ATO - aborted takeoff
ATB - air turnback
DIV - diversion
UNK - unknown
NONE - no crew action taken
N/A - not applicable
OTHER - some action taken, may be specified in narrative remarks

CREW_AL Indicates whether crew alerted to presence of birds at time of bird ingestion.
(YES;NO;UNKNOWN)

BIRD_SEE Indicates whether ingested bird(s) seen prior to ingestion
NO - not seen
YES - seen
SEVERAL - 2 to 10 birds observed
FLOCK - more than 10 birds observed

BIRD_NAM Common bird name. Trailing asterisk (*) implies bird not positively identified as such.

BIRD_SPE Species of positively identified bird. Alphanumeric identification code which conforms to Edward's convention.

#_BIRDS Number of birds ingested. A (-2) implies more than one bird but the exact count is unknown.

WT_OZ_1 Weight (oz.) of first ingested bird.

CTY_PRS Scheduled city pairs of aircraft operation.
(from code:to code) 3 letter city airport code.
Reference AIRPORT column in Appendix A.

AIRPORT Airport at which bird ingestion event occurred.
3 letter city airport code. Reference AIRPORT column in Appendix A.

LOCALE Nearest town, state, country, etc.

US_INCID Indicates whether bird ingestion occurred within United States boundaries.
(YES;NO)

Edwards, E.P., "A Coded List of Birds of the World," IBSN:911882-04-9, 1974.

ENGINE Engine model.
(CFM56;JT8D)

DASH Engine dash number.

DMG_CODE Letter codes summarizing engine damage resulting from the bird ingestion. This column does not exist in the actual FAA database, but was developed by the contractor to compress 17 YES/NO damage fields into a single column. A letter code appears for damage columns whose values are YES. Each page of damage information contains a legend identifying the damage type. In the explanation of damage codes below, a number in parentheses indicates the damage severity code which is further explained in the SEVERITY column. The database column name is given in the explanation of the damage code.

- A(4) - ENG_DAM; engine damaged due to bird ingestion
- B(3) - LEAD_EDG; leading edge distortion/curl, minor fan blades
- C(3) - BEN/DEN; 1 to 3 fan blades bent or dented
- D(2) - BE/DE>3; more than 3 fan blades bent or dented
- E(3) - TORN<3; 1 to 3 fan blades torn
- F(2) - TORN>3; more than 3 fan blades torn
- G(2) - BROKEN; broken fan blade(s), leading edge and/or tip pieces missing; other blades also dented
- H(3) - SHINGLED; shingled (twisted) fan blades
- I(1) - TRVSFRAC; transverse fracture - a fan blade broken chordwise (across) and the piece liberated (includes secondary hard object damage)
- J(2) - SPINNER; dented, broken, or cracked spinner (includes spinner cap)
- K(1) - CORE; bent/broken compressor blades/vanes, blade/vane clash, blocked/disrupted airflow in low, intermediate, and high pressure compressors
- L(3) - NACELLE; dents and/or punctures to the engine enclosure (includes cowl)
- M(1) - FLANGE; flange separations
- N(2) - RELEASED; released (walked) fan blades
- O(1) - TURBINE; turbine damage
- P - OTHER; any damage not previously listed
- Q - UNKNOWN

SEVERITY Numeric code indicating the severity of engine damage resulting from the bird ingestion. This column does not exist in the actual FAA database, but was developed by the contractor as a result of an analysis of reported damage in the database. The lower the severity code, the more severe the damage. The severity rating assigned to a flight is determined as the lowest severity rating attained by any of the damage categories. The corresponding severity ratings for each damage category were given in parentheses in the DMG_CODE discussion above.

- 1 - most severe damage (damage is known)
- 2 - moderately severe damage (damage is known)
- 3 - least severe damage (damage is known)
- 4 - damage indicated, but not specified
- 9 - no damage reported

POW_LOSS Degree of power loss as a result of bird ingestion
- NONE - no power loss
- EPR DEC - engine pressure ratio decrease
- SPOOL DOWN - engine spooled down
- N1 CHANGE - N1 rotor change
- N2 CHANGE - N2 rotor change
- COMPRESSOR - compressor surge/stall
- UNKNOWN - unknown whether power loss occurred

MAX_VIBE Maximum vibration reported as a dimensionless unit.

THROTTLE Voluntary throttle change by crew in response to bird ingestion.
- ADVANCE - voluntary throttle advance
- RETARD - voluntary throttle retard
- IDLE - voluntary throttle retard to idle
- CUTOFF voluntary throttle retard to cutoff
- NONE - no voluntary throttle change

IFSD Indicate whether in-flight shutdown occurred in response to bird ingestion.
- NO - no shutdown
- VIBES - shutdown due to vibrations
- STAL/SURG - shutdown due to compressor stall/surge
- HI EGT - shutdown due to high exhaust gas temperature
- EPR - shutdown due to incorrect engine pressure ratio
- INVLNTRY - involuntary engine shutdown
- PARAMTRS - shutdown due to incorrect engine parameters
- OTHER - other reasons, may be listed in remarks
- UNKNOWN - unknown cause for shutdown

REMARKS Narrative description providing additional information concerning some aspect of the ingestion.

