NAVAL AIR PROPULSION TEST CENTER

TRENTON, NEW JERSEY 08628

(NASA-CR-136900) ROTOR BURST PROTECTION PROGRAM: STATISTICS ON AIRCRAFT GAS TURBINE ENGINE ROTOR FAILURES THAT OCCURRED IN US (Naval Air Propulsion Test Center) 28 p HC CSCL 21E G3/28
N74-21396
Unclas 36552

PROPULSION TECHNOLOGY & PROJECT ENGINEERING DEPARTMENT
NAPTC-PE-40 MARCH 1974

ROTOR BURST PROTECTION PROGRAM: STATISTICS ON AIRCRAFT GAS TURBINE ENGINE ROTOR FAILURES THAT OCCURRED IN U.S. COMMERCIAL AVIATION DURING 1972

REPORT ON NASA DPR C-41581-B, MOD. 5

Prepared by:

R. A. DeLUCIA

Approved by:

B. T. ALLIGOOD, JR
Commander, USN
Director, PT&E Department

G. J. MANGANO

DISTRIBUTION OF THIS REPORT IS UNLIMITED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) NAVAL AIR PROPULSION TEST CENTER TRENTON, NEW JERSEY 08628	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE

ROTOR BURST PROTECTION PROGRAM: STATISTICS ON AIRCRAFT GAS TURBINE ENGINE ROTOR FAILURES THAT OCCURRED IN U.S. COMMERCIAL AVIATION DURING 1972

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Technical Report

5. AUTHOR(S) (First name, middle initial, last name)

G. J. MANGANO and R. A. DeLUCIA

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
MARCH 1974	18	None

8a. CONTRACT OR GRANT NO NASA DPR C-41581-B, Mod. 5 b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) NAPTC-PE-40 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) None

10. DISTRIBUTION STATEMENT

DISTRIBUTION OF THIS REPORT IS UNLIMITED

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY

13. ABSTRACT

This report presents statistical information on the aircraft gas turbine engine rotor failures that occurred in U.S. commercial aviation during 1972. Based on FAA data, results are presented that establish (1) the incidence of rotor failure, (2) the type of fragments generated, (3) whether or not these fragments were contained, (4) the causes of failure, (5) where in the engine failure occurred, (6) what engines were affected and (7) what flight conditions prevailed at failure. The rate of uncontained rotor burst was considered to be significantly high. Blade fragments were generated in 95% of the rotor bursts, 20% of which were uncontained. Although fewer disk and rim fragment bursts occurred, none were contained.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Aircraft Hazards						
Aircraft Safety						
Gas Turbine Engine Rotor Failures						

CONTENTS

DISTRIBUTION OF THIS REPORT IS UNLIMITED

LIST OF FIGURES

INTRODUCTION

1. This report has been prepared as part of the Rotor Burst Protection Program (RBPP), which is sponsored by the National Aeronautics and Space Administration (NASA)[1] and conducted by the Naval Air Propulsion Test Center (NAPTC). The objective of the RBPP is to develop criteria for the design of devices that will be used on aircraft to protect passengers and the aircraft structure from the lethal and devastating fragments that are generated by gas turbine engine rotor bursts.

2. Presented in this report are statistics on gas turbine rotor failures that have occurred in U. S. commercial aviation during 1972. These statistics are based on data compiled from the Flight Standards Mechanical Reliability Reports (MRR) that were published by the Department of Transportation, Federal Aviation Administration (FAA). The compiled data were analyzed to establish:

a. The incidence of rotor failures and the number of contained and uncontained[2] rotor bursts.

b. The distribution of rotor bursts with respect to engine rotor component; i.e., fan, compressor or turbine.

c. The type of rotor fragment (disk, rim or blade) typically generated at burst.

d. The cause of failure.

e. The type of engines involved.

f. The flight condition at the time of failure.

RESULTS

3. The data used for analysis are contained in Appendix A. The results of these analyses are shown in Figures 1 through 6.

a. Figure 1 shows that 196 rotor failures occurred in 1972. These rotor failures accounted for approximately 6.9% of the 2854 shutdowns experienced by the gas turbine powered U. S. commercial aircraft fleet during 1972. Rotor fragments were generated in 127 of the failures

[1]NASA DPR C-41581-B, Mod. 5

[2]An uncontained rotor burst is defined as a rotor failure that produces fragments which penetrate and escape the confines of the engine casing.

experienced, and of these, 30 (23.6% of the rotor bursts) were uncontained. This represents an uncontained rotor burst rate of 4.7 per million gas turbine powered aircraft flight hours, or 1.53 per million engine operation hours. Approximately 6.4 million and 19.6 million aircraft flight and engine operating hours respectively, were logged by the U. S. commercial aviation in 1972. Because of the potentially catastrophic consequences of such bursts, these rates are considered to be significantly high.

b. Figure 2 shows the distribution of rotor bursts (rotor failures that produced fragments) according to the engine component involved--fan, compressor or turbine, the types of fragments that were generated, and the percentage of uncontained failures according to the type fragment generated. These data indicate that:

(1) Turbine rotor bursts occurred more than twice as frequently as did compressor rotor bursts; these corresponded to 58% and 28%, respectively, of the total number of rotor bursts. Fan rotor bursts accounted for 14% of the bursts experienced.

(2) Blade fragments were generated in 95% of the rotor bursts, 20% of these were uncontained. The remaining rotor bursts (5%) produced disk and rim fragments, all of which were uncontained.

c. Figure 3 shows the rotor failure distribution among the types of engines that were affected and the total number of engines in use of the type that experienced rotor failures. It appears that the larger, recently introduced turbo-fan engines such as the JT9D and RB211 experienced the highest percentages of rotor bursts.

d. Figure 4 shows what caused the rotor failures to occur. The dominant causal factors were: (1) design and life predictions problems (35.7%); (2) foreign object damage (26.5%); (3) secondary causes (21.4%).

e. Figure 5 shows the flight conditions that existed when the various rotor failures or bursts occurred. Approximately 90% of the 196 rotor failures occurred during the take-off, climb and cruise stages of flight. Almost 94% of the rotor bursts, and approximately 93% of the uncontained rotor bursts occurred during these same stages of flight. The highest percentage of uncontained rotor bursts (63.3%) were experienced during take-off.

f. Figure 6 shows the annual incidence of uncontained rotor bursts in commercial aviation for the years 1962 through 1972. It appears that for the past several years (1969 to 1972) the incidence of uncontained rotor burst has remained relatively constant at an average of almost 32 uncontained bursts per year.

