DOT/FAA/CT-82/144

A Study of Bird Ingestions into Large High Bypass Ratio Turbine Aircraft Engines

Gary Frings

March 1983

Interim Report

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Federal Aviation Administration
Technical Center
Atlantic City Airport, N.J. 08405

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In order to acquire the data contained herein, contracts were awarded by the FAA Technical Center to the Pratt and Whitney Aircraft Group, General Electric Company and Rolls-Royce, Incorporated.

16. Abstract

A 1-year study has been conducted to document the numbers, weights, and species of birds being ingested into large high bypass ratio aircraft turbine engines. This study will continue into a second year. This interim report presents the findings to date.

17. Key Words		18. Distribution Statement
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TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

OBJECTIVE.

The purpose of this investigation is to determine the numbers, weight, and species of birds which are ingested into large high bypass ratio turbine aircraft engines during service operation on a worldwide basis and what damage, if any, resulted. This validated data base will be used to determine if amendment of existing standards is warranted.

BACKGROUND.

National Transportation Safety Board (NTSB) Recommendation A-76-64 was issued April 1, 1976, as a result of an aircraft accident involving a rejected takeoff after "a number of large birds" were ingested into one of the engines. This recommendation stated in part.

> "Amend 14 CFR 33.77 to increase the maximum number of birds in the various size categories required to be ingested into turbine engines with large inlets. These increased numbers and sizes should be consistent with the birds ingested during service experience of these engines." (Class III - Longer Term Follow-up)

In response to the Safety Board's subsequent inquiry of July 30, 1980, the FAA on October 30, 1980, summarized the status of the work addressing the recommendation made by NTSB. The FAA had made several examinations of NTSB, FAA, and industry engine records to determine the numbers and weights of birds being ingested into turbine engines with large inlets. These engines entered airline service early in 1969. A study of available records was also made by an Ad-Hoc Committee of the Aerospace Industries Association of America, Inc., in 1978. All of these industry and government efforts show available records do not provide the information necessary to enable FAA to make a decision concerning revision of the weights and numbers of birds required to be ingested for engine type certification.

The FAA acknowledged the need for better data relating to the number and weights of birds being ingested in service operation. Because normal reporting activity was not providing sufficient information of this kind, the FAA initiated a special project at the FAA Technical Center. This project is limited to engine bird ingestions being encountered on high bypass ratio turbine aircraft engines during worldwide service operations.

Completeness of the data and the reliability of data sources are major considerations of any effort. In order to achieve the desired valid data base, the FAA Technical Center deemed the following elements essential:

- o Worldwide consideration of data
- o Familiarity with the engine design criteria
- o Proven expertise and prior experience on engine foreign object ingestion interpretation
- o Standardized reporting
- o Minimum impact on the operational fleet
- o Proven expertise in bird identification
- o Airline cooperation and understanding of need

flight, and domestic/foreign operations. To validate the accuracy of the OAG operational data, engine manufacturer's data were obtained as a cross-check. Their operational count was 5.7 percent higher (69,000 operations) than the OAG data. Further analysis revealed that 57,000 of these operations pertained to the type 1 aircraft which is extensively utilized for freighter operations and, therefore, not always included in OAG data. The operational data reported in this study reflect these increased operations. Approximately 1.2 million operations occurred during the study period. Aircraft type 1 had 411,000 operations; aircraft type 2 had 316,000 operations; aircraft type 3 had 263,000 operations; and type 4 had 214,000 operations (figure 1b). These data were used in the analysis section of this report to construct ingestion rates.

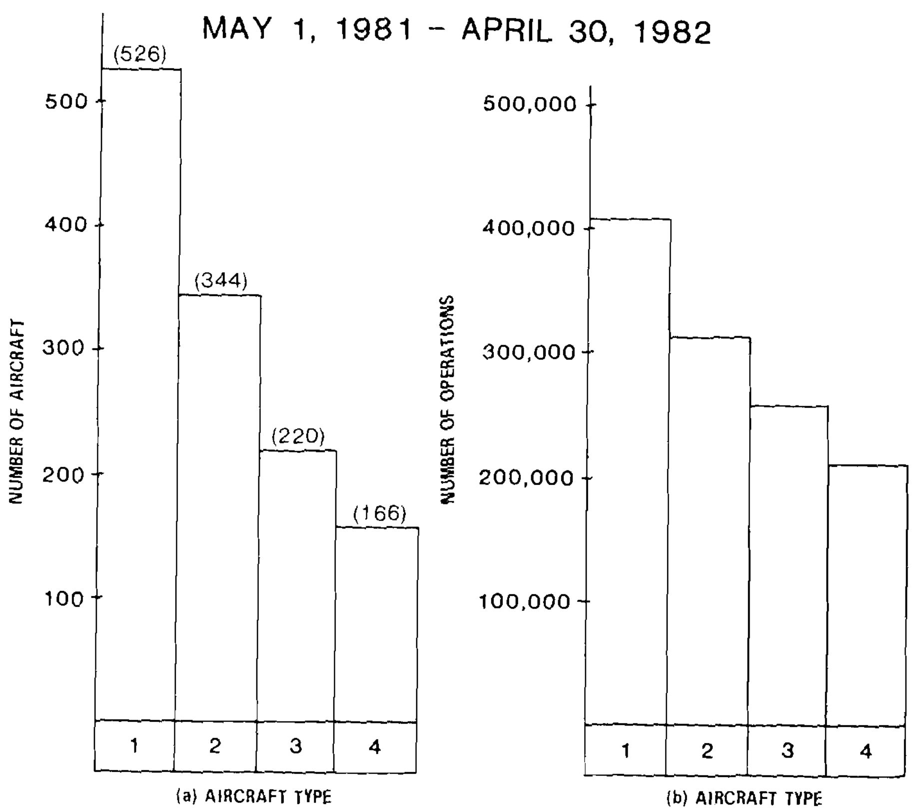


FIGURE 1. EXPOSURE CRITERIA

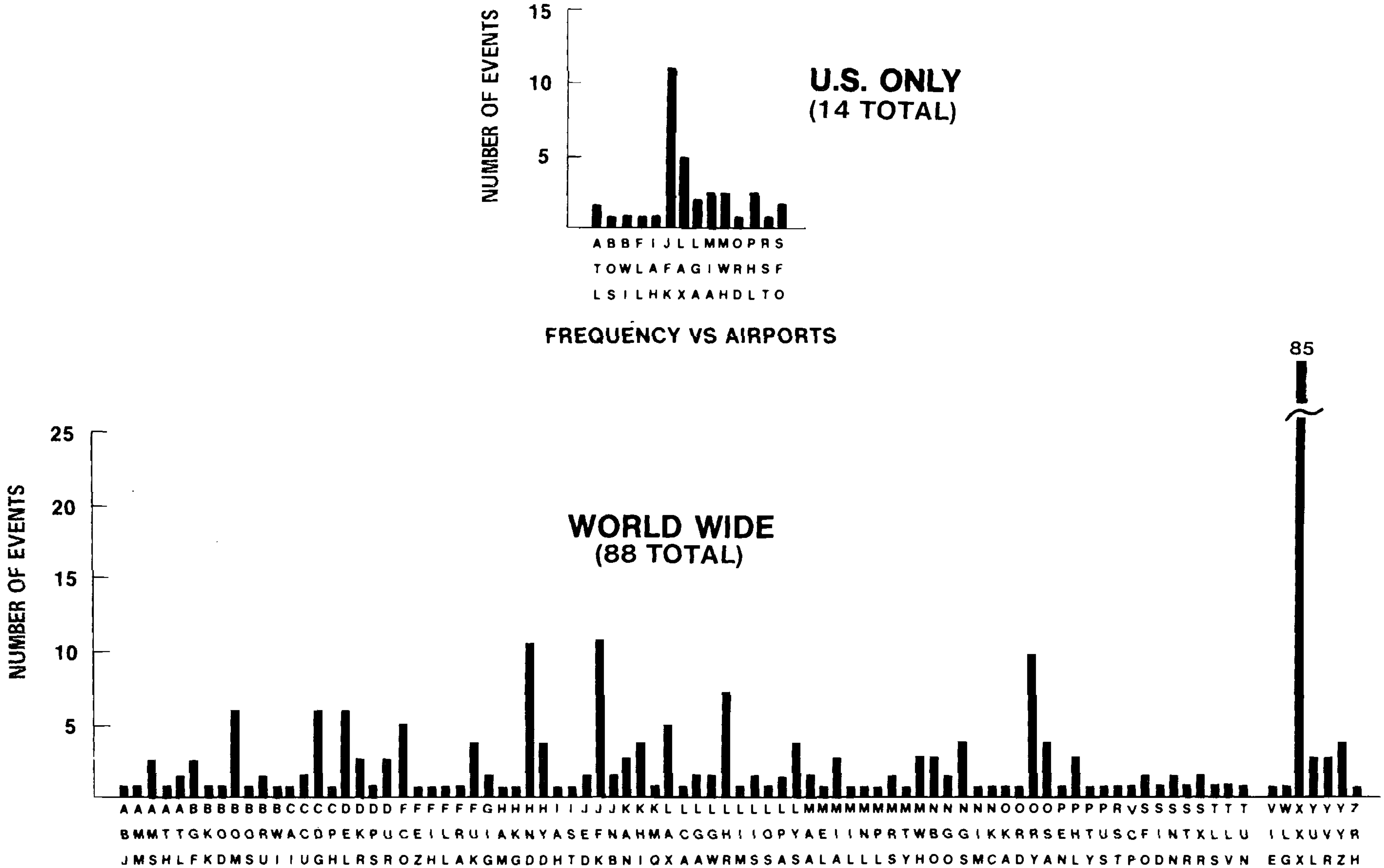


FIGURE 2. FREQUENCY VERSUS AIRPORTS

of the species but also sex and whether the bird was mature or immature. This information, together with location of strike and time of year, allows the ornithologist to determine a range of weights for the bird(s). The bird weights reported in this study are the midpoints of the range of weights as reported by the ornithologist.

TABLE 3. ONE YEAR WORLDWIDE BIRD INGESTION SUMMARY

Events	289
Aircraft #1	119
Aircraft #2	54
Aircraft #3	41
Aircraft #4	75
Engine Model #1	87
Engine Model #2	146
Engine Model #3	56
Ingestion with Damage	188
Bird Weights	145
Multiple Engine	11
Multiple Birds Per Engine	13

Figure 3 depicts the bird ingestion events by month for the first year for all aircraft types. Although there appears to be a considerable increase in the number of engine bird ingestions in the late summer and early fall, it is too early to determine the cause of these increases (increased aircraft operations, bird migration habits, etc.).

Figures 4 through 7 present the same information by aircraft type, while figures 8, 9, and 10 present the information by engine model. Except for minor perturbations, the trend is similar for all the figures.