FAA BIRD INGESTION DATABASE, BOEING 737 AIRCRAFT, OCTOBER 1986 - SEPTEMBER 1987

EDATE	EVT#	ENG POS	ETIME	SIGN EVT	AIRCRAFT	POF	ALTITUDE	SPEED	FL RULES	LT CONDS	WEATHER	CREW AC	CREW AL	BIRD SEE	BIRD NAM	BIRD SPE	# BIRDS	WT OZ 1	CTY PRS	AIRPORT	LOCALE	US INCID	ENGINE	DASH	DMG CODE	SEVERITY	POW LOSS	MAX VIBE	THROTTLE	IFSD	REMARKS
10/01/1986	1	1	-0-	NONE	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	-0-	-0-	-0-	BEG	BELGRADE, YUGOSLAVIA	NO	CFM56	3	A,B	3	NONE	2.0	NONE	NO	-0-
10/02/1986	2	2	16:20:00	NONE	300	CLIMB	700	-0-	IFR	-0-	OVERCAST	DIV	-0-	-0-	-0-	-0-	-0-	-0-	-0-	TVL	LAKE TAHOE, CA	YES	CFM56	3	A,B	3	-0-	4.0	NONE	NO	-0-
10/02/1986	3	2	-0-	NONE	300	TAXI	0	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	CTU	CHENGOU, CHINA	NO	CFM56	3	A,B	3	-0-	-0-	NONE	NO	-0-
10/04/1986	235	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	XFO	CHINA	NO	JT8D	-0-	A,G	2	-0-	-0-	-0-	-0-	-0-
10/05/1986	4	1	-0-	NONE	300	TAKEOFF	100	160	VFR	-0-	CLEAR	ATB	NO-	YES	GULL*	-0-	1	-0-	-0-	MDT	HARRISBURG, PA	YES	CFM56	3	A,H	3	NONE	-0-	NONE	NO	AM EVENT, MEDIUM BIRD
10/08/1986	5	2	-0-	NONE	300	TAXI	0	-0-	VFR	LIGHT	CLEAR	NONE	-0-	-0-	-0-	-0-	-0-	-0-	-0-	PEK	BEIJING, CHINA	NO	CFM56	3		2	NONE	-0-	NONE	NO	-0-
10/10/1986	233	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	0	BOM-	XFD	INDIA	NO	JT8D	-0-	A,H	3	-0-	-0-	-0-	-0-	-0-
10/10/1986	234	2	-0-	NONE	200	TAKEOFF	-0-	-0-	-0-	-0-	-0-	ATB	-0-	-0-	-0-	-0-	-0-	-0-	MAN-CDG	MAN	MANCHESTER, ENGLAND	NO	JT8D	15	A,C	3	-0-	-0-	-0-	-0-	CCDC PS4 CRACK
10/13/1986	6	2	8:00:00	MULT ENG	300	TAKEOFF	-0-	146	VFR	DAWN	SCATTERED	ATB	-0-	FLOCK	GRAY-HEADED LAPWING	5N20	1	9.	-0-	KMG	KUNMING, CHINA	NO	CFM56	3		2	NONE	-0-	NONE	NO	-0-
10/13/1986	6	1	8:00:00	MULT ENG	300	TAKEOFF	-0-	146	VFR	DAWN	SCATTERED	ATB	-0-	FLOCK	GRAY-HEADED LAPWING	5N20	1	9.	-0-	KMG	KUNMING, CHINA	NO	CFM56	3	A,B,E	3	-0-	5.0	IDLE	NO	-0-
10/14/1986	232	2	-0-	NONE	200	LANDING	0	125	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-BOM	BOM	BOMBAY, INDIA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	THUD REPORTED
10/16/1986	7	2	-0-	MULT ENG-BIRDS	300	APPROACH	-0-	-0-	-0-	-0-	CLEAR	NONE	-0-	FLOCK	STARLING	21775	3	3.	-0-	DAL	DALLAS/FT WORTH, TEX-LOVE	YES	CFM56	3		-0-	NONE	-0-	NONE	NO	-0-
10/16/1986	7	1	-0-	MULT ENG-BIRDS	300	APPROACH	-0-	-0-	-0-	-0-	CLEAR	NONE	-0-	FLOCK	STARLING	21775	1	3.	-0-	DAL	DALLAS/FT WORTH, TEX-LOVE	YES	CFM56	3		-0-	NONE	-0-	NONE	NO	-0-
10/19/1986	230	1	-0-	NONE	200	LANDING	0	90	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-TRV	TRV	TRIVANDRUM, INDIA	NO	JT8D	9A		-0-	-0-	-0-	-0-	-0-	-0-
10/19/1986	231	1	-0-	NONE	200	TAKEOFF	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	ELS-	ELS	EAST LONDON, SOUTH AFRICA	NO	JT8D	17		-0-	-0-	-0-	-0-	-0-	-0-
10/20/1986	228	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	XFO	CHINA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
10/20/1986	229	1	-0-	NONE	200	TAKEOFF	0	-0-	-0-	-0-	-0-	ATO	-0-	-0-	-0-	-0-	1	-0-	CCU-	CCU	CALCUTTA, INDIA	NO	JT8D	-0-	A,C	3	-0-	-0-	-0-	-0-	-0-
10/21/1986	226	2	-0-	NONE	200	TAKEOFF	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	XFO	-0-	NO	JT8D	17	A,C,G	2	-0-	0	-0-	-0-	-0-
10/21/1986	227	1	-0-	NONE	200	TAKEOFF	-0-	145	-0-	-0-	-0-	ATB	-0-	-0-	-0-	-0-	1	-0-	GAU-	GAU	GAUHATI, INDIA	NO	JT8D	17A	A,C	3	-0-	YES	-0-	-0-	VIBRATION, THUD, SMELL
10/23/1986	62	1	-0-	MULT BIRDS	200	TAKEOFF	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	-2	-0-	-0-	GHU	GUALEGUAYCHU, CHINA	NO	JT8D	17A	A,B	3	-0-	-0-	NONE	NO	7 FAN BLADES REQUIRED LE TIP REPAIR
10/25/1986	236	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	XFO	-0-	NO	JT8D	-0-	A,C	3	-0-	-0-	-0-	-0-	3 FAN BLADES BENT
10/26/1986	8	1	-0-	MULT ENG	300	TAKEOFF	-0-	-0-	VFR	-0-	-0-	DIV	-0-	-0-	-0-	-0-	1	-0-	-0-	SNA	ORANGE COUNTY, CA	YES	CFM56	3		-0-	NONE	-0-	NONE	NO	-0-
10/26/1986	8	2	-0-	MULT ENG	300	TAKEOFF	-0-	-0-	VFR	-0-	-0-	DIV	-0-	-0-	-0-	-0-	1	-0-	-0-	SNA	ORANGE COUNTY, CA	YES	CFM56	3	A,H	3	NONE	3.0	NONE	NO	-0-
10/28/1986	9	2	-0-	MULT ENG-BIRDS	200	APPROACH	-0-	-0-	-0-	-0-	-0-	-0-	-0-	SEVERAL	ROCK DOVE	2P1	1	14.	PIT-ROA	ROA	ROANOAK, VA	YES	JT8D	15		-0-	NONE	-0-	NONE	NO	TURBINE FAILED ON 11/10/86
10/28/1986	9	1	-0-	MULT ENG-BIRDS	200	APPROACH	-0-	-0-	-0-	-0-	-0-	-0-	-0-	SEVERAL	ROCK DOVE	2P1	-2	14.	PIT-ROA	ROA	ROANOAK, VA	YES	JT8D	15		3	NONE	-0-	NONE	NO	-0-
10/28/1986	10	1	-0-	NONE	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	-0-	-0-	-0-	DAL	DALLAS/FT WORTH, TEX-LOVE	YES	CFM56	3		-0-	NONE	-0-	NONE	NO	-0-
10/29/1986	11	1	-0-	NONE	300	TAKEOFF	0	130	VFR	DAY	PARTLY CLOUD	ATB	YES	FLOCK	ROBIN OR PIGEON*	-0-	-0-	-0-	-0-	CLT	CHARLOTTE, NC	YES	CFM56	3	A,C,H	3	NONE	5.0	IDLE	NO	-0-
10/29/1986	12	1	-0-	NONE	300	CLIMB	-0-	90	-0-	-0-	-0-	NONE	-0-	SEVERAL	GULL*	-0-	1	-0-	-0-	BHM	BIRMINGHAM, ALA	YES	CFM56	3		2	NONE	-0-	NONE	NO	-0-