CONCLUSIONS

4. The incidence of rotor failure and uncontained burst is still significantly high enough to warrant continuation of the experimental and analytical efforts that constitute the Rotor Burst Protection Program.

5. Of all the types of fragments generated at rotor burst, disk fragments, because of their size, high energy content and high rate of uncontainment (100%), continue to be a major threat to the welfare and safety of commercial aircraft passengers.

6. The number of uncontained blade failures is surprisingly high, considering that, under FAA regulations, rotor blade containment is required for engine certification.

7. It appears that causes beyond the control or scope of present technology, such as F.O.D, structural life and integrity prediction, and secondary effects, are still primarily responsible for most of the rotor failures that occur.

INCIDENCE OF ROTOR FAILURE/BURST IN U.S. COMMERCIAL AVIATION 1972

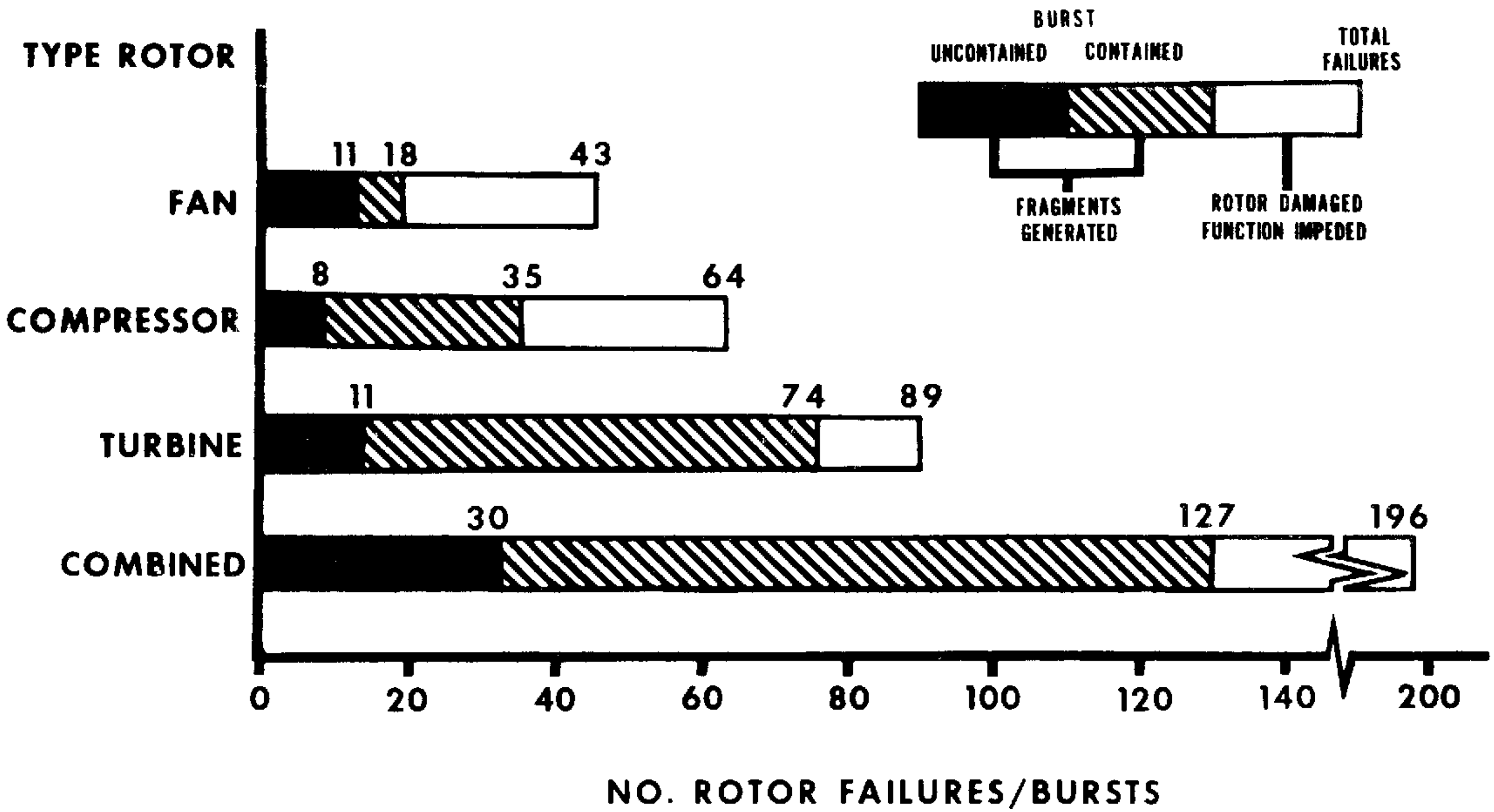


FIGURE 1

NAPTC-PE-40

COMPONENT AND FRAGMENT TYPE DISTRIBUTIONS FOR CONTAINED AND UNCONTAINED ROTOR BURSTS(1) - 1972

ENGINE ROTOR COMPONENT	TYPE OF FRAGMENT GENERATED						TOTALS	
	DISK		RIM		BLADE			
	TF	UCF	TF	UCF	TF	UCF	TF	UCF
FAN	1	1	0	0	17	10	18	11
COMPRESSOR	2	2	0	0	33	6	35	8
TURBINE	2	2	1	1	71	8	74	11
TOTALS	5	5	1	1	121	24	127	30