A necessary step in understanding the engine bird ingestion phenomena is to compare the ingestions of the four aircraft types. In doing so, one must address the problem in terms of rates since the number of ingestions and operations varies considerably among the aircraft types. The resultant ingestion rates do not take into account such influential factors as: number of engines and their location, route structure, operational procedures, and other factors. The number of bird ingestions per 10,000 operations is a convenient number which has been utilized by the industry to make this comparison. Using the total number of operations for each aircraft type, as shown in figure 1b, and the total number of bird ingestions occurring on each aircraft type, as shown in figures 4 through 7, the engine bird ingestion rate per 10,000 operations was constructed for each aircraft type. Figure 11 graphically depicts the results. The worldwide rates are 2.9, 1.7, 1.6 and 3.5 for aircraft types 1 through 4, respectively. The worldwide average ingestion rate considering all aircraft types as a unit is 2.4. It is outside the scope of this interim report to attempt a qualitative explanation of these variations in rates.

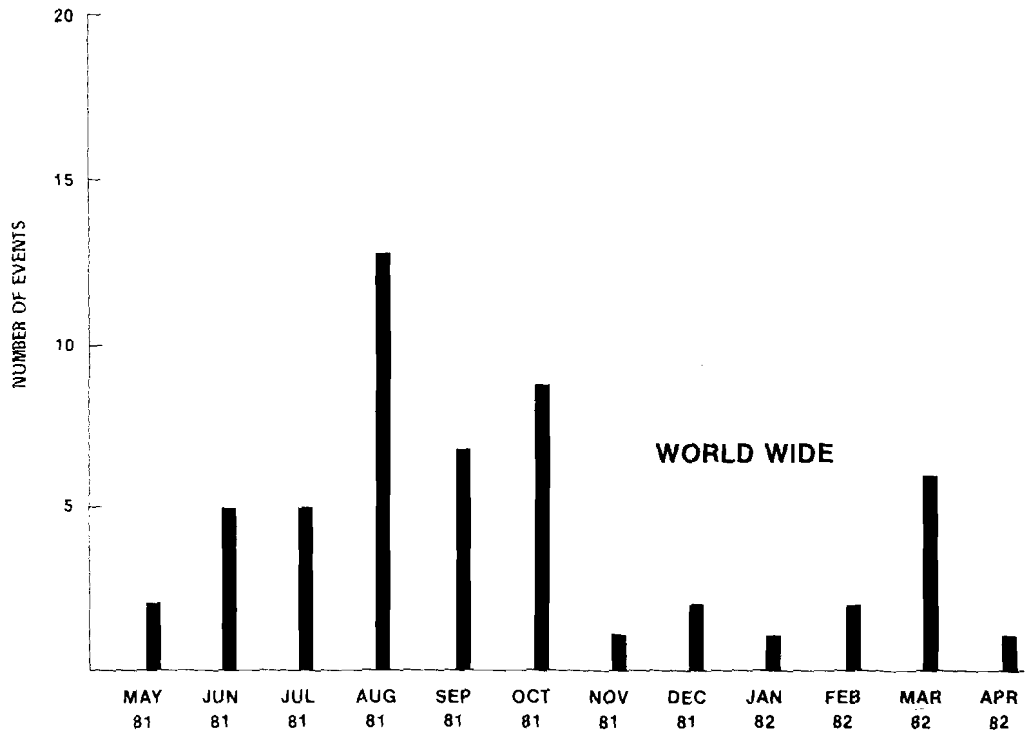


FIGURE 5. FREQUENCY BY MONTH FOR AIRCRAFT 2

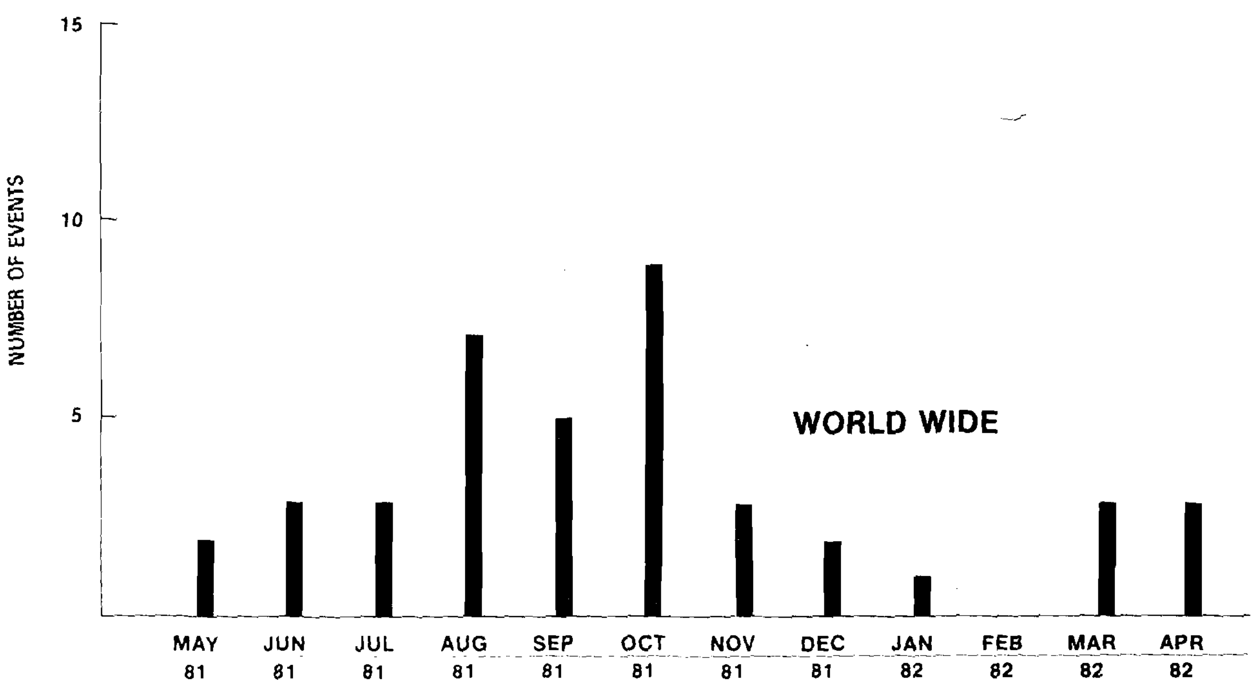


FIGURE 6. FREQUENCY BY MONTH FOR AIRCRAFT 3

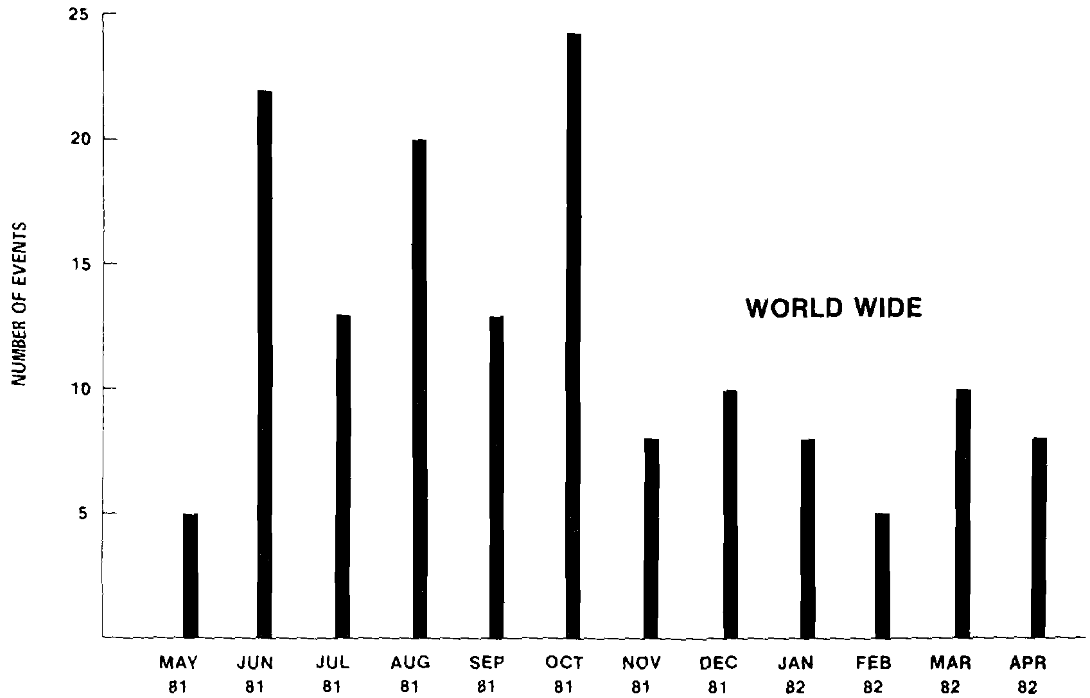


FIGURE 9. FREQUENCY BY MONTH FOR ENGINE MODEL 2

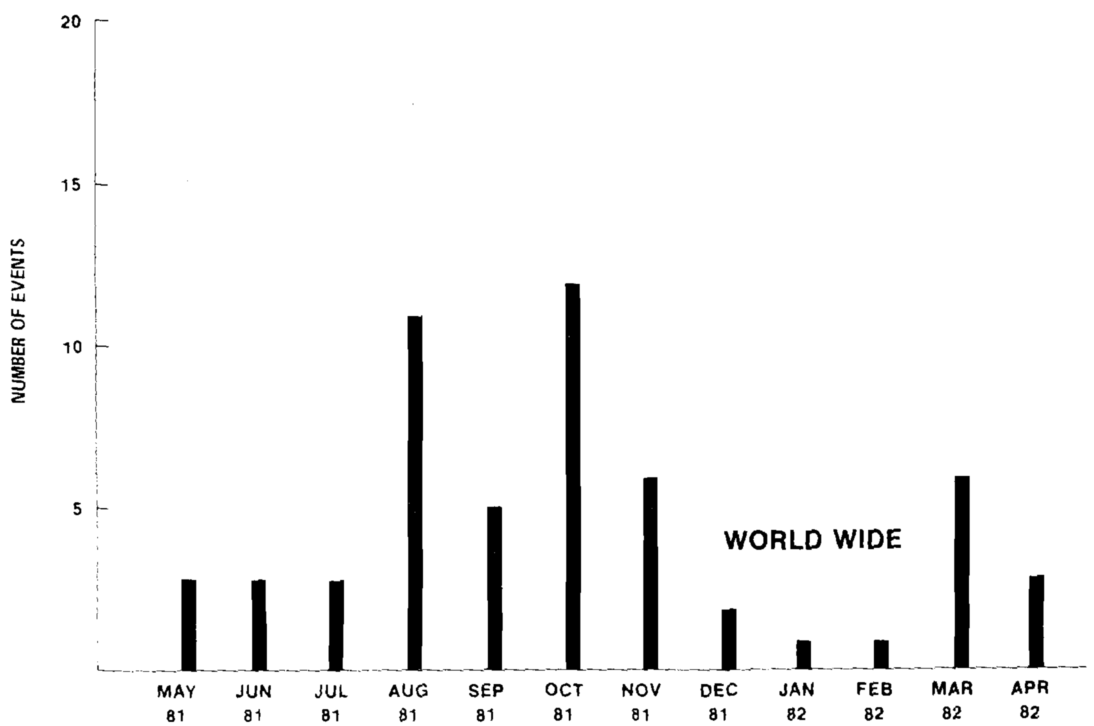


FIGURE 10. FREQUENCY BY MONTH FOR ENGINE MODEL 3

It is important to understand during what portion of a typical flight a bird ingestion is likely to occur. Of the 289 events which were studied during the first year, 43 percent of the ingestions occurred during the takeoff and climb phase of flight, while 28 percent occurred during the aproach and landing phases. With few exceptions, such as descent and taxi, the remaining phases of flight (approximately 25 percent) were unknown. This is again attributable to those cases which were discovered during maintenance or post/preflight inspections.