10/30/1986	225	1	-0-	NONE	200	LANDING	0	20	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	4.	GAU	XFO	INDIA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
11/01/1986	13	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	NO	NIGHTHAWK	5T5	1	2.	-0-	XUS	-0-	YES	JT8D	15		-0-	NONE	-0-	NONE	NO	-0-
11/02/1986	423	2	-0-	NONE	200	TAKEOFF	-0-	-0-	-0-	-0-	-0-	ATB	-0-	-0-	-0-	-0-	-0-	-0-	-0-	XUS	MIDWAY AIRPORT	YES	JT8D	15		-0-	-0-	-0-	-0-	-0-	-0-
11/03/1986	14	1	-0-	NONE	300	UNKNOWN	0	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	-0-	-0-	-0-	KHI	KARACHI, PAKISTAN	NO	CFM56	3	A,H	1	NONE	3.8	NONE	NO	-0-
11/04/1986	15	1	-0-	NONE	300	TAKEOFF	0	<100	VFR	-0-	OVERCAST	NONE	NO	NO	-0-	-0-	1	-0-	-0-	ALB	ALBANY, NY	YES	CFM56	3	A,B,H	3	NONE	-0-	NONE	NO	-0-
11/04/1986	73	2	-0-	NONE	200	TAKEOFF	0	145	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	HYD	HYDERABAD, INDIA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	NO	-0-
11/04/1986	161	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0	-0-	-0-	1	-0-	-0-	XFO	-0-	NO	JT8D	-0-	A,C	3	-0-	-0-	-0-	NO	-0-
11/07/1986	16	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-CHC	XFO	CHRISTCHURCH, NEW ZEALAND	NO	JT8D	15		2	NONE	-0-	NONE	NO	-0-
11/07/1986	74	1	-0-	NONE	200	LANDING	0	125	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	SXR	SRINAGAR, INDIA	NO	JT8D	17A		-0-	-0-	-0-	-0-	NO	-0-
11/09/1986	17	1	-0-	NONE	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	-0-	-0-	-0-	SAT	SAN ANTONIO, TEX	YES	CFM56	3		-0-	NONE	-0-	NONE	NO	-0-
11/09/1986	18	2	-0-	NONE	300	APPROACH	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	-0-	-0-	-0-	DEN	DENVER, COL	YES	CFM56	3		-0-	NONE	-0-	NONE	NO	-0-
11/10/1986	19	2	-0-	NONE	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	-0-	-0-	CLT-DCA	CLT	CHARLOTTE, NC	YES	CFM56	3		-0-	NONE	4.0	NONE	NO	-0-
11/10/1986	20	1	21:13:00	NONE	200	TAKEOFF	100	-0-	VFR	DARK	CLEAR	NONE	YES	-0-	-0-	-0-	1	-0-	PEN-KUL	PEN	PENANG, MAY	NO	JT8D	15A	A,C	3	NONE	-0-	NONE	NO	-0-
11/14/1986	75	1	-0-	NONE	200	TAKEOFF	0	145	-0-	-0-	-0-	ATB	-0-	-0-	-0-	-0-	1	-0-	-0-	BLR	BANGALORE, INDIA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	NO	-0-
11/14/1986	76	1	-0-	NONE	200	TAKEOFF	0	-0-	-0-	-0-	-0-	ATO	-0-	-0-	-0-	-0-	1	-0-	-0-	BBI	BHUBANESWAR, INDIA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	NO	-0-
11/15/1986	21	2	18:30:00	MULT ENG-BIRDS	200	TAKEOFF	-0-	-0-	-0-	DARK	-0-	NONE	NO	NO	ROCK DOVE	2P1	1	14.	ORD-CLT	ORD	CHICAGO, IL	YES	JT8D	15	A,G	2	NONE	-0-	NONE	NO	-0-
11/15/1986	21	1	18:30:00	MULT ENG-BIRDS	200	TAKEOFF	-0-	-0-	-0-	DARK	-0-	NONE	NO	NO	ROCK DOVE	2P1	2	14.	ORD-CLT	ORD	CHICAGO, IL	YES	JT8D	15	A,C,E,G	2	NONE	-0-	NONE	NO	-0-
11/15/1986	22	2	-0-	NONE	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	-0-	-0-	-0-	CNS	CAIRNS, QLD.,AUSTRALIA	NO	CFM56	3	A,C,H	3	NONE	-0-	NONE	NO	-0-
11/15/1986	23	2	-0-	NONE	300	LANDING	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	GRAY-HEADED LAPWING	5N20	1	7.	-0-	AMS	AMSTERDAM, NETHERLANDS	NO	CFM56	3		-0-	NONE	-0-	NONE	NO	-0-
11/18/1986	24	2	-0-	NONE	300	TAKEOFF	-0-	-0-	-0-	-0-	-0-	ATB	-0-	-0-	-0-	-0-	-0-	-0-	-0-	DFW	DALLAS/FT WORTH, TEX	YES	CFM56	3	A,H	3	NONE	5.0	IDLE	NO	-0-
11/20/1986	25	1	15:51:00	NONE	200	TAKEOFF	0	120	VFR	LIGHT	CLEAR	NONE	NO	NO	-0-	-0-	1	-0-	LIH-HNL	LIH	LIHUE, KAUAI, HAWAII	YES	JT8D	9A	A,B,C	3	NONE	-0-	NONE	NO	SMALL BIRD
11/22/1986	26	1	23:08:00	NONE	200	APPROACH	500	-0-	-0-	DARK	CLEAR	NONE	-0-	SEVERAL	-0-	-0-	1	-0-	KUL-ARD	ARD	KEDAH, MALAYSIA	NO	JT8D	15	A,D,H	2	NONE	-0-	NONE	NO	-0-
11/23/1986	27	1	-0-	MULT ENG	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	LHE	LAHORE, PAKISTAN	NO	CFM56	3	A	4	NONE	-0-	NONE	NO	-0-
11/23/1986	27	2	-0-	MULT ENG	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	1	-0-	-0-	LHE	LAHORE, PAKISTAN	NO	CFM56	3	A	4	NONE	-0-	NONE	NO	-0-
11/23/1986	28	1	13:00:00	NONE	300	TAKEOFF	-0-	-0-	-0-	LIGHT	CLEAR	NONE	-0-	-0-	-0-	-0-	-0	-0-	-0-	HOU	HOUSTON, TEX	YES	CFM56	3	A,B,H	3	NONE	HIGH	NONE	NO	-0-
11/24/1986	300	2	-0-	MULT ENG	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-WLG	XFO	WELLINGTON, NEW ZEALAND	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	ODOR
11/24/1986	300	1	-0-	MULT ENG	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-WLG	XFO	WELLINGTON, NEW ZEALAND	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	ODOR
11/26/1986	29	1	15:50:00	NONE	200	TAKEOFF	0	-0-	VFR	LIGHT	CLEAR	OTHER	NO	NO	BLACK WINGED PLOVER	5N10	1	6.	LLW-BLZ	LLW	LILONGWE, MALAWI	NO	JT8D	17A	A,D,G	2	NONE	-0-	NONE	NO	ODOR IN CABIN
11/26/1986	30	2	19:30:00	NONE	200	TAKEOFF	0	-0-	-0-	DARK	-0-	-0-	-0-	YES	RING BILLED GULL	14N12	1	16.	LGA-CLE	LGA	NEW YORK, NY	YES	JT8D	7	A,C,G	2	NONE	-0-	NONE	NO	-0-