(1) FAILURES THAT PRODUCED FRAGMENTS

TF - TOTAL FAILURES

UCF - UNCONTAINED FAILURES

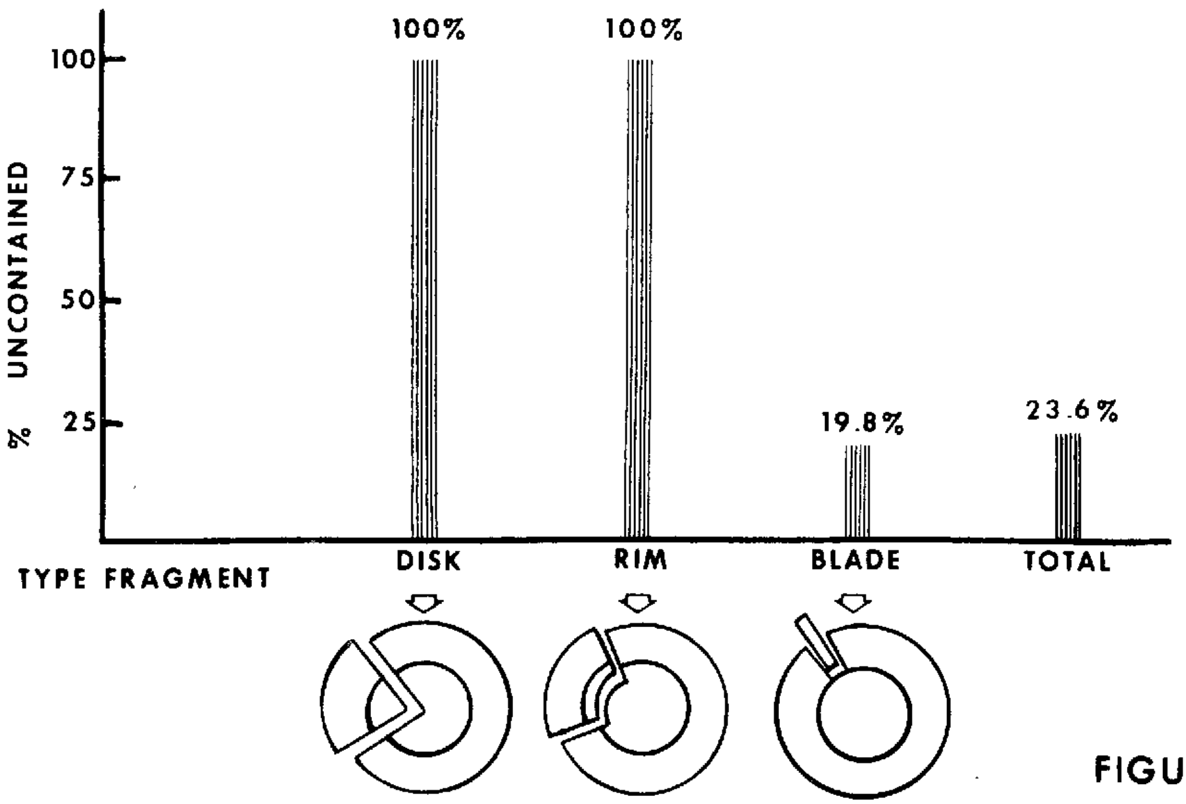
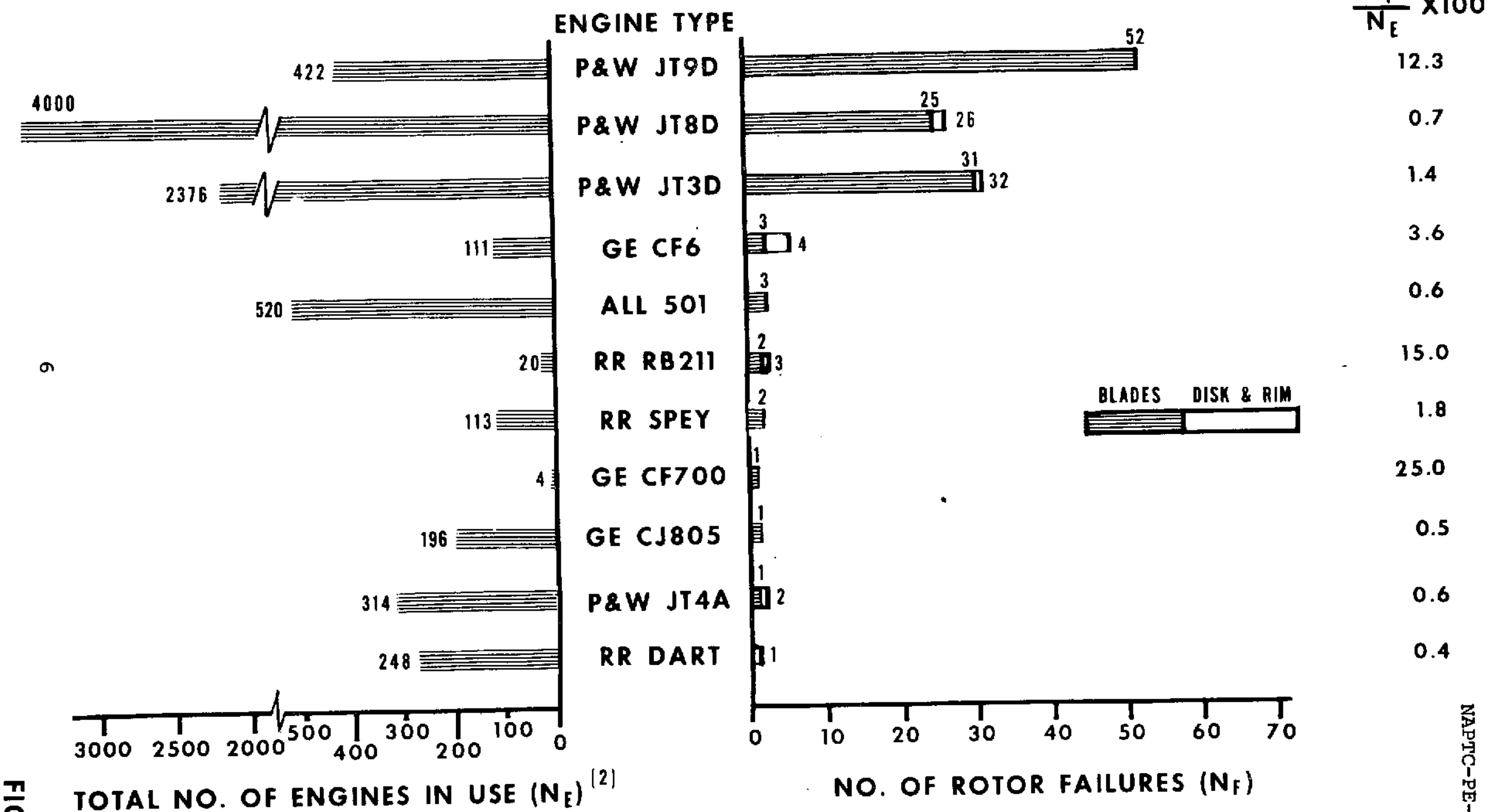


