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Statistics on Aircraft Gas Turbine Engine Rotor Failures that Occurred in U. S. Commercial Aviation During 1982

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Trenton, New Jersey

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July 1988

Final Report

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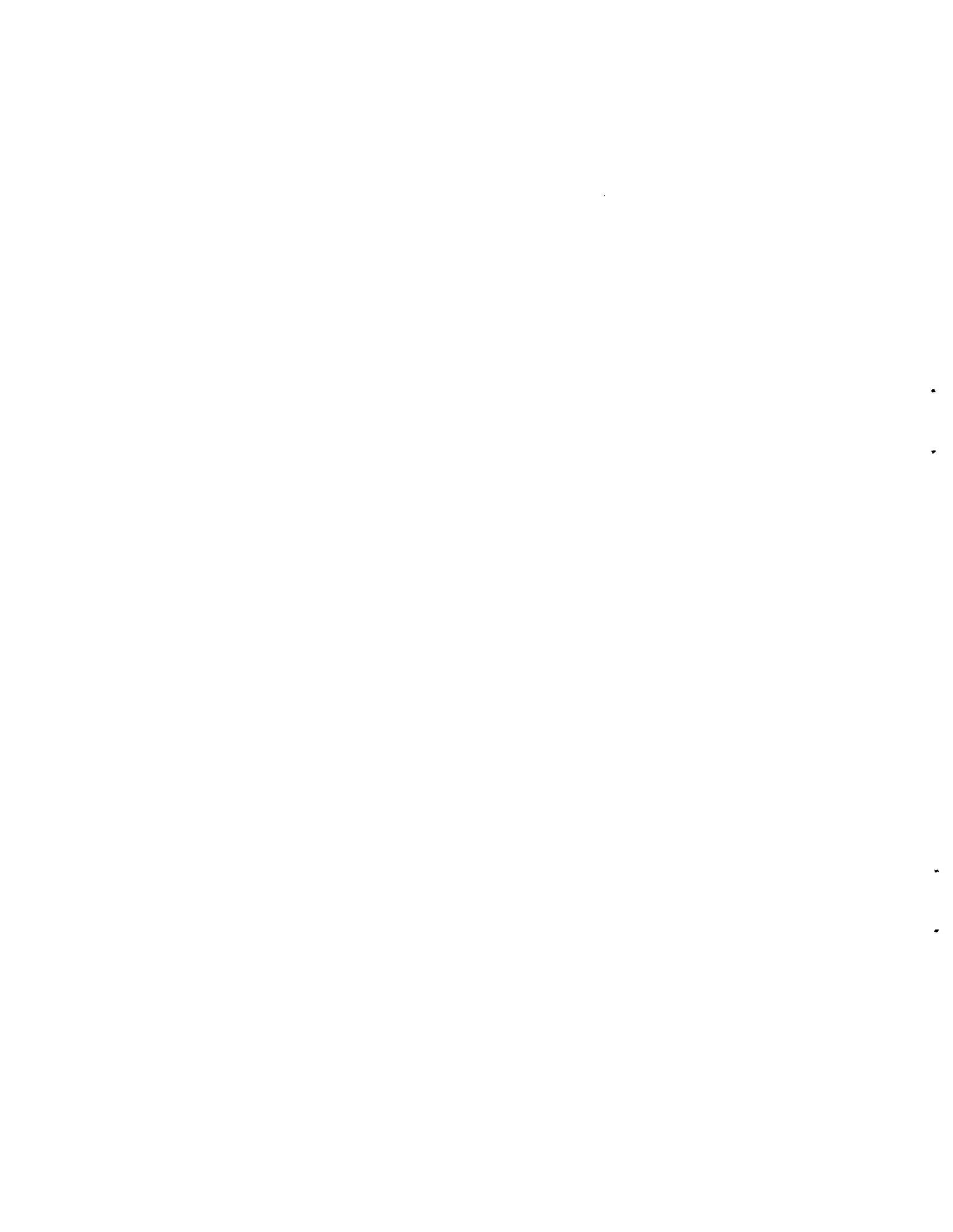
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16. Abstract This report presents statistics relating to gas turbine engine rotor failures which occurred during 1982 in U. S. commercial aviation service use. One-hundred and sixty-one rotor failures occurred in 1982. Rotor fragments were generated in 88 of the failures and, of these, 16 were uncontained. The predominant failure involved blade fragments. Seven disk failures occurred and all were uncontained. Seventy percent of the 161 failures occurred during the takeoff and climb stages of flight. This service data analysis is prepared on a calendar year basis and published yearly. The data support flight safety analysis, proposed regulatory actions, certification standards, and cost benefit analyses.			
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- o New England Region, Burlington, MA, for providing verification of the uncontained engine rotor failure occurrences during calendar year 1982.
- o Flight Standards National Field Office, Oklahoma City, OK, for providing the basic data used to prepare this report.



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EXECUTIVE SUMMARY

This service data analysis is prepared on a calendar year basis and published annually. The data support flight safety analyses, proposed regulatory actions, certification standards, and cost benefit analyses. The following statistics are based on gas turbine engine rotor failures that have occurred in United States commercial aviation during 1982. One hundred and sixty-one rotor failures occurred in 1982. These failures accounted for approximately 9.3 percent of the 1722 shutdowns experienced by the United States commercial fleet. Rotor fragments were generated in 88 of the failures and, of these, 16 were uncontained. This represents an uncontained failure rate of 2.1 per million gas turbine engine powered aircraft flight hours, or 1.3 per million engine operating hours. Approximately 7.6 and 20.8 million aircraft flight and engine operating hours, respectively, were logged in 1982.

Turbine rotor fragment-producing failures were approximately two times greater than that of the compressor rotor fragment-producing failures (60 and 26 respectively, of the total). Fan rotor failures accounted for two of the fragment-producing failures experienced.

Blade failures were generated in 78 of the rotor failures; 8 of these were uncontained. The remaining 10 fragment-generating failures were produced by disk, rim, and seal.

Of the 102 known causes of failures (because of the high percentage of unknown causes of rotor failures, the percentages were based on the total number of known causes), the causal factors were (1) foreign object damage--41 (40.2 percent); (2) secondary causes--39 (38.2 percent); (3) design and life prediction problems--21 (20.6 percent); and (4) operational--1 (1.0 percent). One-hundred and twelve (69.6 percent) of the 161 rotor failures occurred during the takeoff and climb stages of flight. Seventy-one (80.7 percent) of the 88 rotor fragment-producing failures and 14 (87.5 percent) of the 16 uncontained rotor failures occurred during these same stages of flight.

The incidence of engine rotor failures producing fragments has remained relatively constant when compared to 1981 (88 in 1982 and 84 in 1981). The uncontained engine rotor failures likewise has remained constant (16 in 1982 and 1981). Interestingly, the 8-year (1975 through 1982) average of uncontained engine rotor failures has also remained constant at 16.

INTRODUCTION

This report is sponsored by the Federal Aviation Administration (FAA), Technical Center, located at the Atlantic City International Airport, New Jersey.

This service data analysis is published yearly. The data support flight safety analyses, proposed regulatory actions, certification standards, and cost benefit analyses.