EDATE	EVT#	ENG_POS	ETIME	SIGN_EVT	AIRCRAFT	POF	ALTITUDE	SPEED	FL_RULES	LT_CONDS	WEATHER	CREW_AC	CREW_AL	BIRD SEE	BIRD NAM	BIRD SPE	# BIRDS	WT_OZ_1	CTY PRS	AIRPORT	LOCALE	US INCID	ENGINE	DASH	DMG_CODE	SEVERITY	POW LOSS	MAX_VIBE	THROTTLE	IFSD	REMARKS
03/10/1987	50	1	-0-	NONE	300	LANDING	-0-	-0-	-0-	-0-	OVERCAST	NONE	-0-	-0-	SHORE (HORNED) LARK	17Z74	1	1.5	-0-	PEK	BEIJING, CHINA	NO	CFM56	3		-0-	NONE	-0-	NONE	NO	-0-
03/11/1987	358	1	-0-	NONE	200	LANDING	100	124	-0-	-0-	-0-	-0-	-0-	NO	-0-	-0-	-0-	-0-	DEN-OAK	OAK	SAN FRANCISCO, CA-OAKLAND	YES	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
03/12/1987	359	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	XFO	-0-	NO	JT8D	17A	A,C	3	-0-	-0-	-0-	-0-	-0-
03/13/1987	63	2	13:20:00	NONE	200	TAKEOFF	50	125	VFR	DAY	CLEAR	NONE	NO	SEVERAL	-0-	-0-	1	-0-	LIH-HNL	LIH	LIHUE, KAUAI, HAWAII	YES	JT8D	9A		-0-	NONE	-0-	NONE	NO	MEDIUM BIRD
03/16/1987	87	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	IXB	BAGDOGRA, INDIA	NO	JT8D	-0-	A,H	3	-0-	-0-	-0-	NO	-0-
03/17/1987	64	1	7:45:00	NONE	200	UNKNOWN	400	-0-	VFR	-0-	-0-	NONE	-0-	NO	BLACK-HEADED GULL	14N36	1	10.	BAH-DHA	XFO	SAUDI-ARABIA	NO	JT8D	15	A,D,H	2	NONE	-0-	NONE	NO	-0-
03/18/1987	88	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	JAI	JAIPUR, INDIA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	NO	-0-
03/19/1987	51	1	-0-	NONE	300	APPROACH	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	-0-	-0-	-0-	SYD	SIDNEY, NSW, AUSTRALIA	NO	CFM56	3		-0-	NONE	-0-	NONE	NO	-0-
03/21/1987	52	1	13:50:00	NONE	300	LANDING	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	-0-	-0-	-0-	ZRH	ZURICH, SWITZERLAND	NO	CFM56	3	A,H	3	NONE	-0-	NONE	NO	-0-
03/21/1987	53	1	19:00:00	NONE	300	TAKEOFF	1200	150	IFR	-0-	CLEAR	ATB	-0-	-0-	DUCK OR GOOSE*	-0-	-0-	-0-	-0-	MSP	MINN./ST. PAUL, MINN	YES	CFM56	3	A,H	3	NONE	4.0	IDLE	NO	-0-
03/21/1987	65	1	15:00:00	NONE	200	TAKEOFF	0	150	-0-	-0-	CLEAR	ATB	-0-	NO	GULL*	-0-	-0-	-0-	PIE-YYZ	PIE	ST. PETERSBURG, FL	YES	JT8D	9A	A,G	2	NONE	-0-	-0-	NO	-0-
03/21/1987	89	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	PAT	PATNA, INDIA	NO	JT8D	17	A,H	3	-0-	-0-	-0-	NO	-0-
03/21/1987	90	2	-0-	MULT BIRDS	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-2	-0-	-0-	XFO	-0-	NO	JT8D	-0-		-0-	-0-	-0-	-0-	NO	-0-
03/23/1987	54	1	-0-	NONE	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	-0-	-0-	-0-	UET	QUETTA, PAKISTAN	NO	CFM56	3	A,D,E	2	NONE	-0-	NONE	NO	-0-
03/25/1987	307	2	-0-	NONE	200	TAKEOFF	0	120	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	MMY-OKA	MMY	MIYAKO JIMA, JAPAN	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
03/26/1987	66	1	18:35:00	INV POW LOSS	200	TAKEOFF	0	139	-0-	-0-	RAIN	ATB	-0-	YES	SPOTTED THICK-KNEE	9M4	1	15.	JNB-DUR	JNB	JOHANNESBURG, SOUTH AFRICA	NO	JT8D	17A	A,C	3	COMPRESSOR	HIGH	CUTOFF	INVLNTRY	-0-
03/26/1987	67	1	-0-	NONE	200	LANDING	0	80	-0-	-0-	CLEAR	-0-	-0-	NO	-0-	-0-	1	-0-	JNB-WDH	WDH	NAMIBIA, S.W. AFRICA	NO	JT8D	17A	A,C	3	NONE	-0-	NONE	NO	-0-
03/27/1987	91	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	XFO	-0-	NO	JT8D	-0-		-0-	-0-	-0-	-0-	NO	-0-
03/28/1987	55	2	-0-	NONE	300	TAKEOFF	1000	-0-	VFR	-0-	CLEAR	NONE	-0-	-0-	-0-	-0-	-0-	-0-	FLL-PHL	FLL	FT.LAUDERDALE/HOLLYWOOD,FL	YES	CFM56	3	A,D	2	NONE	-0-	NONE	NO	-0-
03/29/1987	92	2	-0-	NONE	200	TAKEOFF	0	145	-0-	-0-	-0-	ATB	-0-	-0-	-0-	-0-	1	-0-	-0-	AKL	AUCKLAND, NEW ZEALAND	NO	JT8D	15	A,D,H	2	-0-	-0-	-0-	NO	-0-
03/29/1987	243	2	12:47:00	NONE	200	LANDING	0	114	-0-	-0-	SCATTERED	-0-	NO	ONE	-0-	-0-	1	-0-	-0-	XFO	GERMANY	NO	JT8D	-0-		-0-	-0-	-0-	-0-	NO	-0-
03/29/1987	360	-0-	-0-	NONE	200	LANDING	0	114	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	NCE	NICE, FRANCE	NO	JT8D	15		-0-	-0-	-0-	-0-	-0-	-0-
03/30/1987	56	1	-0-	NONE	300	TAKEOFF	-0-	-0-	-0-	-0-	-0-	ATB	-0-	-0-	-0-	-0-	-0-	-0-	-0-	DEN	DENVER, COL	YES	CFM56	3	A,H	3	NONE	-0-	NONE	NO	-0-
03/30/1987	308	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-AKL	XFO	AUCKLAND, NEW ZEALAND	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
03/31/1987	425	2	-0-	NONE	200	TAKEOFF	-0-	-0-	-0-	-0-	-0-	ATO	-0-	-0-	-0-	-0-	-0-	-0-	-0-	XUS	-0-	YES	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
04/01/1987	68	2	14:10:00	MULT BIRDS	200	TAKEOFF	0	90	-0-	-0-	CLEAR	ATO	-0-	FLOCK	SWALLOW*	-0-	-2	-0-	PLZ-LON	PLZ	PORT ELIZABETH, S. AFRICA	NO	JT8D	17A		-0-	COMPRESSOR	-0-	IDLE	NO	-0-
04/03/1987	244	2	9:00:00	NONE	200	TAXI	0	40	-0-	-0-	SCATTERED	-0-	-0-	SEVERAL	-0-	-0-	1	-0-	-0-	FRA	FRANKFURT, GERMANY	NO	JT8D	-0-		-0-	-0-	-0-	-0-	NO	SMALL BIRD
04/03/1987	309	-0-	-0-	NONE	200	TAKEOFF	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	CHC	CHRISTCHURCH, NEW ZEALAND	NO	JT8D	-0-		-0-	-0-	0	-0-	-0-	-0-