FIGURE 2

THE INCIDENCE OF ROTOR BURST[1] IN U.S. COMMERCIAL AVIATION
ACCORDING TO ENGINE TYPE AFFECTED - 1972



(1) FAILURES THAT PRODUCED FRAGMENTS
(2) YEARLY AVG. OF AIRCRAFT IN USE AT END OF EACH MONTH

FIGURE 3

NAPTC-PE-40

ROTOR FAILURE/BURST CAUSE CATEGORIES - 1972

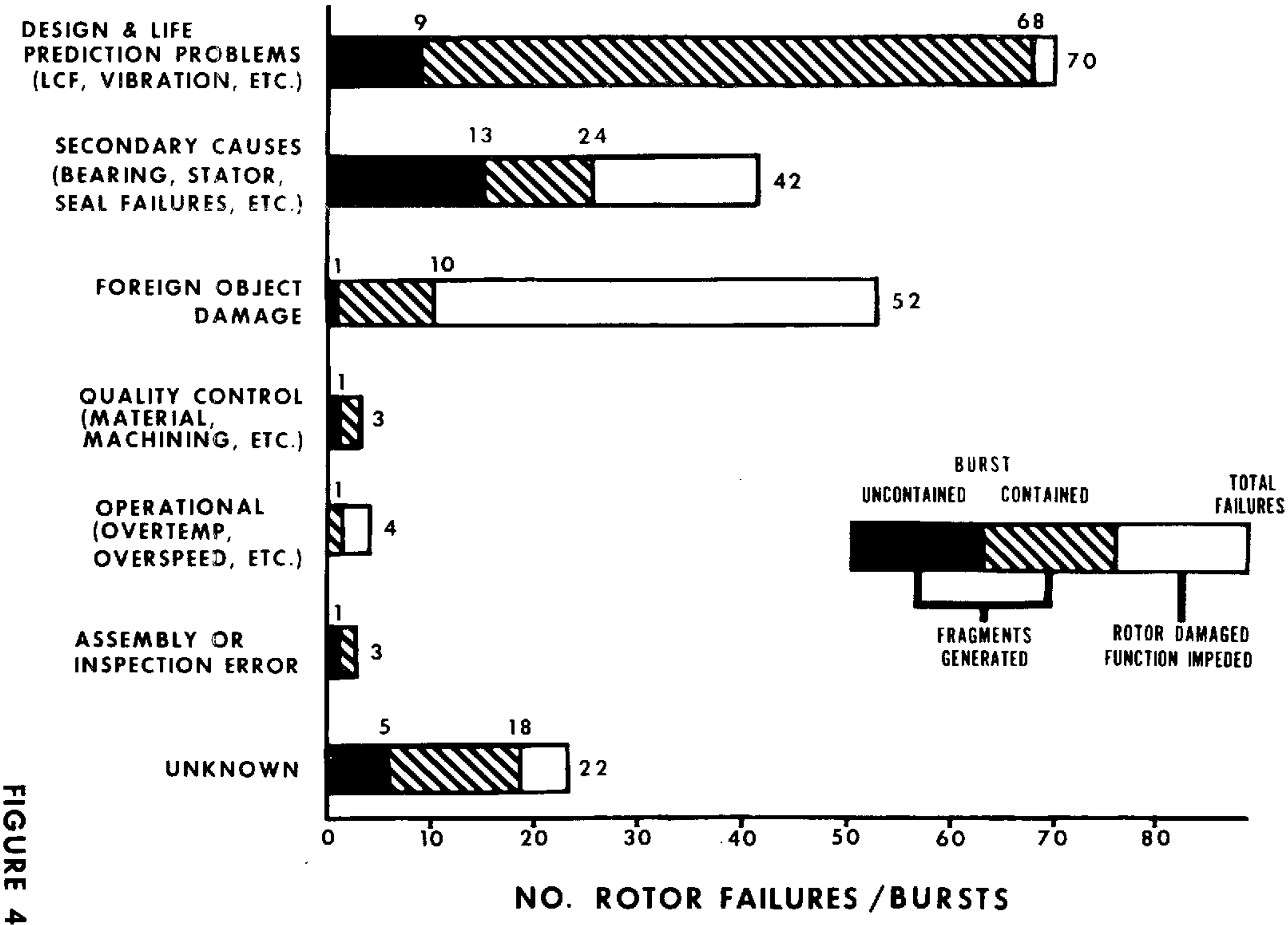


FIGURE 4

FLIGHT CONDITION AT ROTOR FAILURE/BURST - 1972

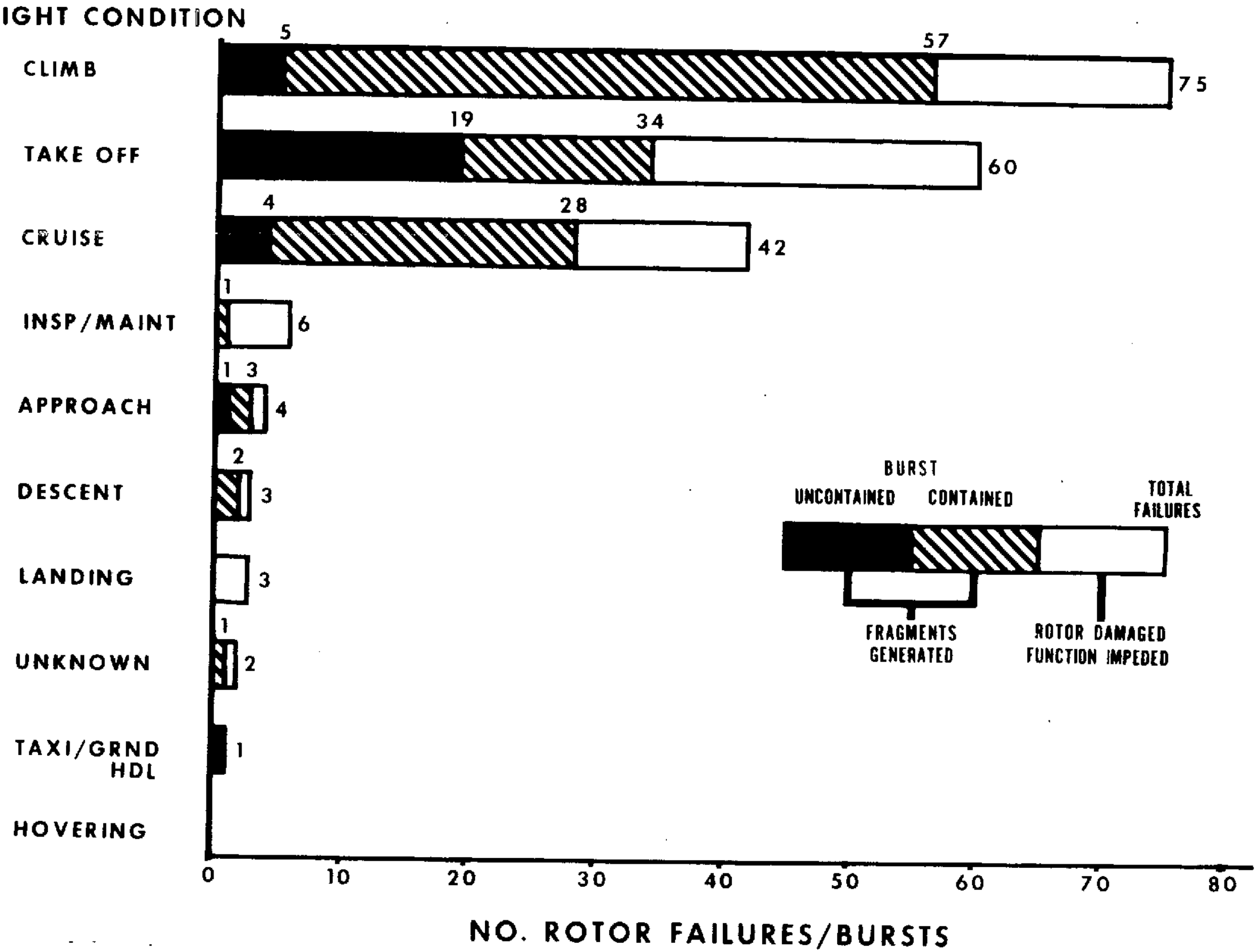


FIGURE 5

THE INCIDENCE OF UNCONTAINED ROTOR BURSTS IN U.S. COMMERCIAL AVIATION

1962 - 1972

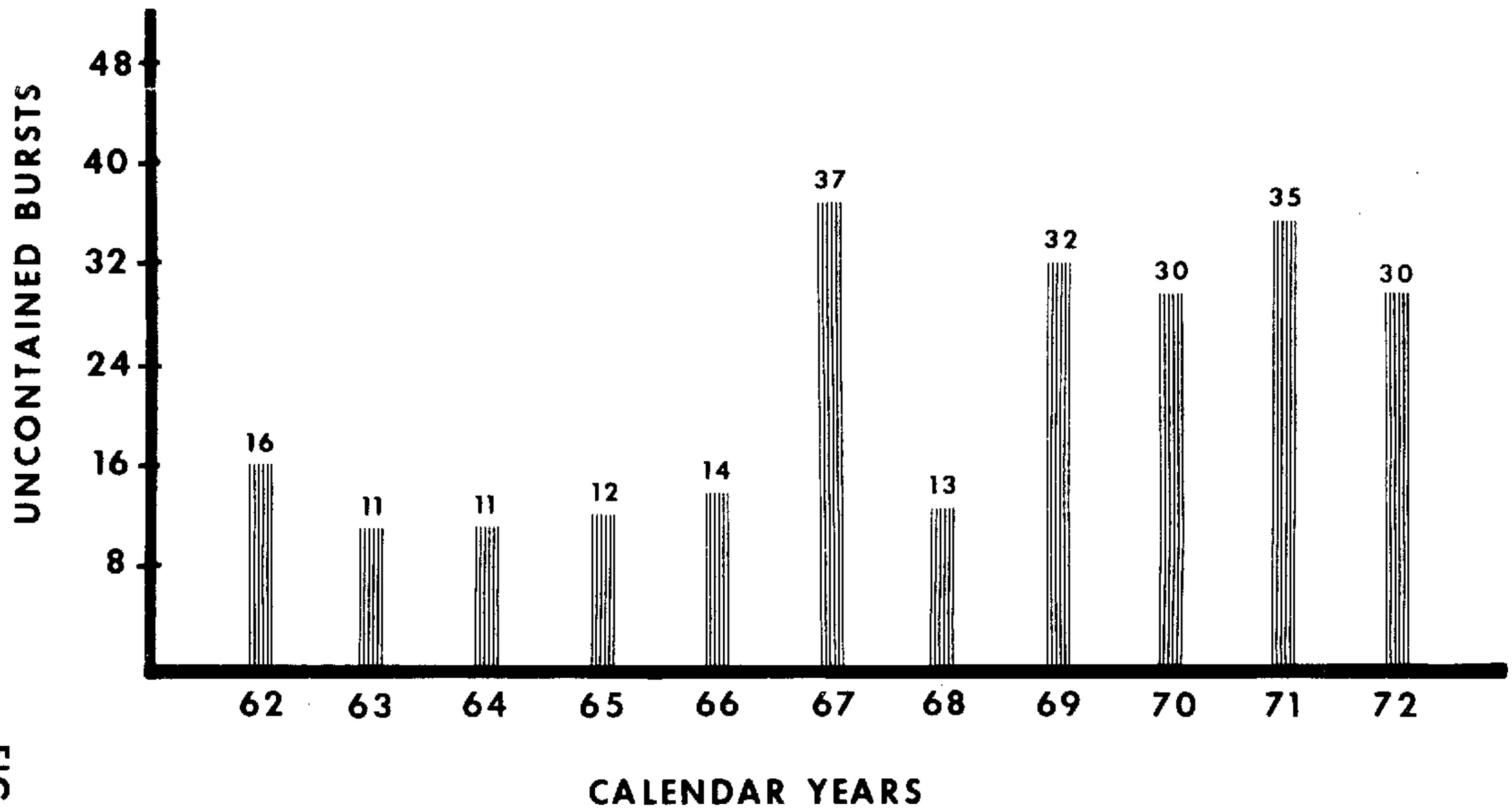


FIGURE 6

NAPTC-PE-40

Appendix A

Data on Rotor Failures in U. S. Commercial Aviation for 1972. Compiled from the Federal Aviation Administration Mechanical Reliability Reports.

Data Compilation Key:

Component Code:

F - Fan

C - Compressor

T - Turbine

Fragment Type Code:

D - Disk

R - Rim

B - Blade

N - None

Cause Code:

1 - Design and Life Prediction Problems

2 - Secondary Causes

3 - Foreign Object Damage

4 - Quality Control

5 - Operational

6 - Assembly and Inspection Error

7 - Unknown

Containment Condition Code:

C - Contained

NC - Not Contained

FLIGHT CONDITION CODE:

1 - Insp/Maint