This report presents data on rotor failure occurrences in United States (U.S.) commercial aviation. Presented in this report are statistics on gas turbine engine failures that have occurred in U.S. commercial aviation during 1982. These statistics are based on data compiled from the Flight Standards Service Difficulty Reports that were published by the FAA. Cross-checks to other accident data sources, such as the FAA New England Region Directorate, were made to substantiate the nature of an engine failure incident (i.e., contained or uncontained). The compiled data were analyzed to establish:

1. The incidence of rotor failures and the incidence of contained and uncontained rotor fragments (an uncontained rotor failure is defined as a rotor failure that produces fragments which penetrate and escape the confines of the engine casing).
2. The distribution of rotor failures with respect to engine rotor components, i.e., fan, compressor, or turbine rotors and their rotating attachments or appendages such as spacers and seals.
3. The number of rotor failures according to engine model and engine fleet hours.
4. The type of rotor fragment (disk, rim, or blade) generated at failure.
5. The cause of failure.
6. The flight conditions at the time of failure.
7. Engine failure rate according to engine fleet hours.

RESULTS

The data used for analyses are contained in appendix A; the results of these analyses are shown in figures 1 through 9.

Figure 1 shows that 161 rotor failures occurred in 1982. These rotor failures accounted for approximately 9.3 percent of the 1722 shutdowns experienced by the U.S. commercial gas turbine powered aircraft fleet during 1982. Rotor fragments were generated in 88 of the failures experienced and, of these, 16 (18.2 percent of the fragment-producing failures) were uncontained. This represents an uncontained failure rate of 2.1 per million gas turbine engine powered aircraft flight hours, or 1.3 per million engine operating hours.

Approximately 7.6 million aircraft flight hours and 20.8 million engine operating hours were logged by the U.S. commercial aviation fleet in 1982. Gas turbine engine fleet operating hours relative to the number of rotor failures and type of engines in use are shown in figure 2.

Figure 3 shows the distribution of rotor failures that produced fragments according to the engine component involved (fan, compressor, turbine), the types of fragments that were generated, and the percentage of uncontained failures according to the type of fragment generated. These data indicate that:

1. The incidence of turbine rotor fragment-producing failures was approximately two times greater than that of the compressor rotor fragment-producing failures; these corresponded to 60 (68.2 percent) and 26 (29.5 percent), respectively, of the total number of rotor failures. Fan rotor failures accounted for two (2.3 percent) of the fragment-producing failures experienced.

2. Blade fragments were generated in 78 (88.6 percent) of the rotor failures; eight (10.3 percent) of these were uncontained. The remaining 10 (11.4 percent) rotor fragment failures were produced by disk, rim, and seal. While the disk and seal failures were a relatively small percentage of the total failures, all of the disk and seal failures were uncontained.

Figure 4 shows the rotor failure distribution among the engine models that were affected and the total number of models in use.

Figure 5 contains a compilation of engine failure rates per million engine flight hours according to engine model, engine type, and containment condition. The engine failure rates per million flight hours by engine type are turbofan--6.9, turboprop--12.1, turboshaft--58.8, and turbojet--none. Uncontained engine failure rates per million flight hours by engine type were turbofan--0.4, turboprop--2.4, and turboshaft--29.4.

Figure 6 shows what caused the rotor failures to occur. Of the 102 known causes of failure (because of the high percentage of unknown causes of rotor failure, the percentages were based on the total number of known causes), the causal factors were (1) foreign object damage--41 (40.2 percent); (2) secondary causes--39 (38.2 percent); (3) design and life prediction problems--21 (20.6 percent); and operational--1 (1.0 percent).

Figure 7 indicates the flight conditions that existed when the various rotor failures occurred. One-hundred and twelve (69.6 percent) of the 161 rotor failures occurred during the takeoff and climb stages of flight. Seventy-one (80.7 percent) of the rotor fragment-producing failures and 14 (87.5 percent) of the uncontained rotor failures occurred during these same stages of flight. The highest number of uncontained rotor failures, nine (56.3 percent), happened during takeoff.

Figure 8 is a cumulative tabulation that describes the distribution of uncontained rotor failures according to fragment type, engine component involved, cause category, and flight condition (takeoff and climb are defined as "high power," all other conditions are defined as "low power") for the years 1976 through 1982. This figure is expanded yearly to include all subsequent uncontained rotor failures. These data indicate that for "secondary causes"

the number of uncontained failures was approximately six times greater at "high" power than "low" power (namely 24 and 4). For "design and life prediction problems" the number of "high" power uncontained failures was approximately three times greater than "low" power (namely 20 and 7); and for "foreign object damage," the number of uncontained failures was six times greater at "high" power than "low" power (namely 6 and 1). This tabulation also indicates that of the 111 total uncontained incidences, blade failures accounted for 72.1 percent; disks failures, 15.3 percent; rim failures, 6.3 percent; and seal/spacer failures, 6.3 percent.

Figure 9 shows the annual incidence of uncontained rotor failures in commercial aviation for the years 1962 through 1982. During 1982, the incidence of uncontained rotor failures (16) was identical to those reported the previous year, 1981. Over the past 7 years, 1976 through 1982, an average of 16 uncontained rotor failures per year have occurred. During the same time period, the rate of uncontained rotor failures has remained relatively constant at an average of approximately one per million engine operating hours.

DISCUSSION AND CONCLUSIONS

The incidence of engine rotor fragment-producing failures has remained relatively constant when compared to 1981 (88 in 1982 and 84 in 1981). The uncontained engine rotor failures, likewise, has remained constant (16 in 1982 and 16 in 1981). Interestingly, the 8-year (1975 through 1982) average of uncontained engine rotor failures has also remained constant at 16.

Of the 16 uncontained events that occurred during 1982, 12 (75.0 percent) involved turbine rotors, three (18.7 percent) involved compressor rotors, and one (6.3 percent) involved a fan rotor.

The predominant cause of failure was attributed to foreign object damage (40.2 percent of the known failures) although no uncontained failures occurred in this category. Secondary causes (38.2 percent of known failures) and design and life prediction problems (20.6 percent of the known causes) each had two uncontained failures. The causes of the remaining 12 uncontained failures (75.0 percent) are unknown.

Uncontained failures occurred in three of the 10 flight modes; i.e., nine during takeoff (56.3 percent), five during climb (31.2 percent), and two on approach (12.5 percent).

The higher incidences of uncontained rotor failures in calendar years 1967 through 1973 (except for 1968) were probably due to the introduction of newly developed engines entering the commercial aviation fleet, such as the JT9D and CF6 engines.

Structural life prediction and verification is being improved by the increased use of spin chamber testing by government and industry as a means of obtaining failure data for statistically significant samples. In addition, increased development and application of high sensitivity, nondestructive inspection methods should increase the probability of cracks being detected prior to failure. The capability to reduce the causes of failures from secondary effects is also being addressed through technology development programs. However, causes due to foreign object damage still appear to be beyond the control or scope of present technology.