04/05/1987	245	2	23:59:00	NONE	200	CLIMB	10	140	-0-	-0-	SCATTERED	-0-	NO	YES	-0-	-0-	-0-	-0-	-0-	KCH	KUCHING, MALAYSIA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
04/07/1987	93	2	-0-	NONE	200	LANDING	0	90	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	CCU	CALCUTTA, INDIA	NO	JT8D	17		-0-	-0-	-0-	-0-	NO	-0-
04/07/1987	361	-0-	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	XFO	ZAIRE	NO	JT8D	15	A,C	3	-0-	-0-	-0-	-0-	-0-
04/09/1987	106	1	19:40:00	NONE	300	TAKEOFF	0	-V1	-0-	-0-	CLEAR	DIV	-0-	-0-	-0-	-0-	-0-	-0-	-0-	CPH	COPENHAGEN, DENMARK	NO	CFM56	3	A,H	3	NONE	3.9	-0-	NO	-0-
04/11/1987	107	1	22:30:00	NONE	300	CLIMB	600	160	IFR	DARK	CLEAR	NONE	-0-	-0-	-0-	-0-	-0-	-0-	SYD-MEL	SYD	SYDNEY, NSW, AUSTRALIA	NO	CFM56	3	A,C	3	NONE	-0-	-0-	NO	-0-
04/12/1987	246	2	-0-	MULT BIRDS	200	APPROACH	100	140	-0-	-0-	SCATTERED	-0-	YES	SEVERAL	-0-	-0-	2	-0-	-0-	ZTH	ZAKINTHOS, GREECE	NO	JT8D	-0-		-0-	-0-	-0-	-0-	NO	-0-
04/14/1987	108	1	-0-	NONE	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	-0-	-0-	-0-	FRA	FRANKFURT, GERMANY	NO	CFM56	3		-0-	NONE	-0-	-0-	NO	-0-
04/17/1987	109	2	-0-	NONE	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	AMERICAN KESTREL	5K26	1	4.	-0-	DAL	DALLAS/FT.WORTH,TEX-LOVE	YES	CFM56	3		-0-	NONE	-0-	-0-	NO	-0-
04/21/1987	70	1	-0-	NONE	200	TAKEOFF	0	130	-0-	-0-	-0-	ATB	-0-	-0-	ROCK DOVE	2P1	1	14.	-0-	XFO	-0-	NO	JT8D	17A	A,G	2	COMPRESSOR	-0-	-0-	-0-	-0-
04/22/1987	247	-0-	8:03:00	NONE	200	CLIMB	-0-	210	-0-	-0-	CLEAR	-0-	NO	NO	-0-	-0-	1	-0-	-0-	PEN	PENANG, MALAYSIA	NO	JT8D	-0-	A,C	3	-0-	-0-	-0-	NO	-0-
04/23/1987	248	2	10:38:00	NONE	200	TAKEOFF	0	110	-0-	-0-	CLEAR	-0-	NO	YES	-0-	-0-	1	-0-	-0-	MAN	MANCHESTER, ENGLAND	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	SMALL BIRD
04/26/1987	310	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-CHC	XFO	CHRISTCHURCH, NEW ZEALAND	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
04/26/1987	311	2	-0-	NONE	200	TAKEOFF	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	WLG-DUD	WLG	WELLINGTON, NEW ZEALAND	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	ODOR
05/01/1987	312	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-AKL	XFO	AUCKLAND, NEW ZEALAND	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
05/01/1987	362	-0-	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	XFO	NIGERIA	NO	JT8D	15A	A,G	2	-0-	-0-	-0-	-0-	-0-
05/03/1987	69	2	-0-	NONE	200	TAKEOFF	0	150	-0-	-0-	-0-	ATB	-0-	-0-	-0-	-0-	-0-	-0-	PIE-YYZ	PIE	ST. PETERSBURG, FL	YES	JT8D	9A		-0-	COMPRESSOR	-0-	NONE	NO	-0-
05/04/1987	110	1	18:38:00	NONE	300	TAKEOFF	-0-	+V1	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	SAT-HOU	SAT	SAN ANTONIO, TEX	YES	CFM56	3		-0-	NONE	-0-	-0-	NO	-0-
05/10/1987	94	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	JRH	JORHAT, INDIA	NO	JT8D	-0-	A,H	3	-0-	-0-	-0-	NO	-0-
05/10/1987	111	2	22:00:00	NONE	300	TAKEOFF	-0-	-0-	-0-	-0-	RAIN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	LIT-HOU	LIT	LITTLE ROCK, ARK	YES	CFM56	3		-0-	NONE	-0-	-0-	NO	-0-
05/12/1987	95	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	BOM	BOMBAY, INDIA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	NO	-0-
05/12/1987	363	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	XFO	ENGLAND	NO	JT8D	15A	A,C	3	-0-	-0-	-0-	-0-	3 FAN BLADES DAMAGED
05/16/1987	364	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	XFO	-0-	NO	JT8D	15	A,C	3	-0-	-0-	-0-	-0-	-0-
05/17/1987	313	2	-0-	NONE	200	LANDING	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	CHC	CHRISTCHURCH, NEW ZEALAND	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	LARGE BIRD
05/18/1987	249	1	13:40:00	MULT BIRDS	200	APPROACH	300	140	-0-	-0-	SCATTERED	-0-	NO	YES	-0-	-0-	2	-0-	-0-	LHR	LONDON, ENGLAND-HEATHROW	NO	JT8D	15		-0-	-0-	-0-	-0-	-0-	-0-
05/20/1987	250	2	8:17:00	MULT BIRDS	200	TAKEOFF	0	100	-0-	-0-	CLEAR	-0-	-0-	SEVERAL	-0-	-0-	2	-0-	-0-	AOR	ALOR SETAR, MALAYSIA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
05/22/1987	96	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	BLR	BANGALORE, INDIA	NO	JT8D	-0-	A,H	3	-0-	-0-	-0-	NO	-0-
05/22/1987	97	1	-0-	NONE	200	TAKEOFF	0	85	-0-	-0-	-0-	ATO	-0-	-0-	-0-	-0-	1	-0-	-0-	VNS	VARANASI, INDIA	NO	JT8D	-0-		-0-	COMPRESSOR	-0-	-0-	NO	POWER LOSS
05/22/1987	98	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	XFO	-0-	NO	JT8D	-0-		-0-	-0-	-0-	-0-	NO	-0-
05/24/1987	99	1	7:35:00	TRVS FRAC	200	TAKEOFF	0	140	VFR	-0-	-0-	ATB	-0-	YES	CATTLE EGRET	1135	1	16.	-0-	LOS	LAGOS, NIGERIA	NO	JT8D	15	A,I	1	COMPRESSOR	-0-	-0-	INVLNTRY	-0-
05/24/1987	251	2	6:30:00	NONE	200	LANDING	0	90	-0-	-0-	SCATTERED	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	ELS	EAST LONDON, SOUTH AFRICA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	NO	LARGE BIRD