Figure 12 graphically depicts the phases of flight where the ingestions occurred. The phase of flight data used to generate this graph is that which was reported by the engine manufacturers who ultimately received it from the operator of the aircraft. It is recognized that phase of flight definitions vary considerably in the industry, however, the data is a compilation from many operators and it is assumed normal data scatter would tend to mitigate any bias in phase of flight definitions.

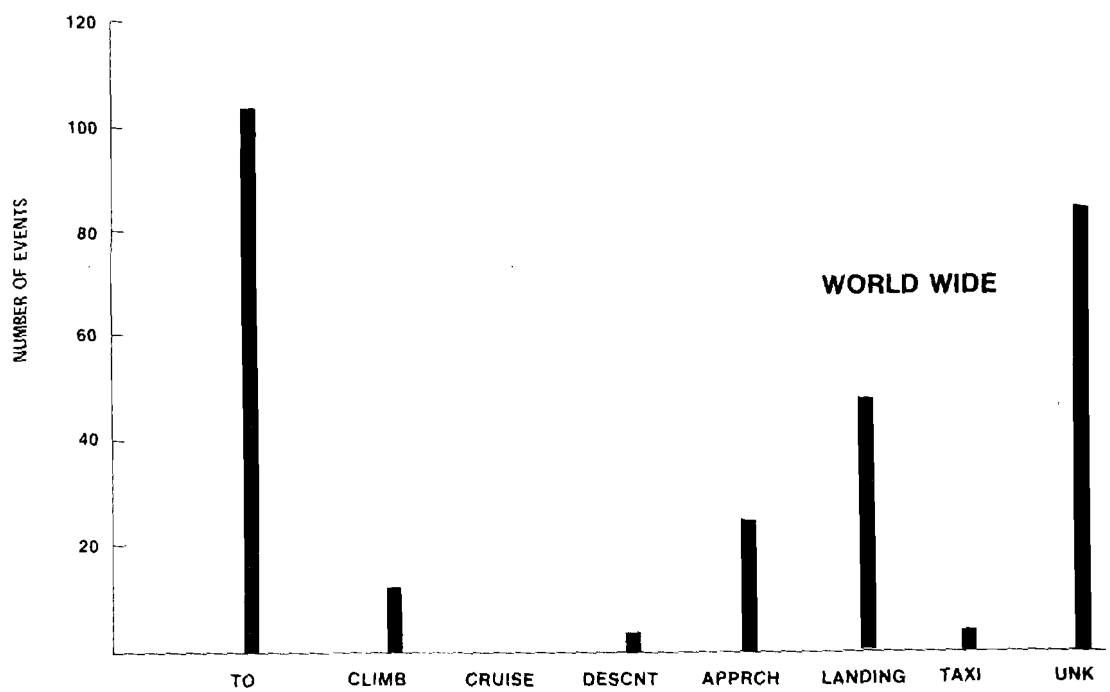


FIGURE 12. FREQUENCY VS PHASE OF FLIGHT

As mentioned, it has been possible to validate the weight of the birds in 145 cases out of the 289 events which occurred. Twenty-eight birds were ingested in the United States while 105 birds were ingested outside the United States (foreign). It was not possible to determine the location for 12 bird ingestion cases. Figure 13 depicts the worldwide bird weight distribution. For the foreign data, there were 5 cases where the bird ingestion weight was equal to or greater than 4 pounds (64 ounces). In the United States, this occurred in 3 cases.

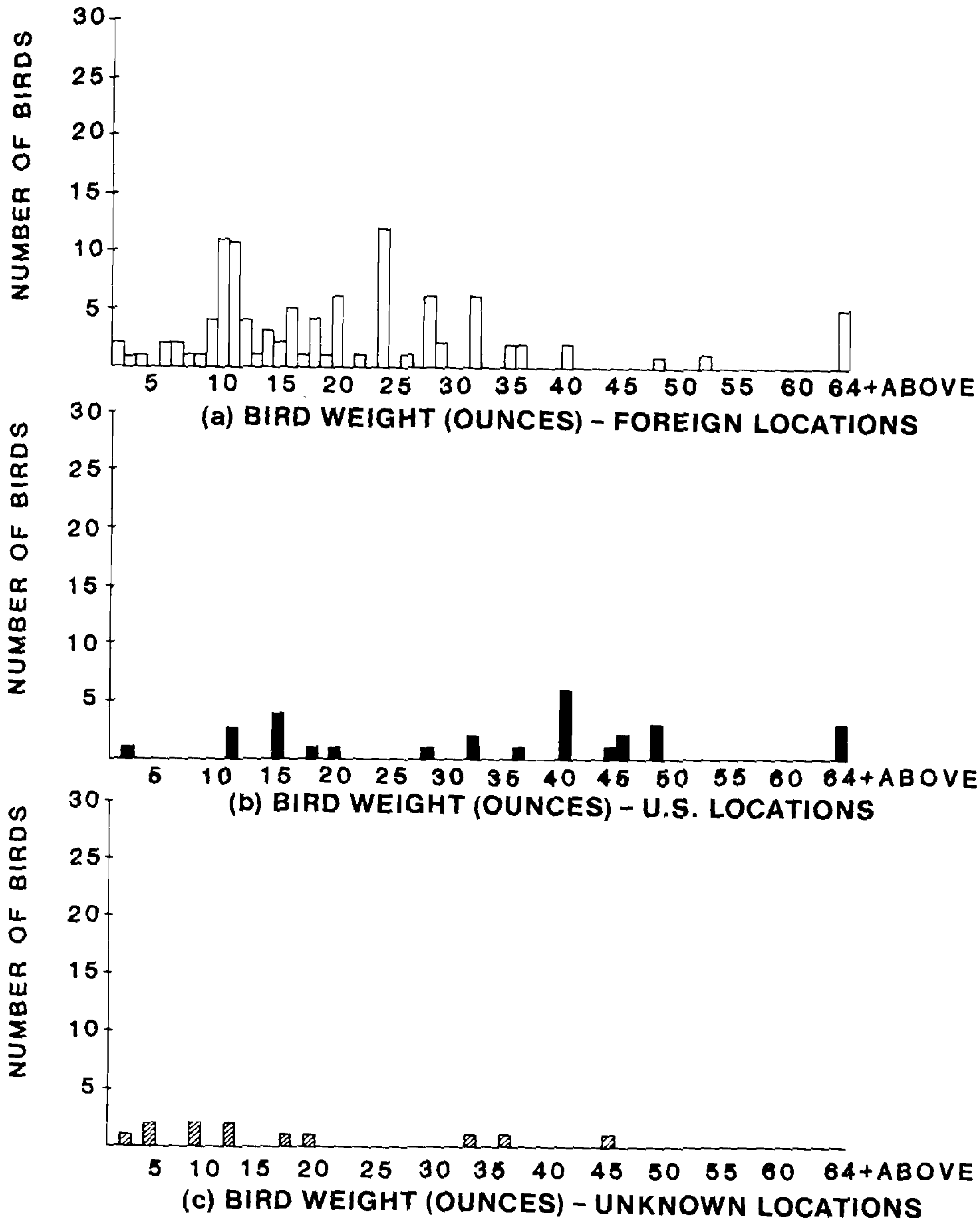


FIGURE 13. WORLDWIDE BIRD WEIGHTS

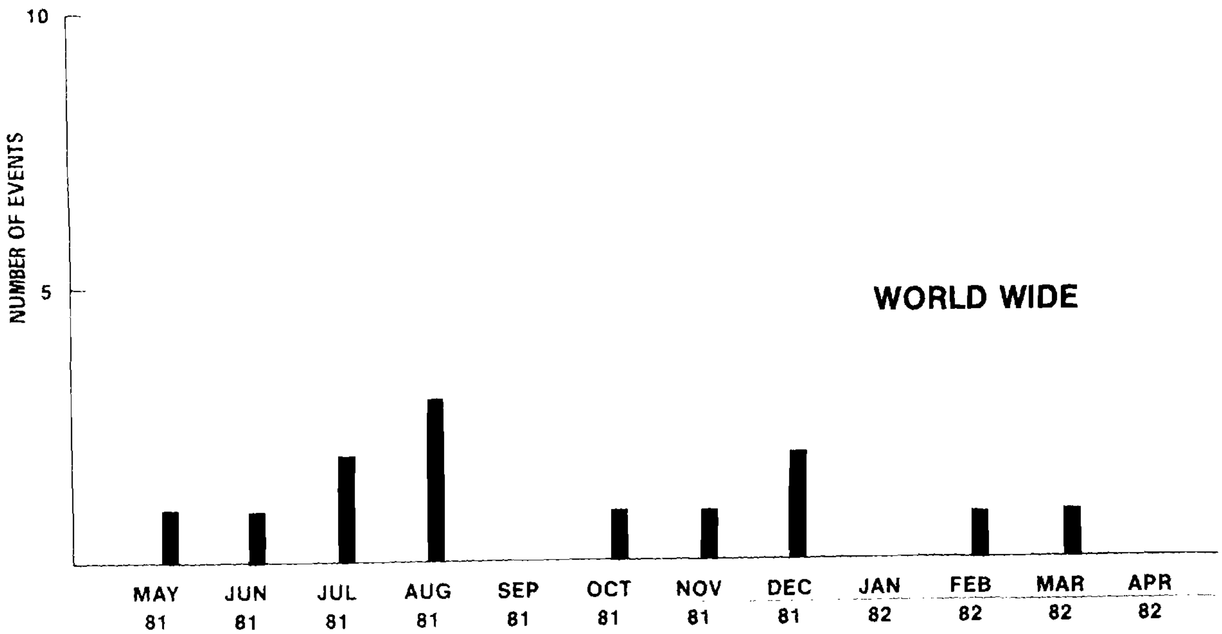


FIGURE 15. FREQUENCY BY MONTH FOR MULTIPLE BIRDS PER ENGINE

The first year's data emphasized that in some instances it was difficult to assess the exact number of birds ingested into an engine. To minimize this problem, a meeting of the three engine manufacturers' representatives and FAA Technical Center personnel was held to discuss "bird printing" methodology. As a result, it is anticipated, during the second year's effort of this study, that the reporting of multiple bird ingestions per engine events will be more consistent. This information is necessary since the present engine certification criteria are based, in part, on a fixed quantity of birds which are required to be ingested into an engine. NTSB recommendation, A-76-64, specified, in part, that "the numbers and sizes (of birds which are ingested during certification) should be consistent with inservice experience."