2 - Taxi/Grnd Hdl

3 - Take Off

4 - Climb

5 - Cruise

6 - Descent

7 - Approach

8 - Landing

9 - Hovering

10 - Unknown

MMR NO.	DATE	AIRLINE	AIRCRAFT	ENGINE	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
72001020	1/1	AAL	747	JT9D	T	B	1	C	4
72003010	1/1	TWA	707	JT3D	C	B	3	C	4
72006019	1/5	TWA	747	JT9D	T	B	1	C	5
72008018	1/6	PAA	727	JT8D	C	B	1	NC	3
72015031	1/19	FAL	CV580	501-D13	C	B	3	C	5
72019002	1/21	SR NX	727	JT8D	C	B	1	C	4
72019025	1/24	EAL	DC-9	JT8D	C	B	2	NC	5
72032008	2/8	TSA	737	JT8D	F	B	1	NC	3
72034047	2/17	TXI	CV600	RR-DART	C	D	7	NC	4
72038028	2/21	UAL	737	JT8D	C	D	2	NC	6
72039016	2/21	DAL	747	JT9D	T	B	1	C	4
72041019	2/26	EAL	DC-8	JT3D	T	B	6	C	5
72068006	4/4	TWA	707	JT3D	T	B	2	C	4
72049029	2/20	TWA	DC-9	JT8D	C	B	3	C	10
72051028	3/11	EAL	DC-9	JT8D	C	B	3	C	4
72054023	3/12	PAA	747	JT9D	C	B	1	C	5
72056008	3/16	TWA	707	JT3D	C	B	1	C	5

MMR NO.	DATE	AIRLINE	AIRCRAFT	ENGINE	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
72057002	3/20	TWA	707	JT3D	T	B	1	C	5
72068006	4/4	TWA	707	JT3D	T	B	2	C	4
72070013	4/5	EAL	DC9	JT8D	T	B	1	C	3
72074019	4/12	DAL	DC8	JT3D	T	B	2	NC	4
72078037	4/17	SAAX	L382G	501 - D22	T	B	7	C	7
72079017	4/17	PAA	747	JT9D	T	B	1	C	5