EDATE	EVT#	ENG POS	ETIME	SIGN EVT	AIRCRAFT	POF	ALTITUDE	SPEED	FL RULES	LT CONDS	WEATHER	CREW AC	CREW AL	BIRD SEE	BIRD NAM	BIRD SPE	# BIRDS	WT OZ 1	CTY PRS	AIRPORT	LOCALE	US INCID	ENGINE	DASH	DMG CODE	SEVERITY	POW LOSS	MAX VIBE	THROTTLE	IFSD	REMARKS
07/26/1987	124	2	9:00:00	AIRWRTHY	200	TAKEOFF	100	150	VFR	-0-	-0-	ATB	-0-	-0-	GLAUCOUS-WINGED GULL	14N22	1	40.	YYZ-YQG	YYZ	TORONTO, ONT., CANADA	NO	JT8D	9A	A,B,G,H	2	COMPRESSOR	YES	-0-	YES	METAL IN TAILPIPE,9th STAGE BLADE DAMAGE
07/26/1987	141	2	-0-	NONE	300	LANDING	0	80	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-DUS	DUS	DUSSELDORF, GERMANY	NO	CFM56	3		-0-	NONE	-0-	-0-	NO	-0-
07/26/1987	266	1	20:37:00	NONE	200	TAKEOFF	-0-	140	-0-	-0-	CLEAR	-0-	NO	YES	-0-	-0-	1	-0-	-0-	XFO	ITALY	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
07/27/1987	321	1	-0-	NONE	200	TAKEOFF	-0-	130	-0-	-0-	-0-	ATO	-0-	-0-	-0-	-0-	-0-	-0-	-0-	XFO	-0-	NO	JT8D	-0-	A,G,H	2	-0-	-0-	-0-	-0-	EPR SYMPTOM
07/29/1987	126	1	17:45:00	NONE	200	TAKEOFF	0	70	-0-	-0-	-0-	-0-	-0-	YES	SPOTTED DOVE	2P65	1	6.	ITO-HNL	ITO	HILO, HAWAII	YES	JT8D	9A		-0-	-0-	-0-	-0-	NO	STRONG ODOR IN CABIN
07/29/1987	142	1	-0-	NONE	300	TAKEOFF	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	AMS-	AMS	AMSTERDAM, NETHERLANDS	NO	CFM56	3		-0-	NONE	-0-	-0-	NO	-0-
07/29/1987	368	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	XUS	-0-	YES	JT8D	7	A,C	3	-0-	-0-	-0-	-0-	-0-
07/30/1987	127	1	4:55:00	AIRWRTHY	200	TAKEOFF	0	130	VFR	-0-	CLEAR	ATO	-0-	-0-	-0-	-0-	-0-	-0-	TXL-BRE	TXL	BERLIN, WEST GERMANY	NO	JT8D	15A	A,C,G,K	1	EPR DEC	-0-	CUTOFF	EPR	FAN CHANGE,ENG SHUTDOWN ON TAXI,COMP DAM
07/30/1987	322	-0-	-0-	NONE	200	TAKEOFF	0	100	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	ISG-OKA	ISG	ISHIGAKI, JAPAN	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
07/31/1987	143	1	-0-	NONE	300	LANDING	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	1	-0-	HRL-HOU	HOU	HOUSTON, TEX	YES	CFM56	3		-0-	NONE	-0-	-0-	NO	STRONG ODOR IN CABIN
07/31/1987	144	1	9:55:00	MULT BIRDS	300	TAKEOFF	500	+V1	VFR	BRIGHT	OVERCAST	ATB	-0-	NO	-0-	-0-	2	-0-	-0-	ADL	ADELAIDE, S. AUSTRALIA	NO	CFM56	3	A,B,D,H	2	-0-	-0-	RETARD	NO	-0-
08/03/1987	128	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	-0-	XFO	JOHANNESBURG, SOUTH AFRICA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
08/03/1987	129	2	-0-	NONE	200	TAKEOFF	0	90	VFR	DAY	PARTLY CLOUD	ATO	NO	YES	-0-	-0-	1	-0-	RAP-FSD	RAP	RAPID CITY, S. DAK	YES	JT8D	9		-0-	COMPRESSOR	-0-	-0-	-0-	#2 ENGINE STALLED AT 80 KTS, PM EVENT
08/03/1987	205	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-YYZ	XFO	TORONTO, ONT., CANADA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
08/03/1987	267	2	9:22:00	MULT BIRDS	200	LANDING	0	-0-	-0-	-0-	BELOW CLOUDS	-0-	-0-	SEVERAL	GULL*	-0-	-2	10.	MUC-ZRH	ZRH	ZURICH, SWITZERLAND	NO	JT8D	15		-0-	-0-	-0-	-0-	NO	-0-
08/03/1987	369	-0-	-0-	NONE	200	APPROACH	1000	140	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	XRY	JEREZ DELA FRONTERA, SPAIN	NO	JT8D	15		-0-	-0-	-0-	-0-	-0-	-0-
08/04/1987	206	1	-0-	NONE	200	TAKEOFF	-0-	-0-	-0-	-0-	-0-	ATO	-0-	-0-	-0-	-0-	-0-	-0-	YAM-YYZ	YAM	SAULT STE. MARIE, CANADA	NO	JT8D	9A		-0-	-0-	-0-	-0-	-0-	TIRE FAILURE
08/04/1987	323	2	-0-	NONE	200	TAKEOFF	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	WLG-DUD	WLG	WELLINGTON, NEW ZEALAND	NO	JT8D	-0-	A,C	3	-0-	-0-	-0-	-0-	-0-
08/05/1987	145	1	-0-	NONE	300	LANDING	-0-	-0-	-0-	DUSK	OVERCAST	NONE	-0-	-0-	GULL*	-0-	-0-	-0-	-BRS	BRS	BRISTOL, ENGLAND	NO	CFM56	3	A,H	3	NONE	3.5	-0-	NO	EVENT OCCURRED IN PM
08/05/1987	146	1	-0-	MULT ENG	300	LANDING	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	1	-0-	-IBZ	IBZ	IBIZA, SPAIN	NO	CFM56	3	A,H	3	NONE	2.2	-0-	NO	-0-
08/05/1987	146	2	-0-	MULT ENG	300	LANDING	-0-	-0-	-0-	-0-	-0-	NONE	-0-	-0-	-0-	-0-	1	-0-	-IBZ	IBZ	IBIZA, SPAIN	NO	CFM56	3	A,H	3	NONE	-0-	-0-	NO	-0-
08/05/1987	207	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-YVR	XFO	VANCOUVER, B.C., CANADA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
08/05/1987	370	-0-	-0-	NONE	200	TAKEOFF	0	130	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	FRA	FRANKFURT, GERMANY	NO	JT8D	15		-0-	-0-	-0-	-0-	-0-	-0-
08/06/1987	147	1	-0-	NONE	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-AMS	XFO	AMSTERDAM, NETHERLANDS	NO	CFM56	3	A	4	NONE	-0-	-0-	NO	FOUND ON GRD INSPEC,4FAN BLADES REPLACED
08/13/1987	208	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-YYZ	XFO	TORONTO, ONT., CANADA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
08/15/1987	433	-0-	9:00:00	NONE	300	LANDING	20	135	-0-	-0-	-0-	-0-	-0-	ONE	FALCON*	-0-	-0-	-0-	-0-	TNG	TANGIER, MOROCCO	NO	CFM56	3		-0-	-0-	-0-	-0-	-0-	-0-
08/17/1987	130	2	15:30:00	NONE	200	LANDING	-0-	-0-	-0-	-0-	-0-	-0-	-0-	NO-	-0-	-0-	-0-	-0-	YVR-YYC	YYC	CALGARY, ALTA , CANADA	NO	JT8D	17A	A,H	3	-0-	-0-	-0-	NO	-0-
08/17/1987	148	2	-0-	NONE	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-SNA	XUS	ORANGE COUNTY, CA	YES	CFM56	3	A,C,H	3	NONE	HIGH	-0-	NO	-0-