ANALYSIS

To examine certain hypotheses, statistical and analytical examinations of the data have been conducted. The results of these examinations are presented in the OBSERVATIONS section of this interim report.

The question has been asked "Are the U.S. and foreign rates similar for both the single and multiple engine ingestions?" Table 8, which combines the data from table 1 and table 4, presents the bird ingestion rates for U.S., foreign, and worldwide areas. Figure 16 graphically illustrates the data of table 8.

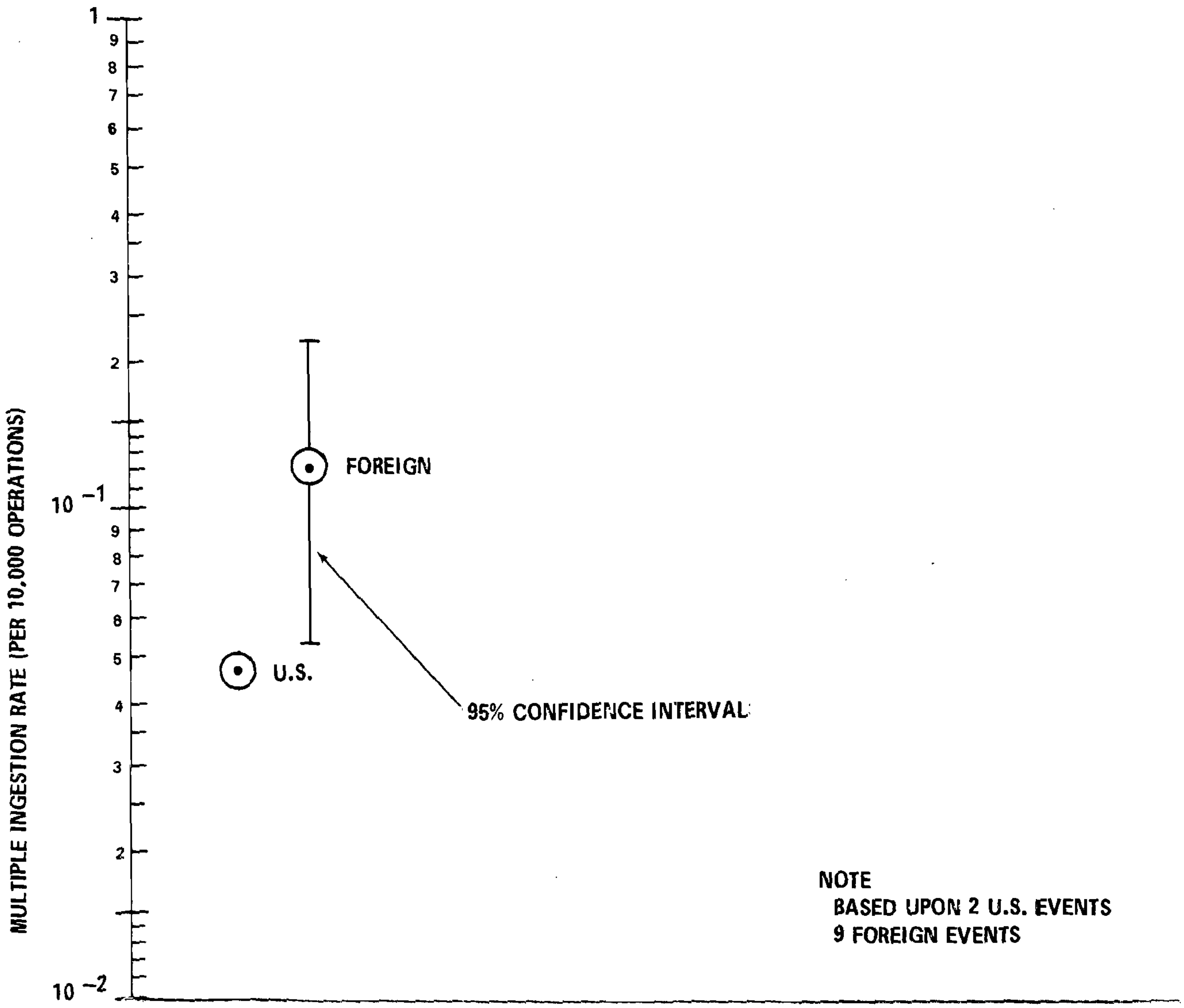


FIGURE 17. MULTIPLE ENGINE INGESTIONS, U.S. VERSUS FOREIGN

A similar test was conducted for the rate of U.S. versus foreign ingestion events (table 1). The calculated U.S. validated ingestion rate is 0.87 per 10,000 operations. Using the described statistical procedure, the confidence interval for the U.S. ingestion rate ranges between 0.61 and 1.20 per 10,000 operations. The foreign validated ingestion rate is 2.15 ingestions per 10,000 operations. Since the foreign ingestion rate does not lie within the 95 percent confidence interval of the U.S. ingestion rate, (figure 18) the conclusion is that the U.S. and foreign rates of bird ingestions per 10,000 operations are, in fact, statistically different.

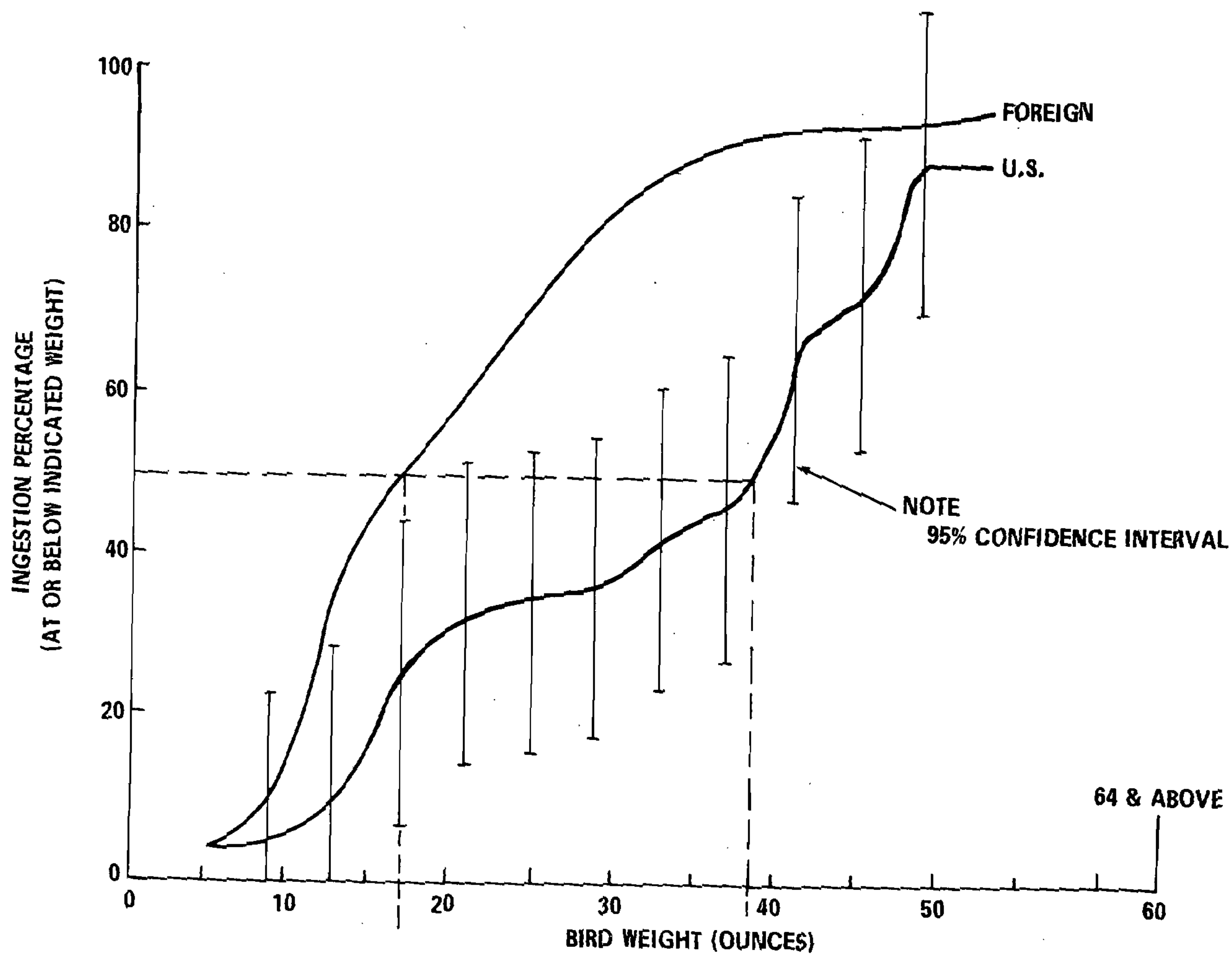


FIGURE 19. U.S./FOREIGN INGESTION AT OR BELOW A GIVEN WEIGHT

The question of which airports, where high bypass ratio turbine engine aircraft operations are conducted, experience the greatest number of ingestions is partially answered in table 9. Figure 20 illustrates table 9 data. It is not possible to compare the absolute number of ingestion events among airports because of the diversity in the numbers of operations conducted. Therefore, a comparison of ingestion rates per 10,000 operations is given. It is apparent, however, that a calculation of the ingestion rate at an airport which has an extremely low operations count produces an ingestion rate which is subject to considerable statistical uncertainty. For example, an airport which experiences one bird ingestion in a year and has only 124 operations (such a case exists), produces an ingestion rate of 80.65 which has such a wide interval of uncertainty associated with it as to make it meaningless. In order to avoid such unfair comparisons, table 9 presents only those airports at which the operations counts for the aircraft types which were monitored during this study are at least 10,000. In order not to bias the data, airports which have had at least 10,000 operations, even though no bird ingestions were reported, are included in table 9.