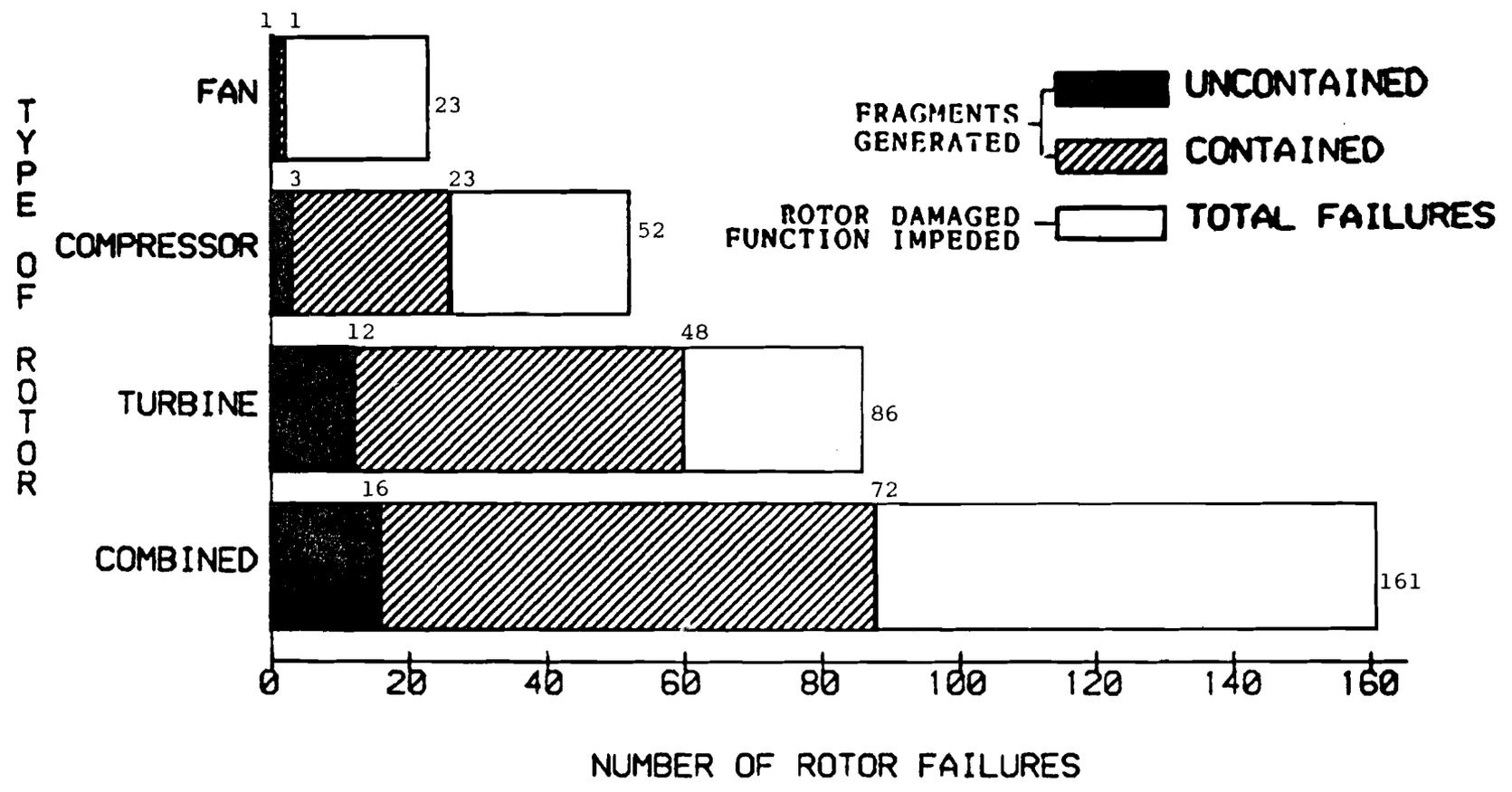


FIGURE 1. INCIDENCE OF ENGINE ROTOR FAILURES IN U.S. COMMERCIAL AVIATION - 1982

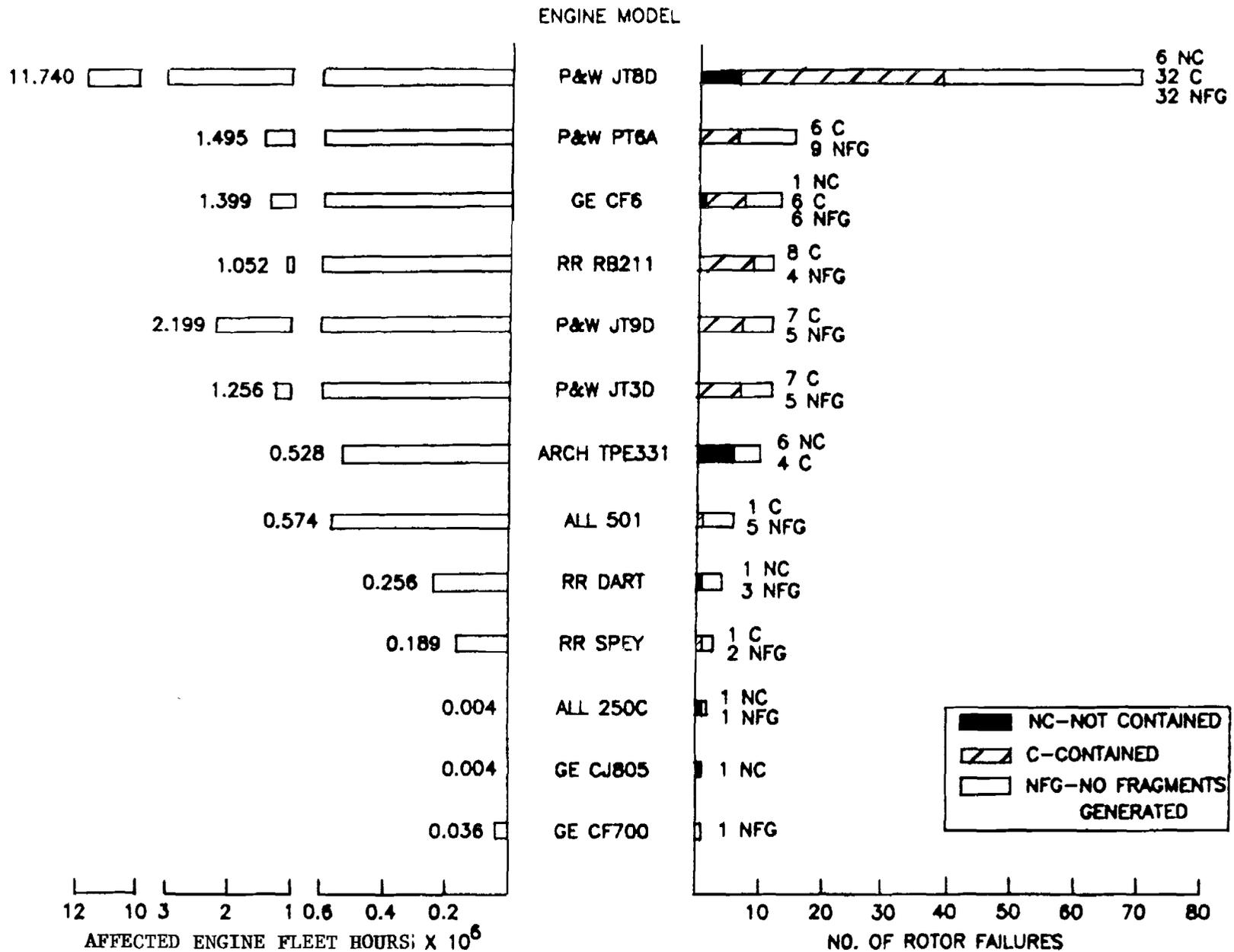


FIGURE 2. THE INCIDENCE OF ENGINE ROTOR FAILURES IN U.S. COMMERCIAL AVIATION ACCORDING TO AFFECTED ENGINE FLEET HOURS FOR EACH ENGINE MODEL - 1982