72089011	5/2	EAL	DC-8	JT4A	C	B	2	C	3
72092010	5/6	TWA	747	JT9D	T	B	1	C	4
72101018	5/17	PAA	747	JT9D	C	B	1	C	3
72101030	5/18	NCA	DC-9	JT8D	F	B	3	C	3
72104002	5/25	PAA	707	JT3D	C	B	1	NC	3
72105003	5/23	TWA	707	JT3D	T	B	1	C	3
72106013	5/29	AAL	727	JT8D	F	B	2	NC	3
72108001	6/1	AAL	707	JT3D	T	B	2	NC	3
72114011	6/10	FTLX	DC-8	JT3D	T	B	2	C	4
72118013	6/10	PAA	747	JT9D	T	B	1	C	4
72118015	6/13	EAL	DC-8	JT3D	T	D	2	NC	3

MMR. NO.	DATE	AIRLINE	AIRCRAFT	ENGINE	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
72119011	6/13	TWA	747	JT9D	T	B	1	C	4
72120012	6/15	TWA	707	JT3D	C	B	1	C	4
72120019	6/17	AAL	727	JT8D	T	B	7	C	4
72120025	6/19	TWA	747	JT9D	T	B	1	C	4
72121005	6/15	ASA	727	JT8D	F	B	3	NC	5
72123014	6/21	AAL	747	JT9D	T	B	7	NC	4
72124010	6/19	PAA	747	JT9D	T	B	2	NC	5
72126008	6/25	TWA	707	JT3D	C	B	1	C	4
72126020	6/22	TWA	747	JT9D	T	B	1	C	4
72129009	6/30	AAL	707	JT3D	C	B	7	NC	3
72132012	7/6	AAL	747	JT9D	T	B	1	NC	3
72138022	7/12	TWA	747	JT9D	T	B	1	C	4
72127024	6/29	PAA	747	JT9D	C	B	1	C	4
72142013	7/15	TWA	747	JT9D	T	B	1	C	4
72142018	7/19	SBWX	DC-8	JT3D	C	B	1	C	4
72144006	7/21	WAL	707	JT3D	C	B	1	C	3
72145015	7/20	PAA	747	JT9D	T	B	1	C	4
72146004	7/24	TWA	707	JT3D	C	B	1	C	4