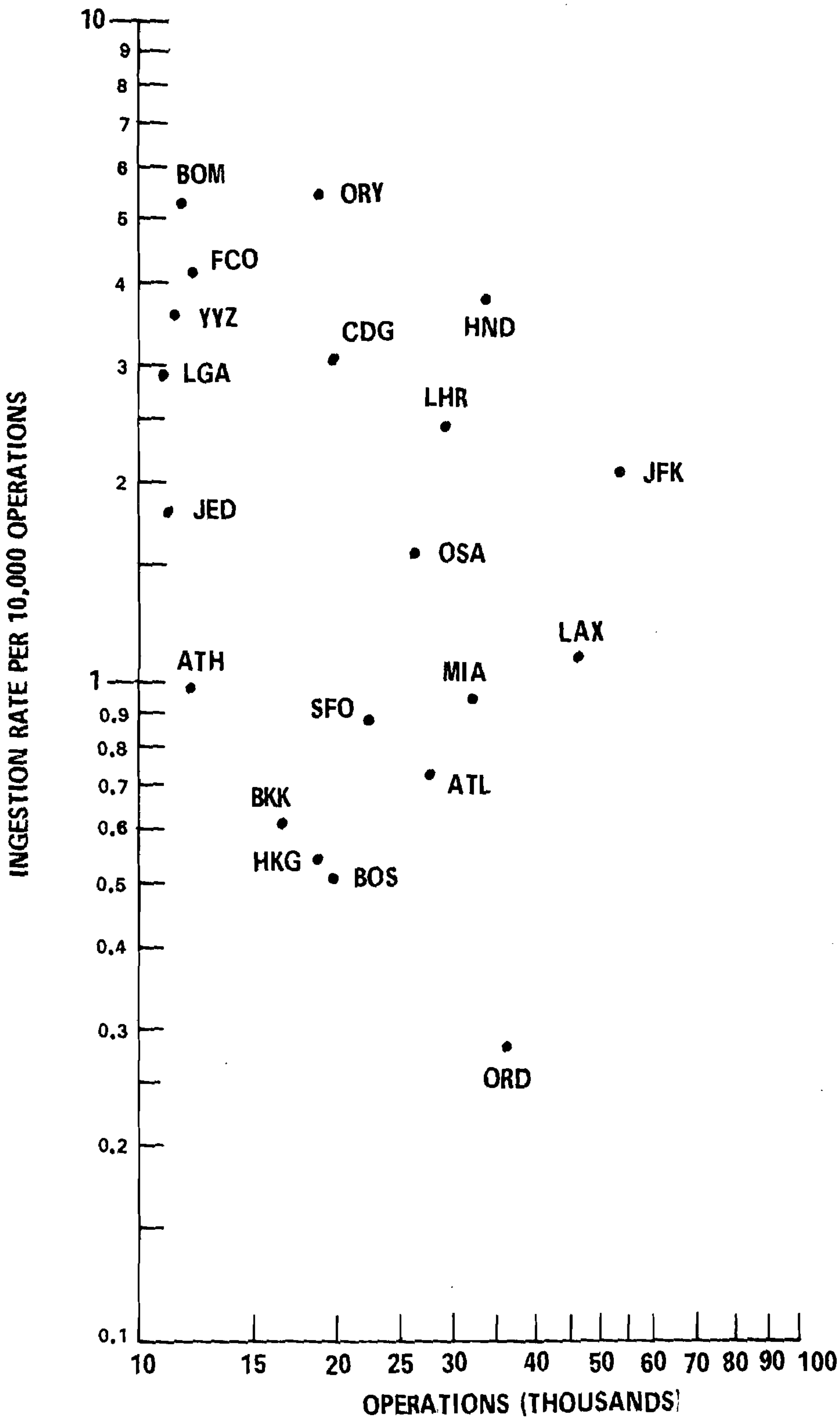


FIGURE 20. INGESTION RATE VERSUS AIRPORT OPERATIONS (WIDE-BODY ONLY)

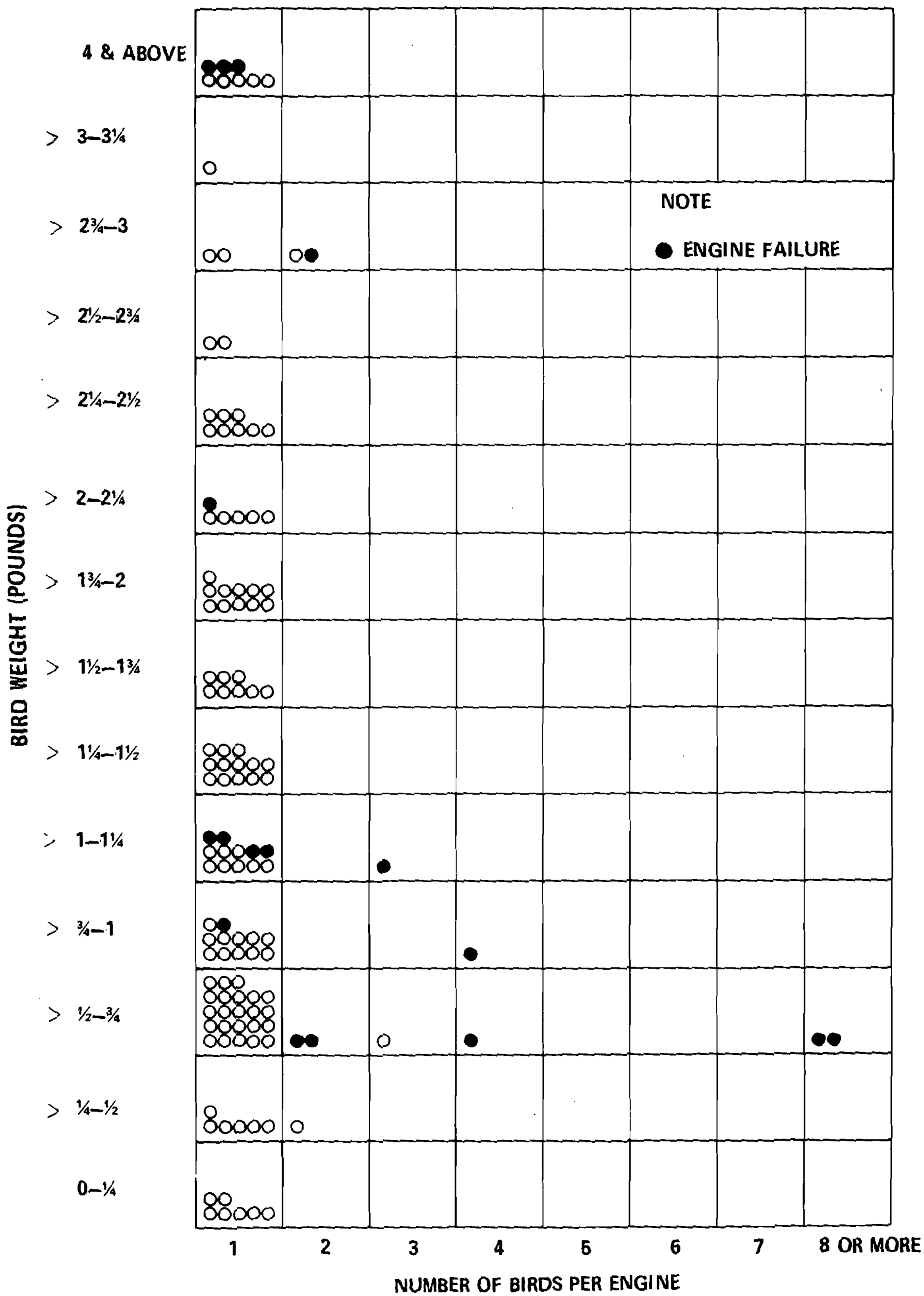


FIGURE 21. BIRD WEIGHT, NUMBER PER EVENT AND ENGINE FAILURE DISTRIBUTION

APPENDIX A

AIRPORT IDENTIFIERS

APPENDIX A

AIRPORT IDENTIFIERS

ABJ Abidjan, Ivory Coast
AMM Amman, Jordan
AMS Amsterdam, Netherlands
ATH Athens, Greece
ATL Atlanta, Ga., USA
BGF Bangui, Cen. African Republic
BKK Bangkok, Thailand
BOD Bordeaux, France
BOM Bombay, India
BOS Boston, Mass. USA
BRU Brussels, Belgium
BWI Baltimore, MD., USA
CAI Cairo, Arab Rep. of Egypt
CCU Calcutta, India
CDG Paris, France, Charles De Gaulle Arpt.
CPH Copenhagen, Denmark
DEL Delhi, India
DKR Dakar, Senegal
DPS Denpasar, Indonesia
DUR Durban, South Africa
KMQ Komatsu, Japan
LAX Los Angeles, CA, USA
LCA Larnaca, Cyprus
LGA Laguardia Airport, NY, USA
LGW London Eng., Gatwick Airport
LHR London Eng.,Heathrow Airport
LIM Lima, Peru
LIS Lisbon, Portugal
LOS Lagos, Nigeria
LPA Las Palmas, Canary Is.
LYS Lyon, France
MAA Madras, India
MEL Melbourne, Australia
MIA Miami, Fla., USA
Mil Milan, Italy
MNL Manila, Philippines
MPL Montpellier, France
MRS Marseille, France
MTY Monterrey, Mexico
MWH Moses Lake, Wash. USA
NBO Nairobi, Kenya
NGO Nagoya, Japan
NGS Nagasaki, Japan
NIM Niamey, Niger
NKC Nouakchott, Mauritania
FCO Rome, Italy, L. Da Vinci Arpt.
FEZ Fez, Morocco
FIH Kinshasa, Zaire
FLL Ft. Lauderdale/Hollywood, Fla., USA
FRA Frankfurt, Republic of Germany
FUK Fukuoka, Japan
GIG Rio de Janeiro, Brazil (International)
HAM Hamburg, Rep. of Germany
HKG Hong Kong, Hong Kong
HND Haneda Airport, Tokyo, Japan
HYD Hyderabad, India
IAH Houston, Texas, USA
IST Istanbul, Turkey
JED Jeddah, Saudi Arabia
JFK John F. Kennedy Int. Airport, New York, USA
JNB Johannesburg, So. Africa
KAN Kano, Nigeria
KHI Karachi, Pakistan
OKA Okinawa, Ryukyu Is., Japan
ORD Chicago, Ill, O'Hare Airport, USA
ORY Paris, France, Orly Airport
OSA Osaka, Japan
PEN Penang, Mayalasia
PHL Philadelphia, PA., USA
PTY Panama City, Panama Republic
PUS Pusan, Rep. of Korea
RST Rochester, Minn., USA
VCP Sao Paulo, Brazil, Viracopos Airport
SFO San Francisco, CA, USA
SID Sal Island, Cape Verde IS.
SNN Shannon, Rep. of Ireland
STR Stuttgart, Rep. of Germany
SXR Srinagar, India
TLS Toulouse, France
TLV Tel Aviv-Yafo, Israel
TUN Tunis, Tunesia
VIE Vienna, Austria
WLG Wellington, New Zealand
YUL Montreal, Quebec, Canada
YVR Vancouver, Br. Columbia, Canada
YYZ Toronto, Ontraio, Canada
ZRH Zurich, Switzerland

APPENDIX B

STATISTICAL PROCEDURE

APPENDIX B

STATISTICAL PROCEDURE

Let r_1 represent the United States (U.S.) rate of occurrence of a phenomenon and let r_2 represent the foreign rate of occurrence, then the general form of the hypothesis (H_o) being explored is

$$H_o : r_1 = r_2$$

with the alternate hypothesis (H_1) being of the form

$$H_1 : r_1 \neq r_2$$

A Poisson approximation to the binomial distribution is employed to examine the rates. If x is defined as the number of observed ingestions and if λ is defined as the Poisson rate parameter, it is known that $2 n \lambda$ has a χ^2 distribution (Johnson, N. L., and Kotz, S., Discrete Distributions, Houghton-Mifflin Boston, 1969) with $2 x + 1$ degrees of freedom (n is defined as the number of operations). To construct a confidence interval for the true value of λ given x ingestions it is necessary to calculate the lower (λ_L) and upper (λ_U) limits of the confidence interval according to