ENGINE ROTOR COMPONENT	TYPE OF FRAGMENT GENERATED									
	DISK		RIM		BLADE		SEAL		TOTAL	
	TF	UCF	TF	UCF	TF	UCF	TF	UCF	TF	UCF
FAN	0	0	0	0	2	1	0	0	2	1
COMPRESSOR	1	1	0	0	24	1	1	1	26	3
TURBINE	6	6	2	0	52	6	0	0	60	12
TOTAL	7	7	2	0	78	8	1	1	88	16

TF-TOTAL FAILURES
UCF-UNCONTAINED FAILURES

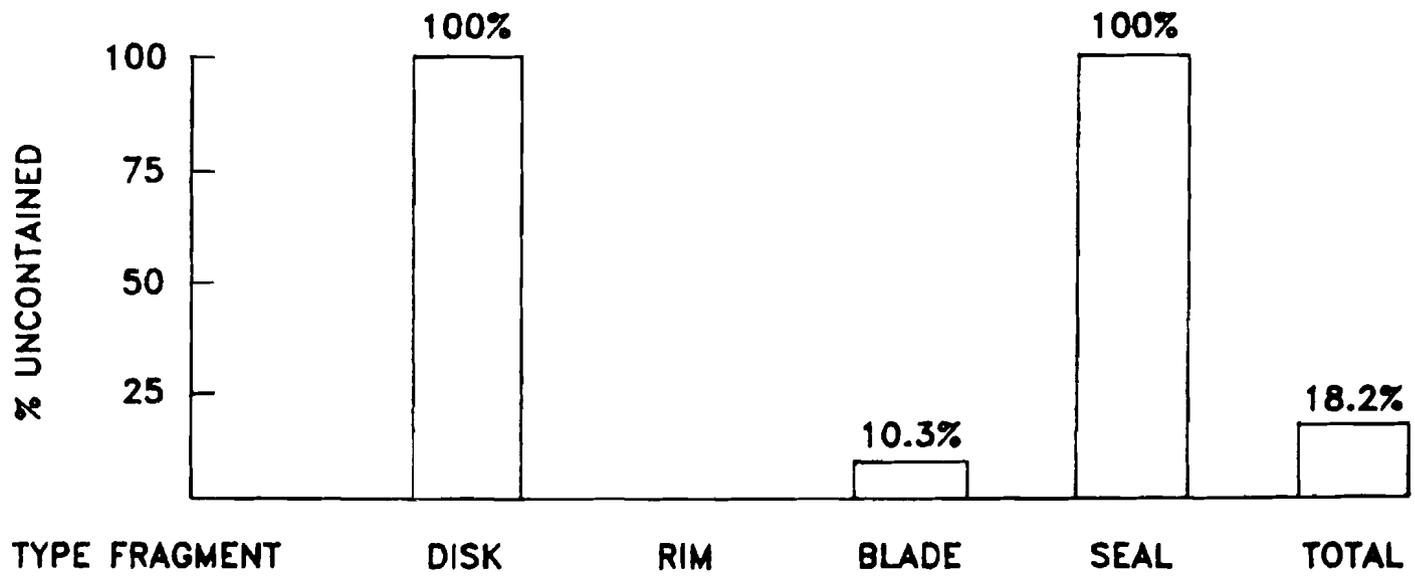
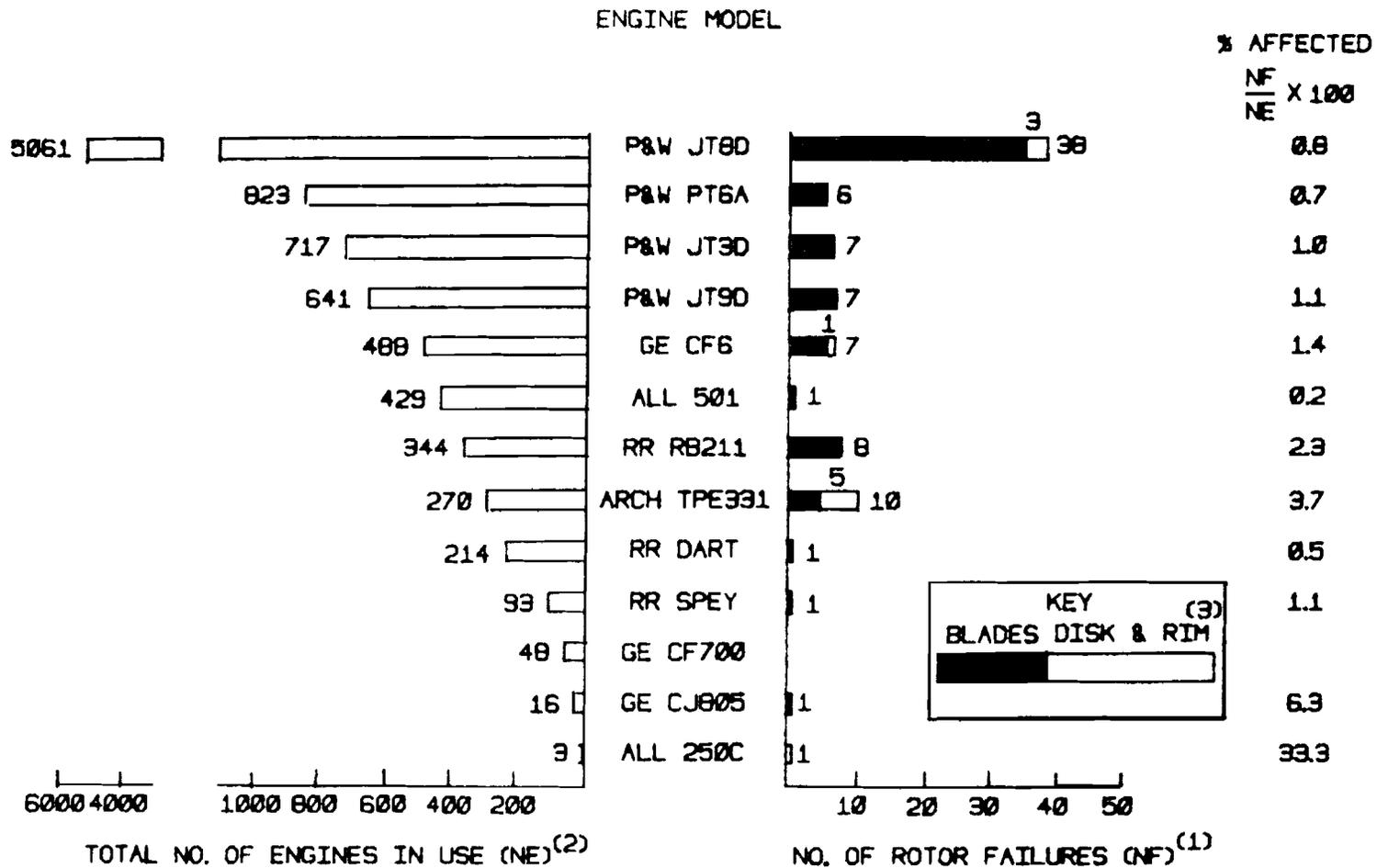


FIGURE 3. COMPONENT AND FRAGMENT TYPE DISTRIBUTIONS FOR CONTAINED AND UNCONTAINED ROTOR ENGINE FAILURES (FAILURES THAT PRODUCED FRAGMENTS) - 1982