08/19/1987	131	1	-0-	MULT BIRDS	200	LANDING	0	-0-	VFR	-0-	-0-	-0-	-0-	YES	KILLDEER	5N33	-2	3.	YXJ-YXS	YXS	PRINCE GEORGE,B.C., CANADA	NO	JT8D	15		-0-	-0-	-0-	-0-	NO	MOMENTARY EGT INC OF 70 DEG.C,2-4 BIRDS
08/20/1987	209	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-YLW	XFO	KELOWNA, B.C., CANADA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
08/22/1987	324	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	ISG-OKA	XFO	JAPAN	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
08/22/1987	371	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-BRU	XFO	BRUSSELS, BELGIUM	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
08/22/1987	372	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	GULL*	-0-	-0-	-0-	-FOR	XFO	FORTALEZA, CEARA, BRAZIL	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
08/23/1987	373	2	-0-	NONE	200	TAKEOFF	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	STV	SURAT, INDIA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
08/25/1987	210	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-YEG	XFO	EDMONTON, ALTA., CANADA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
08/26/1987	188	1	8:23:00	TRVS FRAC	200	LANDING	0	-0-	VFR	-0-	SCATTERED	-0-	-0-	YES	-0-	-0-	-0-	-0-	TYO-HAC	HAC	HACHIJO, JAPAN	NO	JT8D	9A	A,C,G,I	1	NONE	-0-	-0-	NO	2,1st STAGE F BLADES WERE FRAC, 2nd DAM
08/26/1987	374	-0-	-0-	NONE	200	TAKEOFF	0	140	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	HAM	HAMBURG, GERMANY	NO	JT8D	15		-0-	-0-	-0-	-0-	-0-	-0-
08/26/1987	451	-0-	-0-	NONE	200	TAKEOFF	0	+V1	-0-	NIGHT	CLEAR	ATO	NO	NO	-0-	-0-	-0-	-0-	-0-	LEX	LEXINGTON, KY	YES	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	PM EVENT, LOUD ENGINE NOISE
08/28/1987	325	1	-0-	NONE	200	TAKEOFF	-0-	-0-	-0-	-0-	-0-	ATO	-0-	-0-	-0-	-0-	-0-	-0-	-0-	OPO	PORTO, PORTUGAL	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
08/29/1987	211	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-YXJ	XFO	FT. ST. JOHN, B.C., CANADA	NO	JT8D	-0-	A,C	3	-0-	-0-	-0-	-0-	-0-
08/29/1987	268	1	-0-	MULT BIRDS	200	TAKEOFF	0	-0-	-0-	-0-	BELOW CLOUDS	-0-	-0-	YES	SWALLOW*	-0-	2	3.	FRA-LNZ	FRA	FRANKFURT, GERMANY	NO	JT8D	15		-0-	-0-	YES	-0-	NO	SYMPTOM - VIBRATION
08/29/1987	326	2	-0-	NONE	200	TAKEOFF	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	PMR-AKL	PMR	PALMERSTON, NEW ZEALAND	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
08/31/1987	149	2	-0-	NONE	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-IAH	XUS	HOUSTON, TEX	YES	CFM56	3		-0-	NONE	-0-	-0-	NO	FOUND DURING GROUND INSPECTION
08/31/1987	150	1	-0-	NONE	300	LANDING	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-KHI	KHI	KARACHI, PAKISTAN	NO	CFM56	3	A	4	NONE	(2	-0-	NO	3 FAN BLADES DAMAGED
08/31/1987	151	2	-0-	NONE	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-PHX	XUS	PHOENIX, ARIZ	YES	CFM56	3	A	4	NONE	-0-	-0-	NO	1 FAN BLADE DAMAGED
08/31/1987	269	1	8:06:00	NONE	200	TAKEOFF	0	-0-	VFR	-0-	-0-	-0-	-0-	ONE	GULL*	-0-	1	-0-	DUS-ZRH	DUS	DUSSELDORF, GERMANY	NO	JT8D	15		-0-	COMPRESSOR	-0-	-0-	NO	-0-
09/01/1987	327	1	-0-	NONE	200	TAKEOFF	-0-	100	-0-	-0-	-0-	-0-	-0-	FLOCK	PIGEON*	-0-	-0-	-0-	-0-	FNC	FUNCHAL, PORTUGAL	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
09/02/1987	328	1	-0-	NONE	200	LANDING	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	1	-0-	MZG-KHH	KHH	KAOHSIUNG, TAIWAN	NO	JT8D	-0-	A,H	3	-0-	-0-	-0-	-0-	3 FAN BLADES SHINGLED
09/03/1987	375	1	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	XFO	ENGLAND	NO	JT8D	9A	A,C	3	-0-	-0-	-0-	-0-	-0-
09/06/1987	132	2	10:15:00	NONE	200	LANDING	0	-0-	VFR	-0-	CLEAR	-0-	-0-	ONE	OSPREY	2K1	1	56.	IAD-MCO	MCO	ORLANDO, FL	YES	JT8D	7	A,K	1	-0-	-0-	-0-	NO	LPC DAMAGED HOWEVER NOT DUE TO BIRD
09/06/1987	152	1	-0-	NONE	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-DUS	XFO	DUSSELDORF, GERMANY	NO	CFM56	3		-0-	NONE	-0-	-0-	NO	FOUND DURING GROUND INSPECTION
09/07/1987	329	1	-0-	NONE	200	LANDING	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	PMR	PALMERSTON, NEW ZEALAND	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
09/08/1987	449	2	-0-	NONE	200	LANDING	35	130	VFR	DAY	CLEAR	-0-	NO	FLOCK	GULL*	-0-	-0-	-0-	-0-	ORF	NORFOLK, VA	YES	JT8D	15		-0-	-0-	-0-	-0-	-0-	AM EVENT
09/09/1987	330	2	-0-	NONE	200	TAKEOFF	-0-	140	-0-	-0-	-0-	ATB	-0-	-0-	-0-	-0-	-0-	-0-	-0-	ORY	PARIS-ORLY, FRANCE	NO	JT8D	-0-		-0-	COMPRESSOR	-0-	-0-	-0-	ODOR
09/10/1987	153	1	-0-	NONE	300	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-MUC	XFO	MUNICH, GERMANY	NO	CFM56	3		-0-	NONE	-0-	-0-	NO	FOUND DURING GROUND INSPRCTION
09/10/1987	434	-0-	6:25:00	NONE	300	TAKEOFF	0	100	-0-	-0-	-0-	-0-	-0-	-0-	BUZZARD OR FALCON*	-0-	-0-	-0-	-0-	FRA	FRANKFURT, GERMANY	NO	CFM56	3		-0-	-0-	-0-	-0-	-0-	-0-
09/12/1987	212	2	-0-	NONE	200	UNKNOWN	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-YYC	XFO	CALGARY, ALTA., CANADA	NO	JT8D	-0-		-0-	-0-	-0-	-0-	-0-	-0-
09/12/1987	270	1	17:40:00	NONE	200	LANDING	0	110	-0-	-0-	BELOW CLOUDS	-0-	NO	YES	HAWK*	-0-	1	-0-	BEG-MUC	MUC	MUNICH, GERMANY	NO	JT8D	15		-0-	-0-	-0-	-0-	NO	MEDIUM BIRD