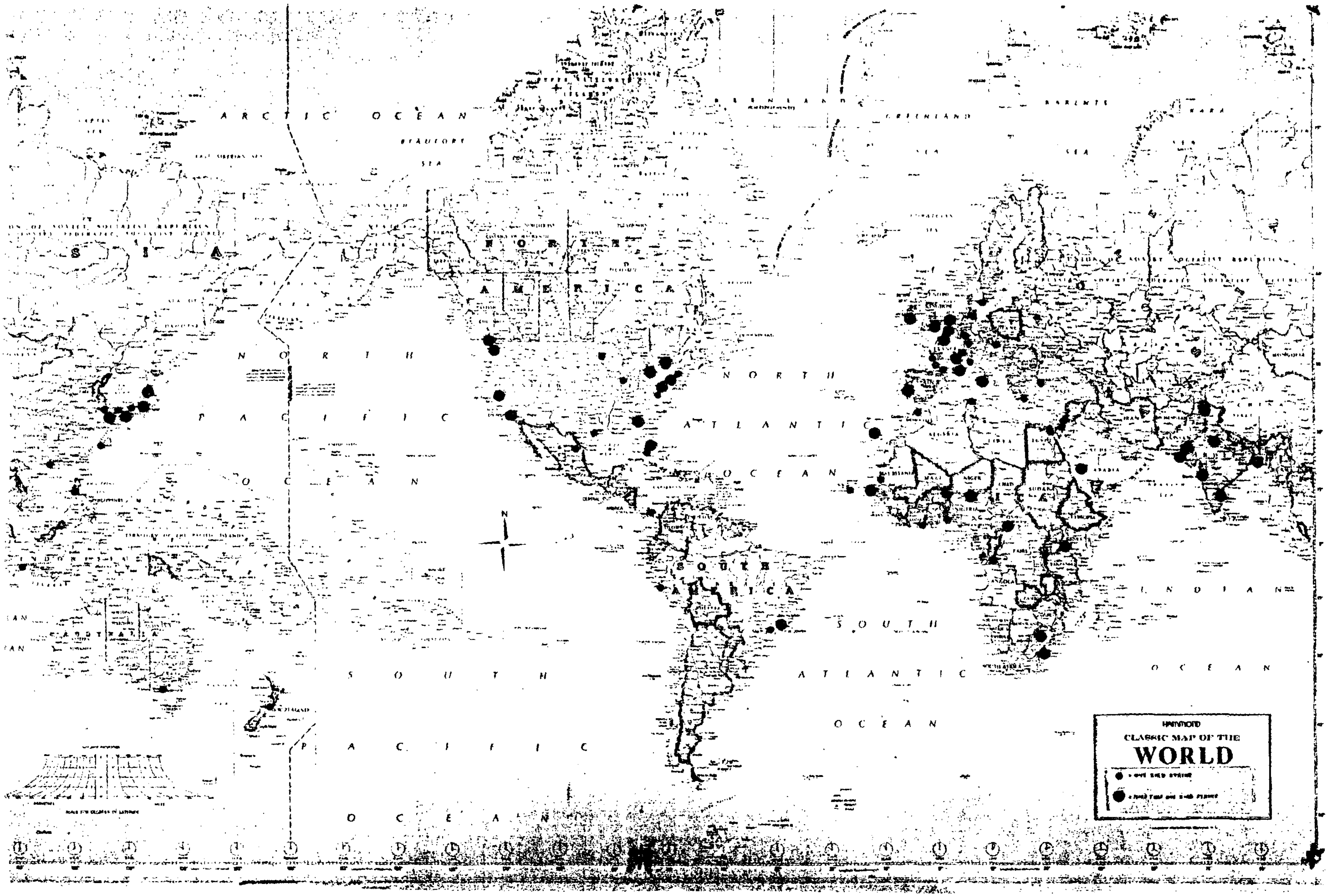
$$\lambda_L = \frac{1}{2n} \chi^2_{2x,\ \alpha/2}$$

$$\lambda_U = \frac{1}{2n} \chi^2_{2(x+1),\ 1-\alpha/2}$$

where α is the desired probability of rejecting the hypothesis when it is, in fact, true. The term $(1-\alpha)$ percent is the "confidence level" associated with not rejecting H_o if it is, in fact, true.

APPENDIX C

WORLD MAP: BIRD INGESTION LOCATIONS, FIRST YEAR


HAMMOND
CLASSIC MAP OF THE
WORLD
ARCTIC OCEAN
BEAUFORT SEA
GREENLAND
BARENTS
NORTH AMERICA
SOUTH AMERICA
ASIA
AUSTRALIA
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
NORTH ATLANTIC OCEAN
SOUTH ATLANTIC OCEAN
INDIAN OCEAN

APPENDIX D

BIRD INGESTION DATA BASE, FIRST YEAR

DATA RECORDED & PROCESSED AT FAA TECHNICAL CENTER, ATLANTIC CITY AIRPORT, N.J. 08405 ON 10/18/82 G FRINGS ACT-320

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT LANDNG	IFSD REASON	BIRD SEEN	BIRD SPECIES	# B D	AV WT OZ	PI-LOT ACT	SIGNI-FICANT REASON
1	050381	0000	ABJ	CLIMB	UNK	3 BLDS	YES	YES	VIBES,PR ECAUTION	UNK	UNK	0	0	ATB	N/A
2	050681	0000	DRY	TO	UNK	4 BLDS	YES	YES	N/A	YES	PIGEONS	0	0	ATO	MULT. EN G INGEST
2	050681	0000	DRY	TO	UNK	4 BLDS	YES	YES	N/A	YES	PIGEONS	0	0	ATO	MULT. EN G INGEST
3	050681	1830	YVR	TO	VFR	5 BLADES BENT	YES	YES	VIBES, B Y PILOT	YES	CROW	1	24	ATB	MULTIPLE BIRDS
3	050681	1830	YVR	TO	VFR	5 BLADES BENT	YES	YES	VIBES, B Y PILOT	YES	DUCK	1	48	ATB	MULTIPLE BIRDS
4	051081	0000	BOM	TO	UNK	ALL BLDS ,1 BKN	YES	NO	N/A	UNK	KITE	1	16	ATO	BLD FRAC TRE
5	051981	0000	XXX	TO	UNK	2 BLADES	NO	YES	N/A	UNK	UNK	0	0	N/A	N/A
6	051981	0000	XXX	UNK	UNK	1 BLD NI CKED	NO	YES	N/A	UNK	UNK	0	0	N/A	N/A
7	052281	0000	XFO	UNK	UNK	N/A	NO	YES	N/A	NO	UNK	0	0	N/A	N/A
8	052381	1430	XFO	UNK	VFR	13 BLDS	NO	YES	N/A	NO	BLK PART RIDGE	1	12	N/A	N/A
9	052781	0000	FCO	LANDNG	UNK	N/A	NO	N/A	N/A	UNK	UNK	0	0	N/A	N/A
10	052881	1422	AMM	TO	UNK	N/A	YES	N/A	VIBES,PR ECAUTION	YES	UNK	0	0	N/A	N/A
11	053081	1730	JFK	CLIMB	UNK	14 BLDS	NO	YES	N/A	NO	UNK	1	32	N/A	N/A

****** SAMPLE SIZE FOR MAY 81 = 11 # STRIKES WITH DAMAGE = 8 % = 72.727

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT LANDNG	IFSD REASON	BIRD SEEN	BIRD SPECIES	# B D	AV WT OZ	PI-LOT ACT	SIGNI-FICANT REASON
12	060281	0000	LYS	TO	UNK	N/A	NO	N/A	N/A	UNK	RED KITE	1	36	N/A	N/A
13	060381	0000	DUR	TO	UNK	3 BLDS-M INOR	NO	YES	N/A	UNK	UNK	0	0	N/A	N/A
14	060581	0127	TLV	TO	VFR	4 BLDS B ENT	NO	YES	N/A	NO	BARN OWL	1	16	N/A	N/A

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT [illegible]	IFSD REASON	BIRD SEEN	BIRD SPECIES	# B D	AV WT OZ	PI- LOT ACT	SIGNI- FICANT REASON
31	061981	0000	SIG	LANDNG	UNK	2 BLDS	NO	YES	N/A	UNK	UNK	0	0	ATB	N/A
32	062081	0000	KAN	TO	UNK	6 BLDS	YES	YES	VIBES	UNK	BLK KITE	1	24	UNK	N/A
33	062281	0000	XXX	UNK	UNK	1 BLD	NO	YES	N/A	NO	UNK	0	0	N/A	N/A
34	062381	0000	JFK	APPRCH	VFR	N/A	NO	N/A	N/A	YES	SEA GULL	1	0	N/A	N/A
35	062381	0830	HND	APPRCH	IFR	N/A	NO	YES	N/A	YES	UNK	0	0	N/A	N/A
36	062581	0000	XXX	UNK	UNK	N/A	NO	N/A	N/A	NO	BLACK SW IFT	1	2	N/A	N/A
37	062581	0000	DKP	TAXI	UNK	NO	UNK	YES	N/A	NO	FRANCOLI N	1	10	N/A	N/A
38	062681	0000	LYS	LANDNG	IFR	N/A	NO	N/A	N/A	UNK	UNK	0	0	N/A	N/A
39	062781	0000	LIS	TO	UNK	2 BLDS BENT	NO	YES	N/A	YES	ROCK DOV E	1	10	N/A	N/A
40	062781	0700	JNB	TO	VFR	NO	YES	YES	HI EGT,1 045 C	UNK	GRAY HEA DED GULL	1	16	ATB	INVLNTRY PWR LOSS
41	062881	0000	MPL	LANDNG	VFR	N/A	NO	N/A	N/A	UNK	UNK	1	35	UNK	N/A
42	062881	0000	XXX	UNK	UNK	N/A	NO	N/A	N/A	NO	BARN OWL	1	16	N/A	N/A
43	062981	0000	MNL	TO	UNK	N/A	NO	N/A	N/A	UNK	UNK	0	0	N/A	N/A

****** SAMPLE SIZE FOR JUN 81 = 32 # STRIKES WITH DAMAGE = 20 % = 62.500

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT [illegible]	IFSD REASON	BIRD SEEN	BIRD SPECIES	# B D	AV WT OZ	PI- LOT ACT	SIGNI- FICANT REASON
44	070381	0000	DEL	LANDNG	VFR	2 HPC BL SHINGLED	NO	YES	N/A	UNK	BLK KITE	1	24	N/A	N/A
45	070381	0000	XUS	UNK	UNK	3 BLDS B ENT	NO	YES	N/A	NO	UNK	1	0	N/A	N/A
46	070381	0000	XXX	UNK	UNK	N/A	NO	N/A	N/A	NO	UNK	0	0	N/A	N/A