7



- NOTES:
- (1) FAILURES THAT PRODUCED FRAGMENTS
 - (2) YEARLY AVG. OF AIRCRAFT IN USE AT END OF EACH MONTH
 - (3) SEAL/SPACER FAILURES INCLUDED IN DISK/RIM COMPILATION

FIGURE 4. THE INCIDENCE OF ENGINE ROTOR FAILURES IN U.S. COMMERCIAL AVIATION ACCORDING TO ENGINE TYPE AFFECTED - 1982

MODEL	AVG NO. IN USE	ENGINE FLIGHT HOURS x10 ⁶	NO. OF FAILURES				FAILURE RATES PER 10 ⁶ ENGINE FLIGHT HRS.			
			C	NC	N	TOTAL	C	NC	N	TOTAL
<u>TURBOFAN</u>										
JT8D	5061	11.740	32	6	32	70	2.7	0.5	2.7	6.0
JT3D	717	1.256	7	0	5	12	5.6	0	4.0	9.6
JT9D	641	2.199	7	0	5	12	3.2	0	2.3	5.5
CF6	488	1.400	6	1	6	13	4.3	0.7	4.3	9.3
RB211	344	1.052	8	0	4	12	7.6	0	3.8	11.4
CF700	48	0.036	0	0	1	1	0	0	27.8	27.8
SPEY	93	0.189	1	0	2	3	5.3	0	10.6	15.9
JT15D	3	0.001	0	0	0	0	0	0	0	0
CFM56	30	0.064	0	0	0	0	0	0	0	0
CJ805	16	0.004	0	1	0	1	0	250.0	0	250.0
TOTAL	7441	17,941	61	8	55	123	3.4	0.4	3.1	6.9
<u>TURBOPROP</u>										
PT6A	823	1.495	6	0	9	15	4.0	0	6.0	10.0
501	429	0.574	1	0	5	6	1.7	0	8.7	10.5
TPE331	270	0.528	4	6	0	10	7.6	11.4	0	18.9
DART	214	0.256	0	1	3	4	0	3.9	11.7	15.6
BASTAN	15	0.018	0	0	0	0	0	0	0	0
250B	7	0.007	0	0	0	0	0	0	0	0
TYNE	15	0.025	0	0	0	0	0	0	0	0
TOTAL	1773	2.903	11	7	17	35	3.8	2.4	5.9	12.1
<u>TURBOSHAFT</u>										
AST14	15	0.025	0	0	0	0	0	0	0	0
250C	3	0.004	0	1	1	2	0	250.0	250.0	500
LTS101	5	0.005	0	0	0	0	0	0	0	0
TOTAL	23	0.034	0	1	1	2	0	29.4	29.4	58.8
<u>TURBOJET</u>										
JT4A	62	0.155	0	0	0	0	0	0	0	0
CJ610	8	0.003	0	0	0	0	0	0	0	0
AVON	5	0.002	0	0	0	0	0	0	0	0
TOTAL	75	0.160	0	0	0	0	0	0	0	0