MMR. NO.	DATE	AIRLINE	AIRCRAFT	ENGINE	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
72147005	7/25	PAA	747	JT9D	T	B	1	C	5
72147008	7/1	EAL	DC-9	JT8D	F	B	4	C	2
72148016	7/27	CAL	DC-10	CF6	T	R	2	NC	4
72148014	7/24	PAA	747	JT9D	T	B	1	C	4
72150012	7/30	TWA	747	JT9D	T	B	1	C	4
72150022	8/1	AAA	DC9	JT8D	F	B	6	NC	3
72159021	8/10	PAA	747	JT9D	T	B	1	C	4
72160005	8/10	TWA	707	JT3D	T	B	1	C	4
72160014	8/13	TWA	747	JT9D	T	B	1	C	4
72165013	8/22	AAL	747	JT9D	C	B	2	C	4
72166017	8/19	PAA	747	JT9D	T	B	1	C	4
72166019	7/30	TWA	747	JT9D	T	B	1	C	6
72166020	8/19	TWA	747	JT9D	T	B	2	C	4
72166021	8/22	TWA	747	JT9D	T	B	1	C	4
72169008	8/28	PAA	727	JT8D	T	B	1	C	4
72169016	8/28	PAA	747	JT9D	F	B	3	C	4
72169017	8/28	PAA	747	JT9D	T	B	1	C	4
72169030	8/25	AWI	DC9	JT8D	F	B	1	NC	3

MMR. NO.	DATE	AIRLINE	AIRCRAFT	ENGINE	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
72173015	8/31	TWA	747	JT9D	C	B	1	C	4
72179007	9/8	BNF	727	JT8D	T	B	1	C	5
72180020	9/7	DAL	747	JT9D	C	B	6	C	5
72180021	9/9	PAA	747	JT9D	T	B	1	C	5
72180033	9/6	EAFT	MD-20	CF700	T	B	3	C	1
72186027	9/19	CAL	747	JT9D	T	B	1	NC	4
72188020	9/23	EAL	L-1011	RB-211	T	B	1	C	5
72189022	9/21	TWA	747	JT9D	T	B	7	C	5
7217006	8/29	CAL	727	JT8D	T	B	7	C	4
72193018	10/2	RDLX	DC8	JT3D	T	B	1	C	4
72194004	9/30	TWA	707	JT3D	F	B	3	C	3
72195019	10/2	BNF	747	JT9D	T	B	1	C	5
72195028	10/1	EAL	DC9	JT8D	C	B	1	C	3
72197016	10/5	EAL	DC-8	JT4A	T	D	2	NC	3
72197029	10/4	SAAX	L-382	501-D22	T	B	7	C	5
72200021	10/6	PAA	747	JT9D	T	B	1	C	4
72201008	10/10	TWA	747	JT9D	T	B	1	C	3
72204021	10/17	TWA	747	JT9D	T	B	1	C	4

MMR NO.	DATE	AIRLINE	AIRCRAFT	ENGINE	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
72207015	10/21	PAA	747	JT9D	T	B	1	C	4
72213015	12/20	PAA	747	JT9D	T	B	5	C	4
72210008	10/28	NAL	727	JT8D	C	B	2	NC	3
72211009	10/29	PAA	747	JT9D	T	B	1	C	4
72215016	10/23	BNF	DC-8	JT3D	C	B	1	C	5
72219020	11/15	CAPX	DC-8	JT3D	C	B	1	NC	3
72223010	11/21	NWA	727	JT8D	T	B	1	NC	3
72209016	10/23	NAL	DC-10	CF6	C	B	1	C	7
72225010	11/14	UAL	DC-8	JT3D	T	B	7	C	4
72228002	11/19	NWA	707	JT3D	F	B	4	NC	3
72228017	11/10	NWA	747	JT9D	F	B	1	NC	7
72229016	11/17	TWA	747	JT9D	T	B	2	C	5
72234015	11/13	SOU	DC-9	JT8D	F	B	2	NC	3
72237016	12/3	CAL	747	JT9D	T	B	7	C	3
72236006	11/29	PAA	707	JT3D	C	B	2	C	5
72240020	12/5	NAL	DC-10	CF6	T	B	2	C	5
72241016	12/6	TWA	747	JT9D	T	B	1	C	5
72024032	2/2	OZA	DC-9	JT8D	T	N	2	-	3

MMR. NO.	DATE	AIRLINE	AIRCRAFT	ENGINE	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
72243006	12/7	PAA	707	JT3D	T	B	2	NC	3
72244022	12/10	PAA	747	JT9D	C	B	1	C	4
72230-010	11/24	AA	BAC111	SPEY	T	B	7	C	3
72245018	12/17	PAA	747	JT9D	T	B	1	C	4
72245020	12/17	PAA	747	JT9D	C	B	1	C	5
72245026	12/12	CAL	DC-9	JT8D	F	B	3	C	4
72245034	12/13	EAL	L-1011	RB211	T	B	1	C	5
73002004	12/21	NWA	707	JT3D	F	B	7	C	3
72248017	12/16	DAL	DC-8	JT3D	C	B	2	C	3
72248020	12/17	EAL	DC-9	JT8D	C	B	2	C	5
73001017	12/15	TWA	727	JT8D	F	B	7	NC	3
73001022	12/19	EAL	DC-8	JT3D	T	B	1	C	4
73005033	12/27	TWA	747	JT9D	T	B	1	C	4
73005050	12/28	EAL	L-1011	RB211	F	D	7	NC	5
73002004	12/17	NWA	707	JT3D	F	B	4	C	3
73005031	12/29	PAA	747	JT9D	T	B	1	C	4
72132014	7/3	PAA	747	JT9D	C	B	7	C	4
72191013	9/22	UAL	DC-10	CF6	F	B	2	NC	3