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT DAMAGE	IFSD REASON	BIRD SEEN	BIRD SPECIES	# B D	AV WT OZ	PI-LOT ACT	SIGNI-FICANT REASON
63	072281	0000	XUS	UNK	UNK	1 BLADE BENT	NO	YES	N/A	NO	UNK	1	0	N/A	N/A
64	072581	0000	XUS	UNK	UNK	N/A	NO	YES	N/A	NO	GULL	1	0	N/A	N/A
65	072681	1200	XFO	LANDNG	IFR	ACOUSTIC LINING	NO	YES	N/A	NO	CROW	1	8	N/A	N/A
66	073181	0000	LHR	TO	UNK	ACOUSTIC LINING	NO	YES	N/A	YES	BLK HEADED GULL	1	10	N/A	MULTIPLE ENG STK
66	073181	0000	LHR	TO	UNK	3 BLADES DENTED	NO	YES	N/A	YES	BLK HEADED GULL	1	10	N/A	MULTIPLE ENG STK

****** SAMPLE SIZE FOR JUL 81 = 23 # STRIKES WITH DAMAGE = 16 % = 69.565

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT DAMAGE	IFSD REASON	BIRD SEEN	BIRD SPECIES	# B D	AV WT OZ	PI-LOT ACT	SIGNI-FICANT REASON
67	080181	0000	TLS	TO	UNK	2 BLDS TWISTED	NO	YES	N/A	UNK	UNK	0	0	N/A	N/A
68	080181	0000	NGS	TO	VFR	5 BLDS	UNK	YES	N/A	UNK	BLK KITE	1	28	UNK	N/A
69	080281	0000	BOM	TO	IFR	3 BLADES ,LINING	NO	YES	N/A	NO	BLACK KITE	1	40	N/A	N/A
70	080281	0000	TYO	LANDNG	UNK	7 BLDS,1 OGV	NO	YES	N/A	UNK	UNK	0	0	N/A	N/A
71	080281	0000	YUL	APPRCH	UNK	HPC DAMAGE	NO	YES	N/A	UNK	HOODED MERGANSER	1	19	N/A	N/A
72	080481	0000	XXX	UNK	UNK	N/A	NO	N/A	N/A	UNK	TURTLE DOVE	0	4	N/A	N/A
73	080681	0000	DEL	LANDNG	UNK	N/A	NO	YES	N/A	UNK	BLK KITE	1	24	N/A	N/A
74	080781	0000	KHI	LANDNG	UNK	N/A	NO	N/A	N/A	UNK	BLK KITE	1	24	N/A	N/A
75	080781	1200	HND	TO	UNK	NO	NO	YES	MOM HI EGT VIPES	YES	BLUE HERRON	1	0	ATB	N/A
76	080781	2133	PHL	DESCNT	UNK	NO	NO	N/A	N/A	YES	UNK	1	0	N/A	N/A
77	080781	2350	YUL	TAXI	VFR	N/A	NO	N/A	N/A	NO	UNK	0	0	N/A	N/A

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT [illegible]	IFSD REASON	BIRD SEEN	BIRD SPECIES	# B D	AV WT OZ	PI- LOT ACT	SIGNI- FICANT REASON
94	082081	0000	CDG	TO	VFR	2 BLDS REPLACED	YES	YES	N/A	UNK	PIGEON	1	11	ATB	N/A
95	082081	0000	XXX	UNK	UNK	N/A	NO	YES	N/A	NO	UNK	0	0	N/A	N/A
96	082181	0402	LHR	LANDNG	VFR	N/A	NO	YES	N/A	YES	GULLS	0	0	N/A	N/A
97	082381	0930	HND	APPRCH	IFR	N/A	NO	YES	N/A	YES	BLK TAILED GULL	0	20	N/A	MULT. ENG STRKE
97	082381	0930	HND	APPRCH	IFR	N/A	NO	YES	N/A	YES	BLK TAILED GULL	0	20	N/A	MULT. ENG STRKE
98	082481	0000	MIL	TO	VFR	4 BLDS BENT	YES	YES	N/A	UNK	HOODED CROW	1	17	ATO	N/A
99	082581	0000	FCO	TO	VFR	7 BLDS	YES	YES	N/A	UNK	UNK	0	0	N/A	N/A
100	082581	0000	XXX	UNK	UNK	N/A	NO	N/A	N/A	NO	UNK	0	0	N/A	MULT ENG INGEST
100	082581	0000	XXX	UNK	UNK	N/A	NO	N/A	N/A	NO	UNK	0	0	N/A	MULT ENG INGEST
101	082681	0000	FUK	APPRCH	UNK	N/A	NO	YES	N/A	YES	DOMESTIC PIGEON	0	10	N/A	N/A
102	082681	0000	OKA	UNK	UNK	1 BLADE	NO	YES	N/A	YES	GOLDEN PLOVER	2	6	N/A	MULT BRD INGEST
103	082681	0000	ORD	TO	UNK	ALL BLDS ,2 BKN	YES	YES	VIBES	UNK	RING BILLED GULL	4	15	ATB	TRNSV BLD FRACT
104	082681	0000	XUS	UNK	UNK	N/A	NO	N/A	N/A	NO	UNK	1	0	N/A	N/A
105	082681	0750	CPH	TO	UNK	N/A	UNK	N/A	N/A	UNK	HERRING GULL	1	40	UNK	N/A
106	082781	1925	HND	TO	VFR	2 BLDS	NO	YES	N/A	NO	SEA GULLS	0	20	N/A	N/A
107	082881	0000	MTY	TO	VFR	5 BLDS BENT	YES	YES	N/A	UNK	HAWK	1	29	N/A	N/A

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT ENGINE	IFSD REASON	BIRD SEEN	BIRD SPECIES	# B D	AV WT OZ	PI- LOT ACT	SIGNI- FICANT REASON
121	090881	0000	KAN	LANDNG	VFR	2 BLDS	NO	YES	N/A	UNK	SHITE HAWK	0	0	N/A	N/A
122	090881	0647	PHL	APPRCH	VFR	1PC,9HPC BLDS BNT	NO	YES	N/A	YES	CANADIAN GOOSE	1	112	N/A	N/A
123	091181	0000	LGW	LANDNG	VFR	N/A	NO	N/A	N/A	UNK	UNK	0	0	N/A	N/A
124	091181	0900	FEZ	TO	VFR	12 BLDS	NO	YES	N/A	NO	UNK	1	0	N/A	N/A
125	091281	1345	DEL	LANDNG	VFR	1 BLD BKN,15 DMG	YES	NO	HIGH EGT 1018 C	YES	INDIAN VULTURE	1	176	N/A	BLD FRACTURE
126	091281	1730	LAX	TO	UNK	2 BLDS	NO	YES	N/A	NO	UNK	1	0	N/A	N/A
127	091381	0000	ATL	CLIMB	VFR	2 BLDS BENT FWD	YES	YES	NOSE COWL DENTED	YES	RED TAIL HAWK	1	40	ATB	N/A
128	091581	0000	HYD	TO	VFR	8 BLDS	YES	YES	N/A	UNK	UNK	0	0	ATB	N/A
129	091581	0500	LHR	LANDNG	VFR	1 BLD BENT	NO	YES	N/A	UNK	COMMON GULL	1	15	N/A	N/A
130	091781	0000	ATH	TO	VFR	N/A	NO	N/A	N/A	UNK	UNK	0	0	N/A	N/A
131	091781	0700	JFK	APPRCH	UNK	13 BLDS	NO	YES	N/A	YES	HERRING GULL	1	20	N/A	N/A
132	091881	1830	FUK	UNK	UNK	N/A	NO	N/A	N/A	NO	BLK TAILED GULL	1	20	N/A	N/A
133	092181	0000	HYD	TO	VFR	N/A	NO	N/A	N/A	UNK	BLACK KITE	1	28	N/A	N/A
134	092281	1230	XFO	APPRCH	VFR	N/A	NO	N/A	N/A	UNK	UNK	1	0	N/A	N/A
135	092381	0000	LGA	LANDNG	VFR	2 BLADES	NO	YES	N/A	UNK	HERRING GULL	1	32	N/A	N/A
136	092381	0942	KMQ	TO	VFR	N/A	NO	N/A	N/A	YES	KITE	1	0	N/A	N/A

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT DAM	IFSD /REASON	BIRD SEEN	BIRD SPECIES	# B D	AV WT OZ	PI- LOT ACT	SIGNI- FICANT REASON
153	100881	0000	VBO	TO	UNK	ALL BLADES	YES	YES	N/A	UNK	VULTURE	1	0	ATO	N/A
154	100881	1300	LAX	TO	UNK	3 BLDS	NO	YES	VIBES	UNK	SEA GULL	1	28	ATB	N/A
155	100981	0000	XFO	UNK	UNK	N/A	NO	N/A	N/A	UNK	UNK	0	0	N/A	N/A
156	101081	0000	JFK	DESCNT	UNK	3 BLDS	NO	YES	N/A	UNK	UNK	0	0	N/A	N/A
157	101081	0200	BOM	TO	UNK	N/A	NO	N/A	N/A	YES	KITE	0	0	ATO	N/A
158	101081	1240	NGS	LANDNG	VFR	N/A	NO	N/A	N/A	YES	KITE	1	0	N/A	N/A
159	101281	0000	XFO	UNK	UNK	2 BLDS	NO	YES	N/A	NO	UNK	1	22	UNK	N/A
160	101281	0000	KAN	LANDNG	UNK	3 BLDS	NO	YES	N/A	UNK	UNK	0	0	N/A	N/A
161	101281	0900	NGO	LANDNG	VFR	2 BLDS B ENT	NO	YES	N/A	NO	PIGEON	1	0	N/A	N/A
162	101381	0000	ORY	LANDNG	IFR	N/A	NO	N/A	N/A	UNK	PIGEON	1	0	N/A	N/A
163	101381	1400	LAX	TO	UNK	10 BLDS	YES	YES	VIBES	UNK	PIGEON	1	11	ATB	N/A
164	101381	1622	YYZ	APPRCH	VFR	11 BLDS	NO	YES	N/A	NO	MEADOWLARK	1	5	N/A	N/A
165	101481	0000	XFO	UNK	UNK	N/A	NO	N/A	N/A	UNK	UNK	0	0	N/A	N/A
166	101581	0000	BOS	TO	VFR	4 BLDS	YES	YES	N/A	UNK	HERRING GULL	1	44	ATB	N/A
167	101681	0000	ORY	LANDNG	IFR	N/A	NO	N/A	N/A	UNK	PIGEON	1	0	N/A	N/A
168	101981	0000	TUN	TO	VFR	3 BLDS	YES	YES	N/A	UNK	UNK	0	0	ATB	N/A