C - CONTAINED NC - NOT CONTAINED N - FUNCTION IMPEDED NO FRAGMENTS GENERATED

FIGURE 5. GAS TURBINE ENGINE FAILURE RATES ACCORDING TO ENGINE MODEL AND TYPE - 1982

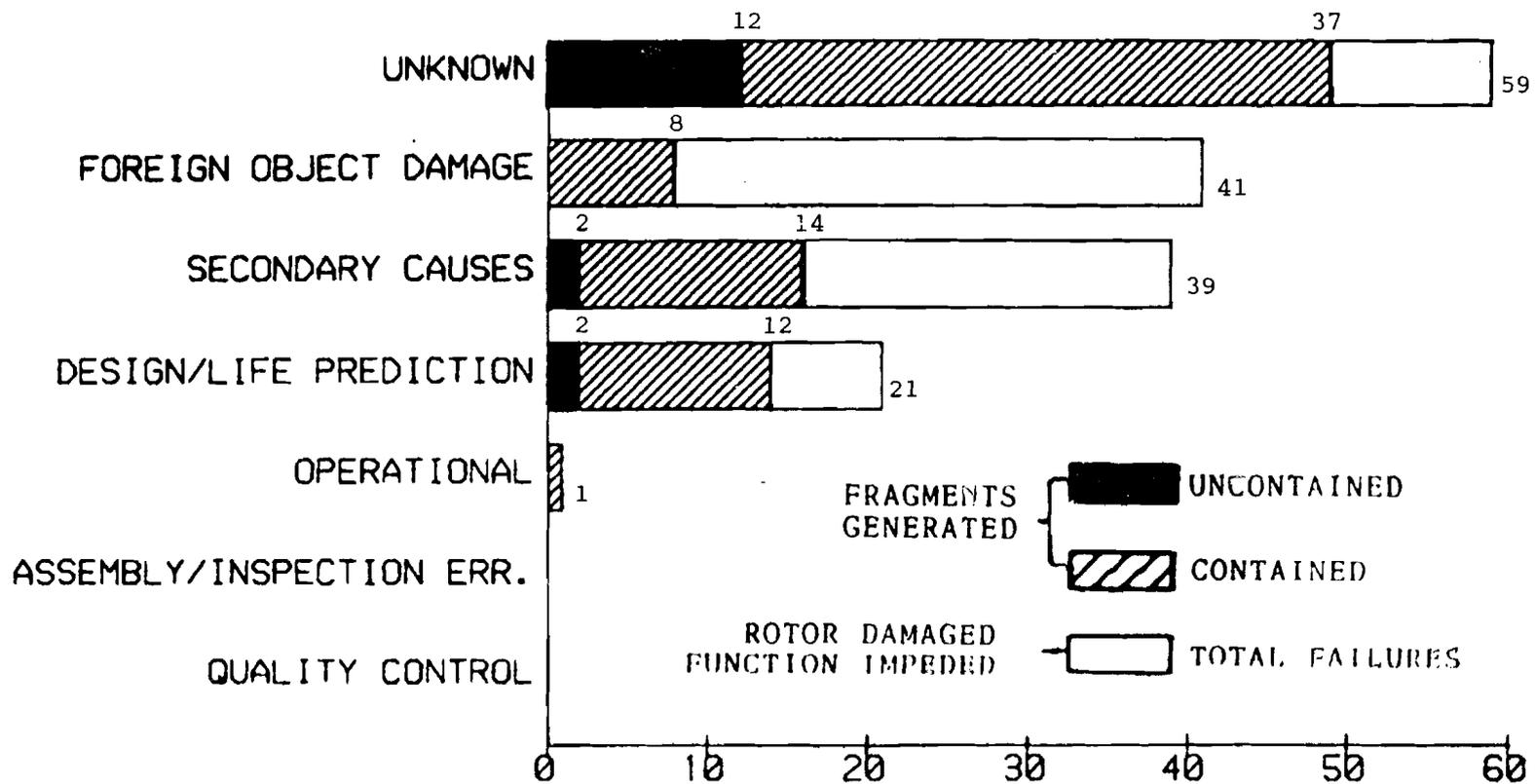


FIGURE 6. ENGINE ROTOR FAILURE CAUSE CATEGORIES - 1982

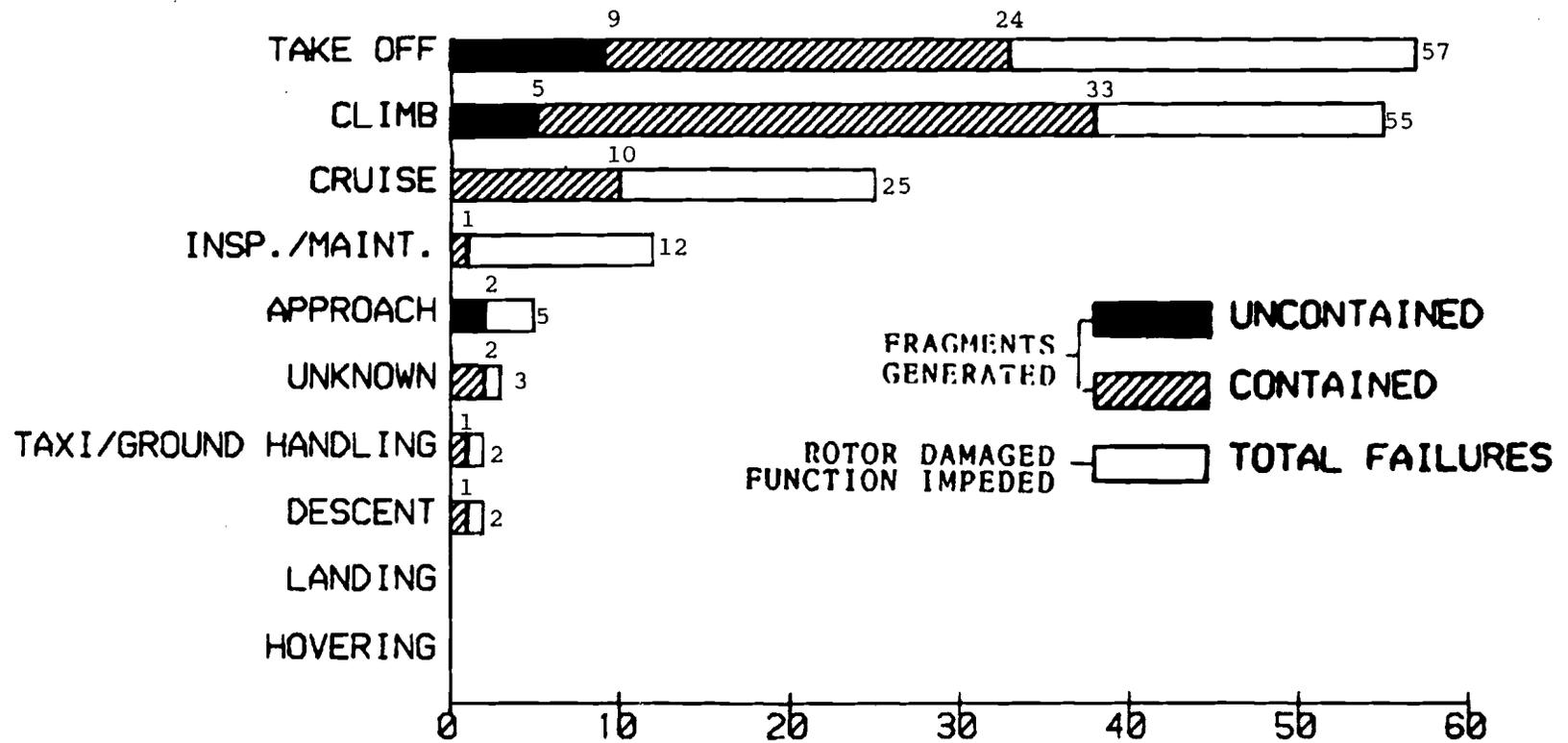


FIGURE 7. FLIGHT CONDITION AT ENGINE ROTOR FAILURE - 1982

(1) FLIGHT CONDITION	TYPE OF FRAGMENT GENERATED			ENGINE ROTOR COMPONENT			DESIGN/LIFE PREDICTION PROBLEMS			SECONDARY CAUSES			FOREIGN OBJECT DAMAGE			QUALITY CONTROL			OPERATIONAL			ASSEMBLY/INSPECTION REPORTS			UNKNOWN	SUBTOTAL	TOTAL	
	HI	LOW	UNK	HI	LOW	UNK	HI	LOW	UNK	HI	LOW	UNK	HI	LOW	UNK	HI	LOW	UNK	HI	LOW	UNK	HI	LOW	UNK				
DISK	FAN																											
	COM.	4			1						1									1			7					17
	TUR.		3						1											3	2	1	4	5	1			
RIM	FAN																											
	COM.	2																		3	1		5	1				7
	TUR.										1												1					
BLADE	FAN	7	1		3			5	1	2	2								3		1	20	2	3				
	COM.	5			3	1														7	2		15	3				80
	TUR.	1	3		15	3	1													7	5	2	23	11	3			
SEAL	FAN																											
	COM.	1																		2	1		3	1				7
	TUR.				2																1			3				
SUBTOTAL	20	7	0	24	4	1	6	1	2	4	0	0	0	0	0	0	0	0	27	11	4	81	23	7			111	
TOTAL	27			29			9			4			0			0			42			111						

(1) TAKEOFF AND CLIMB ARE DEFINED AS "HIGH POWER" AND ALL OTHER CONDITIONS ARE DEFINED AS "LOW POWER."