APPENDIX C

STATISTICAL HYPOTHESIS TESTING

Statistical analyses are based on an underlying probabilistic model of the processes that give rise to the data. For example, to provide the basis for comparing the weights of ingested birds in the United States and overseas it is necessary to hypothesize an underlying random distribution of bird weights. Statistical analyses are somewhat more sophisticated than descriptive data analyses and more care is required to ensure that the methods are appropriate for the data.

Statistical analysis is basically formalized inductive reasoning. Hypotheses about bird ingestion hazards are evaluated for consistency with the data that have been collected. Statistical analysis provides the rules for quantifying the level of consistency forming the basis for objective unbiased decisions. The process is known formally as statistical hypothesis testing, and a brief outline of the procedure is presented here.

The basis of a statistical hypothesis test is the hypothesis, which is a formal statement about a relationship in the data. In comparing the weight distributions of U. S. ingestions versus foreign ingestions, one hypothesis is that there is no difference in the sizes of the birds ingested here versus those ingested overseas. If the data are found to be consistent with the hypothesis it is accepted; otherwise the hypothesis is rejected.

The rules for deciding whether to accept or reject the hypothesis are based on the possible errors that could be made. A type I error refers to the situation in which the hypothesis is true; however we reject the hypothesis. Alternatively, when we accept the hypothesis when it is not true we commit a type II error.

The goal of the statistician is to minimize the likelihood of both types of errors. Unfortunately the likelihood of a type I error is reciprocally linked to the likelihood of a type II error so that lowering the likelihood of a type I error will increase the likelihood of a type II error. Since only one error can be fully controlled, it has become standard practice to control the likelihood of a Type I error, which is called the significance level of the test. The test hypothesis is chosen so that it should be accepted unless there is strong evidence that it is not true, and the test is constructed to minimize the likelihood of a type II error for the given significance level over a broad range of alternatives.

The mechanics of conducting a statistical hypothesis test are implemented by calculating a test statistic. The test statistic is a function of the data that are related to the test hypothesis. It is usually constructed so that small values are consistent with the null hypothesis and large values are consistent with the alternative hypothesis. The cutoff for accepting or rejecting the null hypothesis is called the critical value and is a function of the desired significance level.

Another aspect in evaluating the efficiency of a statistical test is its ability to detect when the test hypothesis is false. This ability is called the power of the test and is defined to be the probability of rejecting the test hypothesis when it is false. Generally there are many alternatives to the test hypothesis so that the power of the test is a function of the specific alternate hypothesis.

A variation on the statistical hypothesis test is the calculation of a confidence interval for a parameter such as the overall probability of ingestion (POI). Since there is no specific hypothesis about the POI, a confidence interval is used to describe the range of probabilities that are consistent with the data. The confidence level associated with a confidence interval corresponds to one minus the significance level of a hypothesis test and is a measure of the likelihood that the true value of the parameter (in this case the POI) is contained in the interval.