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT DAMAGE	IFSD REASON	BIRD SEEN	BIRD SPECIES	# B D	AV WT OZ	PI- LOT ACT	SIGNI- FICANT REASON
184	102681	0000	CCU	TO	VFR	5 BLDS BENT	YES	YES	N/A	UNK	UNK	0	0	ATO	N/A
185	102681	0530	JFK	TO	IFR	NO	NO	N/A	N/A	NO	HERRING GULL	1	40	ATO	SURGED,HI EGT
186	102881	0000	DPS	TO	UNK	N/A	NO	N/A	N/A	UNK	UNK	0	0	N/A	N/A
187	102881	0000	SIG	DESCNT	VFR	4 BLDS	NO	YES	N/A	UNK	DUCK	1	32	N/A	N/A
188	103081	0000	XXX	UNK	UNK	1 IPC88 HPC BLDS	NO	YES	N/A	UNK	RING BILL GULL	1	18	N/A	N/A
189	103081	1230	FUK	TO	UNK	2 BLADES	UNK	YES	N/A	NO	SEAGULLS	1	24	N/A	N/A
190	103081	1500	NGS	TO	VFR	3 BLDS BENT	YES	YES	N/A	YES	KITE	1	0	ATO	N/A
191	103181	1125	SFO	CLIMB	UNK	N/A	NO	N/A	N/A	YES	DUCK	1	0	N/A	N/A
****** SAMPLE SIZE FOR OCT 81 = 48						# STRIKES WITH DAMAGE = 30					% = 62.500				
192	110181	0000	XXX	UNK	UNK	4 BLDS	NO	YES	N/A	UNK	UNK	0	0	N/A	N/A
193	110381	0000	HKG	TO	UNK	1 BLD TIP BENT	YES	YES	N/A	NO	BLACK KITE	1	32	N/A	N/A
194	110381	0000	DRY	LANDNG	IFR	N/A	NO	N/A	N/A	UNK	PIGEON	1	0	N/A	N/A
195	110581	0000	TYO	APPRCH	UNK	2 BLDS	NO	YES	N/A	UNK	UNK	0	0	N/A	N/A
196	110681	0000	HYD	TO	VFR	ALL BLDS	YES	YES	N/A	UNK	UNK	0	0	ATB	N/A
197	110781	0000	XXX	UNK	UNK	NOSE COWL DENTED	NO	YES	N/A	NO	HERRING GULL	1	44	N/A	N/A
198	110881	0000	LPA	TO	VFR	4 BLADES	YES	YES	N/A	YES	SEAGULL	1	0	ATO	N/A
199	111081	0000	XFO	UNK	UNK	N/A	NO	N/A	N/A	NO	UNK	0	0	N/A	N/A

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT [illegible]	IFSD REASON	BIRD SEEN	BIRD SPECIES	# B D	AV WT OZ	PI-LOT ACT	SIGNI-FICANT REASON
216	121581	1215	CDG	TO	UNK	4 BLDS	YES	YES	N/A	UNK	PARTRIDGE	1	12	ATB	MULT BIRDS
216	121581	1215	CDG	TO	UNK	4 BLDS	YES	YES	N/A	UNK	BLK HEADED GULL	1	14	ATB	MULT BIRDS
217	121681	0000	NIM	TO	UNK	5 BLDS	YES	YES	VIBES	UNK	UNK	0	0	ATB	N/A
218	122181	0000	BPU	TO	UNK	10 BLDS SHINGLED	UNK	YES	N/A	UNK	UNK	0	0	ATB	N/A
219	122281	0000	JFK	TO	VFR	2 BLADES	NO	YES	2 STALLS	NO	GRTR BLK BAK GULL	2	48	ATB	POSS MULT BDS
220	122781	0000	LGA	APPRCH	IFR	4 BLDS	NO	YES	N/A	YES	PIGEON	1	11	N/A	N/A
221	122781	0000	XUS	APPRCH	VFR	N/A	NO	N/A	N/A	NO	GULL	0	0	N/A	N/A
222	122881	0000	XFO	UNK	UNK	N/A	NO	N/A	N/A	UNK	UNK	0	0	N/A	N/A
223	122981	0000	ORY	TO	UNK	2 BLDS	YES	N/A	N/A	UNK	UNK	0	0	ATB	N/A
224	122981	0000	XXX	UNK	UNK	3 BLDS	NO	YES	N/A	NO	UNK	1	0	N/A	N/A
225	122981	0000	PEN	TO	IFR	4 BLDS	NO	YES	N/A	UNK	UNK	0	0	N/A	N/A
226	123181	0000	LPA	CLIMB	VFR	N/A	NO	YES	PRECAUTIONARY	UNK	UNK	0	0	UNK	N/A
227	123181	0000	XFO	UNK	VFR	N/A	NO	N/A	N/A	UNK	BLK KITE	1	24	N/A	N/A
****** SAMPLE SIZE FOR DEC 81 = 15						# STRIKES WITH DAMAGE = 9					% = 60.000				
228	010182	1704	CCU	DESCNT	UNK	ALL BLDS	YES	NO	BLD PIECES LOST	UNK	WHITE B. VULTURE	1	176	N/A	TRANSVRS BLD FRAC
229	010382	1100	YVR	TO	VFR	BLD SET, COWL	NO	YES	BANG	YES	EAGLE, DUCK, OTHER	0	0	ATO	MULT BDS
230	010482	0000	XFO	UNK	UNK	3 BLDS LE DEFORM	NO	YES	N/A	UNK	UNK	0	0	N/A	N/A

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT DAMAGE	IFSD REASON	BIRD SEEN	BIRD SPECIES	# BD	AV WT OZ	PILOT ACT	SIGNIFICANT REASON
247	021682	0000	NBO	LANDNG	UNK	4 BLDS DEFRMED	NO	YES	N/A	UNK	UNK	0	0	N/A	N/A
248	022382	0000	DUR	TO	VFR	8 BLDS	YES	YES	N/A	UNK	UNK	0	0	ATO	N/A
249	022782	0000	XFO	UNK	UNK	1 BL LE BENT	NO	YES	N/A	NO	SEAGULL	1	0	N/A	N/A
250	022882	1200	BRU	TO	UNK	1 BLD FRACTURED	YES	NO	MOM HI EGT	YES	BLK HEADED GULLS	4	11	ATB	MULT BDS PWR LOSS

****** SAMPLE SIZE FOR FEB 82 = 9 # STRIKES WITH DAMAGE = 7 % = 77.778

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT DAMAGE	IFSD REASON	BIRD SEEN	BIRD SPECIES	# BD	AV WT OZ	PILOT ACT	SIGNIFICANT REASON
251	030282	0000	XFO	UNK	UNK	2 BLDS DISTORTED	NO	N/A	N/A	UNK	UNK	0	0	N/A	N/A
252	030382	0000	MWH	APPRCH	VFR	CORE INGESTION	NO	N/A	N/A	NO	CANADIAN GOOSE	1	80	N/A	MULT ENG
252	030382	0000	MWH	APPRCH	VFR	CORE	NO	YES	N/A	NO	CANADIAN GOOSE	1	80	N/A	MULT ENG
253	030582	0000	MIA	CLIMB	UNK	4 BLADES	YES	YES	N/A	YES	GULLS	0	0	UNK	N/A
254	030682	1200	XXX	UNK	UNK	5 BLDS	NO	YES	N/A	NO	LAPWING	0	8	N/A	N/A
255	030782	1000	SFO	TO	UNK	N/A	NO	N/A	N/A	YES	UNK	0	0	N/A	N/A
256	030882	0110	XFO	UNK	UNK	SEVERAL BLADES	NO	YES	N/A	NO	REDWATLD LAPWING	1	10	N/A	N/A
257	030982	0700	HND	TO	VFR	N/A	NO	YES	N/A	NO	DUSKY THRUSH	1	3	N/A	N/A
258	031182	0000	LAX	LANDNG	UNK	N/A	NO	YES	N/A	UNK	UNK	0	0	UNK	N/A
259	031182	1700	BGF	TO	UNK	2 BLDS	YES	YES	N/A	UNK	UNK	0	0	UNK	N/A
260	031382	1700	BWI	LANDNG	UNK	N/A	NO	N/A	N/A	UNK	UNK	0	0	N/A	MULT ENG INGEST
260	031382	1700	BWI	LANDNG	UNK	N/A	NO	YES	N/A	UNK	UNK	0	0	N/A	MULT ENG INGEST

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT [illegible]	IFSD REASON	BIRD SEEN	BIRD SPECIES	# B D	AV WT OZ	PI- LOT ACT	SIGNI- FICANT REASON
275	032782	0000	TYO	LANDNG	UNK	2 BLDS,1 CURLED	NO	N/A	N/A	UNK	UNK	0	0	N/A	N/A
276	032782	1415	CAI	TO	VFR	3 BLDS DENTED	YES	YES	N/A	UNK	PLACK KITE	1	24	ATB	N/A
277	032882	0000	XFO	UNK	UNK	ONE BLD BENT	UNK	YES	N/A	NO	UNK	1	0	N/A	N/A
278	032882	1700	AMS	TO	VFR	3 BLDS BENT	YES	YES	CRACKED OIL LINE	UNK	UNK	0	0	ATB	N/A

****** SAMPLE SIZE FOR MAR 82 = 28 # STRIKES WITH DAMAGE = 19 % = 67.857

EVT#	DATE	TIME	ARPT	FLIGHT PHASE	WX	FAN DAMAGE	POWR LOSS /RED	CONT	IFSD REASON	BIRD SEEN	BIRD SPECIES	# B D	AV WT OZ	PI- LOT ACT	SIGNI- FICANT REASON
279	040982	0000	LIS	CLIMB	UNK	3 BLDS B EVT	UNK	YES	VIBES	YES	UNK	1	0	ATB	N/A
280	041082	0000	XFO	UNK	VFR	1 BLADE TORN	NO	YES	N/A	UNK	UNK	0	0	N/A	N/A
281	041182	0000	XFO	UNK	UNK	1 BLADE DEFRMED	NO	YES	N/A	UNK	UNK	0	0	N/A	N/A
282	041382	1940	YYZ	TO	VFR	4 BLADES DMGD	YES	YES	N/A	UNK	SHORT EA RED OWL	1	12	ATB	N/A
283	041582	0000	XXX	UNK	UNK	N/A	NO	N/A	N/A	NO	UNK	0	0	N/A	N/A
284	041882	0000	XFO	UNK	UNK	ACOUSTIC LINING	NO	YES	N/A	NO	GLAUCOUS WNG GULL	1	52	N/A	N/A
285	042082	0000	XFO	UNK	UNK	N/A	NO	N/A	N/A	NO	UNK	0	0	N/A	N/A
286	042182	0000	KUS	UNK	UNK	1 BLADE BENT	NO	YES	N/A	NO	UNK	0	0	N/A	N/A
287	042182	1000	YYZ	TO	IFR	6 BLADES BENT	UNK	YES	VIBES	YES	RING BIL LED GULL	1	18	ATB	N/A
288	043082	0000	XFO	UNK	UNK	3 BLADES DMGD	NO	N/A	N/A	NO	RED WATL D LAPWNG	1	10	N/A	N/A
289	043082	0000	XFO	UNK	UNK	N/A	NO	N/A	N/A	NO	SEAGULL	0	24	N/A	N/A

****** SAMPLE SIZE FOR APR 82 = 11 # STRIKES WITH DAMAGE = 8 % = 72.727