FIGURE 8. UNCONTAINED ENGINE ROTOR FAILURE DISTRIBUTIONS ACCORDING TO CAUSE AND FLIGHT CONDITIONS - 1976 THROUGH 1982

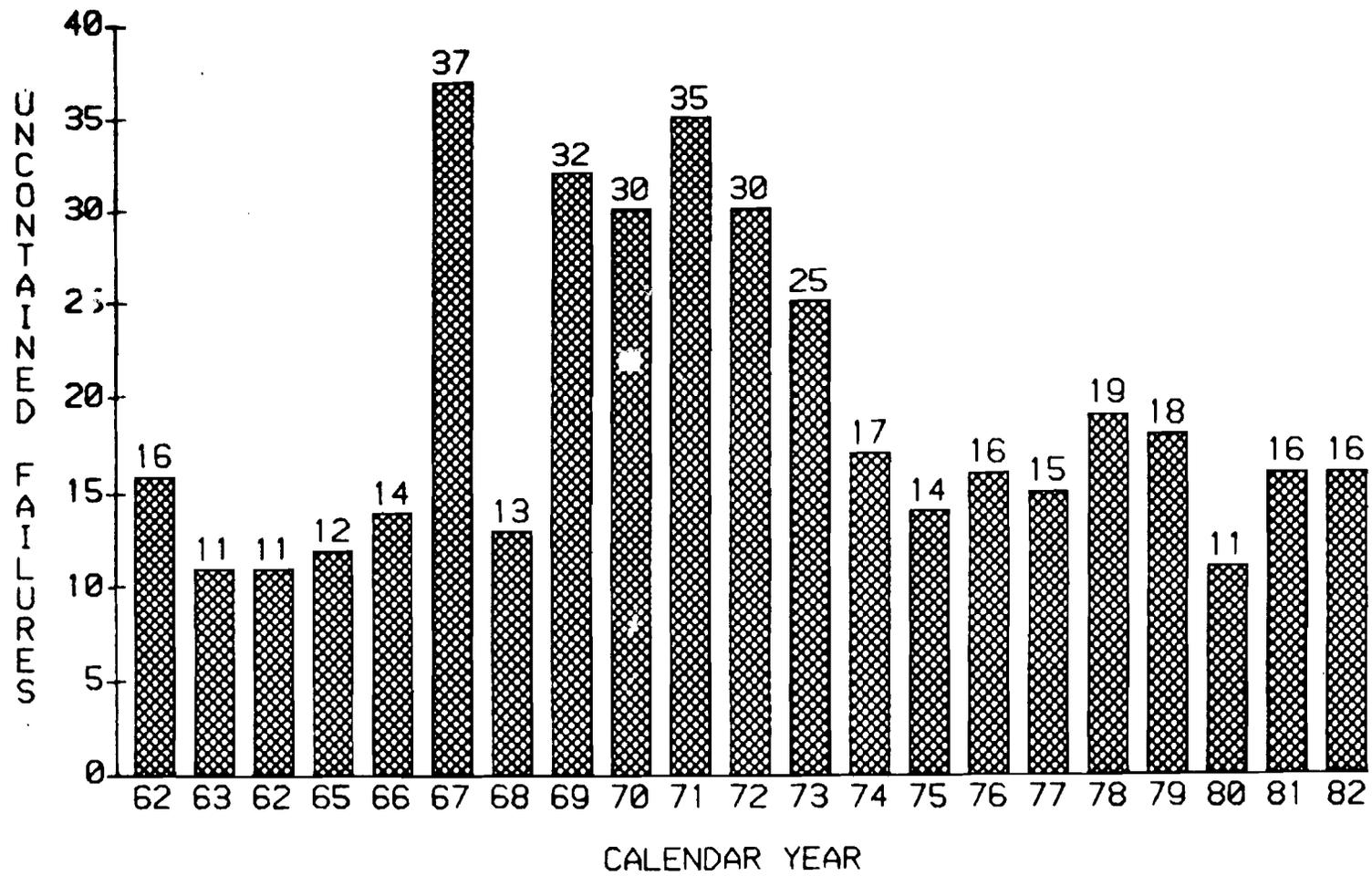


FIGURE 9. THE INCIDENCE OF UNCONTAINED ENGINE ROTOR FAILURES IN U.S. COMMERCIAL AVIATION - 1962 THROUGH 1982

APPENDIX A

Data of Engine Rotor Failures in U.S. Commercial
Aviation for 1982. Compiled from the
Federal Aviation Administration Service
Difficulty Reports.

DATA COMPILATION KEY

Component Code:

F - Fan
C - Compressor
T - Turbine

Fragment Type Code:

D - Disk
R - Rim
B - Blade
S - Seal
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
N - No Fragments Generated

Flight Condition Code:

1 - Insp/Maint
2 - Taxi/Grnd Hdl
3 - Takeoff
4 - Climb
5 - Cruise
6 - Descent
7 - Approach
8 - Landing
9 - Hovering
10 - Unknown

CHARACTERISTICS OF ROTOR FAILURES - 1982

SDR NO.	SUBMITTER	AIRCRAFT	ENGINE	COMPONENT	FRAGMENT		CONTAINMENT	FLIGHT
					TYPE	CAUSE		
01252036	AKBA	DC9	JT8D	C	B	3	C	3*
02082039	TWAA	B727	JT8D	C	B	3	C	4
02102035	AALA	B727	JT8D	F	B	7	C	4
02162037	SWAA	B737	JT8D	T	B	2	C	3
03012037	USAA	B727	JT8D	C	B	2	C	3
03012038	NWAA	B727	JT8D	C	B	2	C	4
03042035	PAAA	B727	JT8D	C	D	2	NC	3
04222031	UALA	B737	JT8D	T	B	1	C	3
05142021	AALA	B727	JT8D	T	B	7	C	4
05072024	BNFA	B727	JT8D	C	B	3	C	4
05182015	USAA	DC9	JT8D	T	B	7	NC	4
05202021	USAA	B727	JT8D	T	B	1	C	3
05252027	TXIA	DC9	JT8D	T	B	7	C	3
05262030	HALA	DC9	JT8D	T	R	7	C	5
06012030	PAIA	B737	JT8D	T	B	2	C	5
06022001	MIDA	DC9	JT8D	T	B	2	C	3
06032029	USAA	DC9	JT8D	T	B	1	C	4
06182029	TXIA	DC9	JT8D	C	B	3	C	5
06282026	TWAA	B727	JT8D	T	B	1	C	4
07012025	WALA	B727	JT8D	T	B	2	C	4
07262033	AKBA	DC9	JT8D	T	B	7	C	3
07282032	HALA	DC9	JT8D	C	B	3	C	4
07292023	OZAA	DC9	JT8D	T	B	2	C	4
08252038	USAA	DC9	JT8D	T	B	7	C	4
09032026	ISAA	B727	JT8D	C	S	7	NC	3
09082027	REPA	DC9	JT8D	T	B	7	C	3
09012028	USAA	DC9	JT8D	T	B	7	C	3
09172023	USAA	DC9	JT8D	C	B	3	C	3
10272034	USAA	DC9	JT8D	T	B	7	C	4
11032026	USAA	DC9	JT8D	T	B	7	NC	3
11032027	USAA	DC9	JT8D	T	B	7	NC	3
12022028	HALA	DC9	JT8D	C	B	3	C	3
12012085	USAA	DC9	JT8D	T	B	7	C	3
01063002	SWAA	B737	JT8D	T	B	2	C	3
01043023	USAA	DC9	JT8D	T	B	7	C	3
01043025	UALA	B737	JT8D	T	B	2	C	4
01063001	EALA	B727	JT8D	F	B	1	NC	3
09202030	PEXA	B737	JT8D	T	-	7	-	3
01292038	JAMA	DC9	JT8D	F	-	3	-	1
02032034	TAGA	B727	JT8D	F	-	3	-	1
02162036	TWAA	B727	JT8D	F	-	3	-	3
03012040	TAGA	B727	JT8D	F	-	3	-	6
03042034	UALA	B737	JT8D	F	-	3	-	4
03122033	TWAA	B727	JT8D	F	-	3	-	4
04062030	AFLA	B737	JT8D	T	-	7	-	5