MMR. NO.	DATE	AIRLINE	AIRCRAFT	ENGINE	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
72023014	1/27	EAL	727	JT8D	T	B	1	C	5
72230010	11/24	AAL	BC-111	SPEY	T	B	7	C	3
72174015	9/4	MDNX	CV-990	GT805	T	B	7	C	4
72073024	4/11	NAL	DC-8	JT3D	T	B	7	C	5
72119-006	6/15	CAL	727	JT8D	F	N	3	-	3
72126-019	6/25	AAL	747	JT9D	F	N	3	-	8
72126-029	6/23	AAL	DC-10	CF-6	F	N	3	-	3
72127-009	6/23	PAA	707	JT3D	F	N	3	-	3
72165-029	8/31	TXI	DC-9	JT8D	F	N	3	-	1
72178-015	9/2	SAAX	DC-8	JT3D	F	N	3	-	3
72198-006	10/7	PAI	727	JT8D	F	N	3	-	3
72199-013	10/6	PSAX	727	JT8D	F	N	3	-	3
72216-009	11/3	CAL	727	JT8D	F	N	3	-	4
72217-027	11/4	NCA	DC-9	JT8D	F	N	3	-	8
72247-018	12/13	ACAX	737	JT8D	F	N	3	-	4
72247-019	12/15	PAI	737	JT8D	F	N	3	-	3
72047-009	3/2	PAA	747	JT9D	F	N	3	-	4
72247-033	12/13	UAL	DC-10	CF6	F	N	3	-	5

A1-10

MMR NO.	DATE	AIRLINE	AIRCRAFT	ENGINE	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
72247-033	12/13	UAL	DC-10	CF6	C	N	3	-	5
72131-027	7/3	TWA	CU880-22	CJ805	C	N	2	-	1
72051-034	3/12	UVAY	L188C	501-D13	C	N	3	-	5
72077-001	4/19	AAL	707	JT3D	F	N	3	-	5
72003-009	12/31	TWA	707	JT3D	F	N	3	-	5
72212-026	10/30	AAL	DC-10	CF-6	F	N	*3	-	
72212-026	10/30	AAL	DC-10	CF-6	F	N	*3	-	*3
72212-026	10/30	AAL	DC-10	CF-6	F	N	*3	-	
72131-020	6/9	SWAX	737	JT8D	F	N	3	-	5
72134-018	7/6	AAL	747	JT9D	C	N	3	-	3
72107-007	5/26	TWA	747	JT9D	C	N	2	-	3
72139-019	7/15	MDNX	CV990	CJ805	F	N	3	-	3
72044-007	2/28	RDLX	DC-8	JT3D	C	N	3	-	3
72203-029	10/8	CNTC	L-888	501-D13	C	N	3	-	3
72015-008	1/17	CAL	727	JT8D	T	N	5	-	4
72003-023	12/30	TWA	727	JT8D	T	N	5	-	3
72162-019	9/15	CAPX	DC-8	JT4A	T	N	1	-	4
72237015	12/1	PAA	B-727	JT8D	C	N	2	-	5

*Three engines same aircraft

MMR NO.	DATE	AIRLINE	AIRCRAFT	ENGINE	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
72184-028	9/14	CAPX	DC-8	JT4A	T	N	7	-	4
72180-033	9/6	EAFT	MD-20	CF700	T	N	3	-	1
72194-004	9/30	TWA	707	JT3D	F	N	3	-	3
72118-022	6/13	EAL	DC-9	JT8D	F	N	3	-	3
72087016	5/1	EAL	DC-9	JT8D	C	N	3	-	8
72138020	7/11	PAA	747	JT9D	T	N	2	-	4
72141017	7/3	DAL	DC-9	JT8D	T	N	2	-	4
72175018	9/1	PAA	747	JT9D	C	N	2	-	4
72176012	9/5	AAL	BAC111	SPEY	T	N	2	-	3
72241020	12/7	DAL	DC8	JT3D	T	N	1	-	4
73002018	12/21	ACAX	737	JT8D	C	N	3	-	3
73003029	12/21	UAL	727	JT8D	C	N	7	-	5
72248025	12/15	EAL	L1011	RB211	C	N	7	-	3
72097013	5/11	EAL	727	JT8D	C	N	2	-	5
72159020	8/10	CAL	747	JT9D	C	N	3	-	4
72038040	2/20	TWA	DC-9	JT8D	C	N	3	-	5
72016021	1/16	SOU	DC-9	JT8D	C	N	2	-	4
72018028	1/24	TWA	747	JT9D	C	N	2	-	4

MMR NO.	DATE	AIRLINE	AIRCRAFT	ENGINE	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
72024017	2/1	UAL	747	JT9D	C	N	3	-	6
72035014	2/16	TWA	747	JT9D	C	N	2	-	4
72040033	2/25	UVAY	L188C	501-D13	C	N	3	-	8
72041009	2/25	EAL	727	Jt8D	C	N	2	-	10
72046001	3/4	AAL	707	JT3D	C	N	3	-	5
72068033	4/3	AAL	CV580	501-D13	T	N	2	-	5
72126030	6/27	AAL	DC10	CF6	T	N	2	-	7
72131036	7/4	AAL	DC10	CF6	C	N	3	-	3
72161008	8/15	TWA	707	JT3D	T	N	2	-	4
72165029	8/2	TXI	DC-9	JT8D	F	N	3	-	1
72166020	8/19	TWA	747	JT9D	T	N	2	-	3
72167007	8/18	ACAX	737	JT8D	C	N	3	-	3
72184022	9/16	PAA	747	JT9D	C	N	2	-	4
72216015	10/30	NWA	747	JT9D	T	N	5	-	5
72216023	11/3	TXI	DC-9	JT8D	C	N	3	-	1
72212027	10/28	CAL	DC-10	JT3D	C	N	3	-	4
72233019	11/28	UAL	DC-8	JT3D	G	N	3	-	4
77005049	12/20	LTVT	MO-20	GF700	F	N	7	-	5