* 2 engines affected, same aircraft

CHARACTERISTICS OF ROTOR FAILURES - 1982

SDR NO.	SUBMITTER	AIRCRAFT	ENGINE	COMPONENT	FRAGMENT		CONTAINMENT CONDITION	FLIGHT CONDITION
					TYPE	CAUSE		
04092032	UALA	B727	JT8D	C	-	2	-	3
04212032	BNFA	B727	JT8D	T	-	2	-	3
04222030	ACLA	B737	JT8D	F	-	3	-	3
06032030	ACLA	B737	JT8D	F	-	3	-	7
06282027	PSAA	DC9	JT8D	T	-	1	-	4
08062036	SWAA	B737	JT8D	T	-	2	-	5
07302035	PAIA	B727	JT8D	T	-	7	-	4
08232028	OZAA	DC9	JT8D	F	-	3	-	4
08312028	PAIA	B737	JT8D	F	-	3	-	3
11022024	WALA	B737	JT8D	F	-	1	-	1
11122025	JAMA	DC9	JT8D	F	-	3	-	1
11302020	SWAA	B737	JT8D	C	-	3	-	3
12142029	REPA	DC9	JT8D	C	-	3	-	3
12142030	REPA	DC9	JT8D	C	-	3	-	3
01043024	OZAA	DC9	JT8D	T	-	2	-	5
02023020	AALA	B727	JT8D	C	-	1	-	1
03032036	EALA	DC9	JT8D	C	-	3	-	5
08062036	SWAA	B737	JT8D	T	-	2	-	5
11102014	USAA	DC9	JT8D	C	-	3	-	3
02232024	OZAA	DC9	JT8D	F	-	3	-	3
07272030	PAAA	B727	JT8D	F	-	3	-	3
10152024	PAIA	B727	JT8D	F	-	3	-	5
09202032	JAMA	DC9	JT8D	C	-	3	-	1
02083023	AALA	B727	JT8D	T	-	7	-	4
07192036	TWAA	B747	JT9D	C	B	7	C	3
08262037	NWAA	B747	JT9D	C	B	7	C	4
08272030	NWAA	DC10	JT9D	T	B	7	C	4
09022025	NWAA	DC10	JT9D	T	B	7	C	3
10182020	F'TLA	B747	JT9D	T	B	2	C	3
10272033	NWAA	DC10	JT9D	T	B	1	C	4
02112036	PAAA	B747	JT9D	C	B	7	C	5
02262035	NWAA	B747	JT9D	C	-	2	-	3
05252028	TWAA	B747	JT9D	F	-	2	-	4
08242028	F'TLA	B747	JT9D	T	-	2	-	5
09142024	NWAA	B747	JT9D	T	-	2	-	4
12022027	NWAA	B747	JT9D	T	-	2	-	4
11152024	UACA	DC8	JT3D	C	B	7	C	3
09242009	TWAA	B707	JT3D	C	B	7	C	4
09162029	DALA	DC8	JT3D	T	B	7	C	4
03082031	TWAA	B707	JT3D	T	B	7	C	4
01053012	TWAA	B707	JT3D	T	B	7	C	10
06282025	TWAA	B707	JT3C	T	B	1	C	4
08122027	UALA	DC8	JT3D	F	-	3	-	3
08122030	CAPA	DC8	JT3D	C	-	7	-	7
09292019	UACA	DC8	JT3D	T	-	7	-	10
01053012	TWAA	B707	JT3D	T	-	7	-	4
09282019	UACA	DC8	JT3D	T	-	1	-	1
10082011	DALA	DC8	JT3D	T	B	7	C	5

CHARACTERISTICS OF ROTOR FAILURES - 1982

<u>SDR NO.</u>	<u>SUBMITTER</u>	<u>AIRCRAFT</u>	<u>ENGINE</u>	<u>COMPONENT</u>	<u>FRAGMENT TYPE</u>	<u>CAUSE</u>	<u>CONTAINMENT CONDITION</u>	<u>FLIGHT CONDITION</u>
04142034	RIOA	DHC6	PT6A	T	B	7	C	5
09142037	MTRA	DHC6	PT6A	C	B	7	C	3
09142038	MTRA	DHC6	PT6A	C	B	7	C	4
01193072	RANA	N262	PT6A	T	B	7	C	4
10222040	PREA	DHC6	PT6A	T	B	7	C	4
06282035	CCDA	99A	PT6A	T	B	7	C	6
03042050	MVAA	99	PT6A	T	-	7	-	3
08052048	CICA	STCG73	PT6A	T	-	2	-	5
10292031	RMAA	DHC7102	PT6A	T	-	2	-	5
03102039	PCAA	N262	PT6A	T	-	2	-	2
03112032	PCAA	N262	PT6A	C	-	3	-	1
03302033	MTR	SD3-30	PT6A	T	-	2	-	5
08272029	CAIT	SD3-30	PT6A	C	-	3	-	7
10132013	AWAA	DC7	PT6A	C	-	2	-	5
11122021	RMAA	DC7	PT6A	C	-	3	-	4
03042033	AALA	DC10	CF6	T	B	7	C	4
07292022	PAAA	DC10	CF6	T	B	7	C	4
08272026	EALA	DC10	CF6	T	R	7	C	4
08272031	EALA	DC10	CF6	T	B	5	C	4
12212026	WALA	DC10	CF6	C	B	2	NC	3
02023018	PAAA	DC10	CF6	T	B	7	C	5
04282023	PAAA	DC10	CF6	T	B	7	C	4
06222014	WALA	DC10	CF6	T	-	1	-	3
09082026	WRLA	DC10	CF6	C	-	2	-	3
09282008	WRLA	DC10	CF6	F	-	3	-	3
10192025	WALA	DC10	CF6	C	-	1	-	1
12212024	WRLA	DC10	CF6	F	-	3	-	3
12062025	WRLA	DC10	CF6	C	-	7	-	3
10012026	FDEA	MD20	CF700	C	-	3	-	4
01142036	CAAA	22	CJ805	T	B	7	NC	4
04012046	SUNA	SA226	TPE331	T	B	1	NC	4
04142036	BRIA	SA226	TPE331	T	D	7	NC	4
11262029	SWIA	SA226	TPE331	T	B	7	C	3
06032066	AMWA	SA226	TPE331	T	D	7	NC	3
10132091	AMWA	SA226	TPE331	T	B	7	C	4
11262029	SWOA	SA226	TPE331	T	D	7	NC	3
03082036	AMWA	SA226	TPE331	T	B	1	C	3
07092061	AMWA	SA226	TPE331	T	D	7	NC	3
01192041	SUNA	SA226	TPE331	T	D	7	NC	4
01272035	BRTA	SA226	TPE331	T	B	7	C	4
02102038	EALA	L1011	RB211	C	B	1	C	5
02222040	TWAA	L1011	RB211	T	B	1	C	5
03152033	TWAA	L1011	RB211	C	B	1	C	10
06012034	EALA	L1011	RB211	T	B	1	C	4
06212030	TWAA	L1011	RB211	T	B	2	C	5
07082024	TWAA	L1011	RB211	C	B	2	C	4
08102029	EALA	L1011	RB211	C	B	2	C	4
09072031	TWAA	L1011	RB211	C	B	2	C	1

CHARACTERISTICS OF ROTOR FAILURES - 1982

<u>SDR NO.</u>	<u>SUBMITTER</u>	<u>AIRCRAFT</u>	<u>ENGINE</u>	<u>COMPONENT</u>	<u>FRAGMENT TYPE</u>	<u>CAUSE</u>	<u>CONTAINMENT CONDITION</u>	<u>FLIGHT CONDITION</u>
02102037	EALA	L1011	RB211	F	-	3	-	3
02112038	TWAA	L1011	RB211	C	-	3	-	5
04232022	TWAA	L1011	RB211	F	-	3	-	4
07302037	TWAA	L1011	RB211	C	-	2	-	4
02122038	USAA	BAC1-11	506	C	B	1	C	3
04192031	PEAA	BAC1-11	506	C	-	2	-	3
08052035	PEAA	BAC1-11	506	C	-	3	-	3
04282025	RAAA	YS-11A	542	T	B	7	NC	7
07092007	ABXA	YS-11A	542	C	-	2	-	5
07282031	MPCA	YS-11A	542	T	-	2	-	4
02023015	ACZA	F27	532	T	-	1	-	1
01073023	REPA	CV580	501	T	B	7	C	2
01253032	ASPA	STCAP	501	C	-	2	-	4
07062031	ZIAA	188C	501	T	-	2	-	5
10262025	TIAA	382	501	C	-	3	-	3
10212020	TIAA	382	501	C	-	3	-	4
01063003	SRAA	382	501	T	-	7	-	5
05212025	SFAA	206L1	250C28	T	D	7	NC	7
07142125	ALGA	206L1	250C28	T	-	2	-	1

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