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Statistics on Aircraft Gas Turbine Engine Rotor Failures that Occurred in U.S. Commercial Aviation During 1983

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Trenton, New Jersey

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Final Report

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16. Abstract

This report presents statistics relating to gas turbine engine rotor failures which occurred during 1983 in commercial aviation service use. One-hundred and seventy-two failures occurred in 1983. Rotor fragments were generated in 96 of the failures and, of these, 9 were uncontained. The predominant failures involved blade fragments, 95.4 percent of which were contained. Five disk failures occurred and four were uncontained. Fifty-nine percent of the 172 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 analyses, proposed regulatory actions, certification standards, and cost benefit analyses.

17. Key Words

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- 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 basis and published yearly. 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 1983.

One hundred and seventy-two rotor failures occurred in 1983. These failures accounted for approximately 10.8 percent of the 1588 shutdowns experienced by the U.S. commercial fleet. Rotor fragments were generated in 96 of the failures and, of these, 9 were uncontained. This represents an uncontained failure rate of 1.2 per million gas turbine engine powered aircraft flight hours, or 0.4 per million engine operating hours. Approximately 7.6 and 20.6 million aircraft flight and engine operating hours, respectively, were logged in 1983.

Turbine rotor fragment producing failures were approximately two times greater than that of the compressor rotor fragment producing failures (61 and 27 respectively, of the total). Fan rotor failures accounted for 8 of the fragment-producing failures experienced.

Blade failures were generated in 89 of the rotor failures; 4 of these were uncontained. The remaining 7 fragment generating failures were produced by disk, rim, and seal.

Of the 110 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--49 (44.5 percent); (2) secondary causes--35 (31.8 percent); (3) design and life prediction problems--23 (20.9 percent); and (4) operational--3 (2.7 percent). One-hundred and two (59.3 percent) of the 172 rotor failures occurred during the takeoff and climb stages of flight. Sixty (62.5 percent) of the 96 rotor fragment producing failures and 7 (77.8 percent) of the 9 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 1982 (96 in 1983 and 88 in 1982). The uncontained engine rotor failures has decreased 43.8 percent in 1983 (16 in 1982 and 9 in 1983). The 9 year (1975 through 1983) average of uncontained engine rotor failures has decreased from 16 to 15.

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.

The intent and purpose of this report is to present data as objectively as possible on rotor failure occurrences in United States commercial aviation. Presented in this report are statistics on gas turbine engine utilization and failures that have occurred in U.S. commercial aviation during 1983. These statistics are based on service data compiled by the FAA Flight Standards District Office. The National Safety Data Branch of the FAA Aviation Standards National Field Office disseminate this information in a service difficulty data base and the Air Carrier Aircraft Utilization and Propulsion Reliability Report. 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) typically 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 analysis are contained in Appendix A. The results of these analyses are shown in figures 1 through 9.

Figure 1 shows that 172 rotor failures occurred in 1983. These rotor failures accounted for approximately 10.8 percent of the 1588 shutdowns experienced by the gas turbine powered aircraft fleet during 1983. Rotor fragments were generated in 96 of the failures experienced and, of these, 9 (9.4 percent of the fragment-producing failures) were uncontained. This represents an uncontained failure rate of 1.2 per million gas turbine engine powered aircraft flight hours, or 0.4 per million engine operating hours.

Approximately 7.6 million and 20.6 million aircraft flight and engine operating hours, respectively, were logged by the U.S. commercial aviation fleet in 1983. 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 type 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 61 (63.5 percent) and 27 (28.1 percent), respectively, of the total number of rotor failures. Fan rotor failures accounted for 8 (8.3 percent) of the fragment producing failures experienced.

2. Blade fragments were generated in 89 (92.7 percent) of the rotor failures; four (4.4 percent) of these were uncontained. The remaining 7 (7.3 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, 80 percent of disk failures and the one seal failure were uncontained.

Figure 4 shows the rotor failure distribution among the engine models that were affected and the total number of the 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--7.4, turboprop 11.8, turboshaft--147.9, and turbojet--none. Uncontained engine failure rates per million flight hours by engine type were turbofan--0.5, turboprop--0.3, turboshaft and turbojet--none.

Figure 6 shows what caused the rotor failures to occur. Of the 110 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--49 (44.5 percent); (2) secondary causes--35 (31.8 percent); (3) design and life prediction problems--23 (20.9 percent); and operational--3 (2.7 percent).

Figure 7 indicates the flight conditions that existed when the various rotor failures occurred. One-hundred and two (59.3 percent) of the 172 rotor failures occurred during the takeoff and climb stages of flight. Sixty (62.5 percent) of the rotor fragment producing failures and seven (77.8 percent) of the uncontained rotor failures occurred during these same stages of flight. The highest number of uncontained rotor failures, six (66.7 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 1983.

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 seven times greater at "high" power than "low" power (namely 27 and 4). For "design and life prediction problems" the number of uncontained failures was approximately three times greater at "high" power than "low" power (namely 21 and 8); and for "foreign object damage" the number of uncontained failures was seven times greater at "high" power than "low" power (namely 7 and 1). This tabulation also indicates that of the 120 total uncontained incidences, blade failures accounted for 70.0 percent; disks failures, 17.5 percent; rim failures, 5.8 percent; and seal/spacer failures, 6.7 percent.

Figure 9 shows the annual incidence of uncontained rotor failures in commercial aviation for the years 1962 through 1983. During 1983, the incidence of uncontained rotor failures (9), was 56.3 percent lower than those reported the previous year, 1982. Over the past 9 years, 1975 through 1983, an average of 15 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 1982 (88 in 1982 and 97 in 1983). The uncontained engine rotor failures has decreased 43.8 percent (9 in 1983 and 16 in 1982). The 9-year (1975 through 1983) engine rotor failures has decreased from 16 to 15.

Of the 9 uncontained events that occurred during 1983, 3 (33.3 percent) involved turbine rotors, one (11.1 percent) involved compressor rotors, and five (55.6 percent) involved fan rotors.

The predominant cause of failure was attributed to foreign object damage (44.5 percent of the known failures) and one uncontained failure occurred in this category. Secondary causes (31.8 percent of the known failures) and design and life prediction problems (20.9 percent of the known causes) had three and two uncontained failures, respectively. The causes of the remaining three uncontained failures (33.3 percent) are unknown.

Uncontained failures occurred in four of the ten flight modes; i.e., six during takeoff (66.7 percent), one during climb (11.1 percent), one in cruise (11.1 percent), and one during taxi/ground handling (11.1 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.

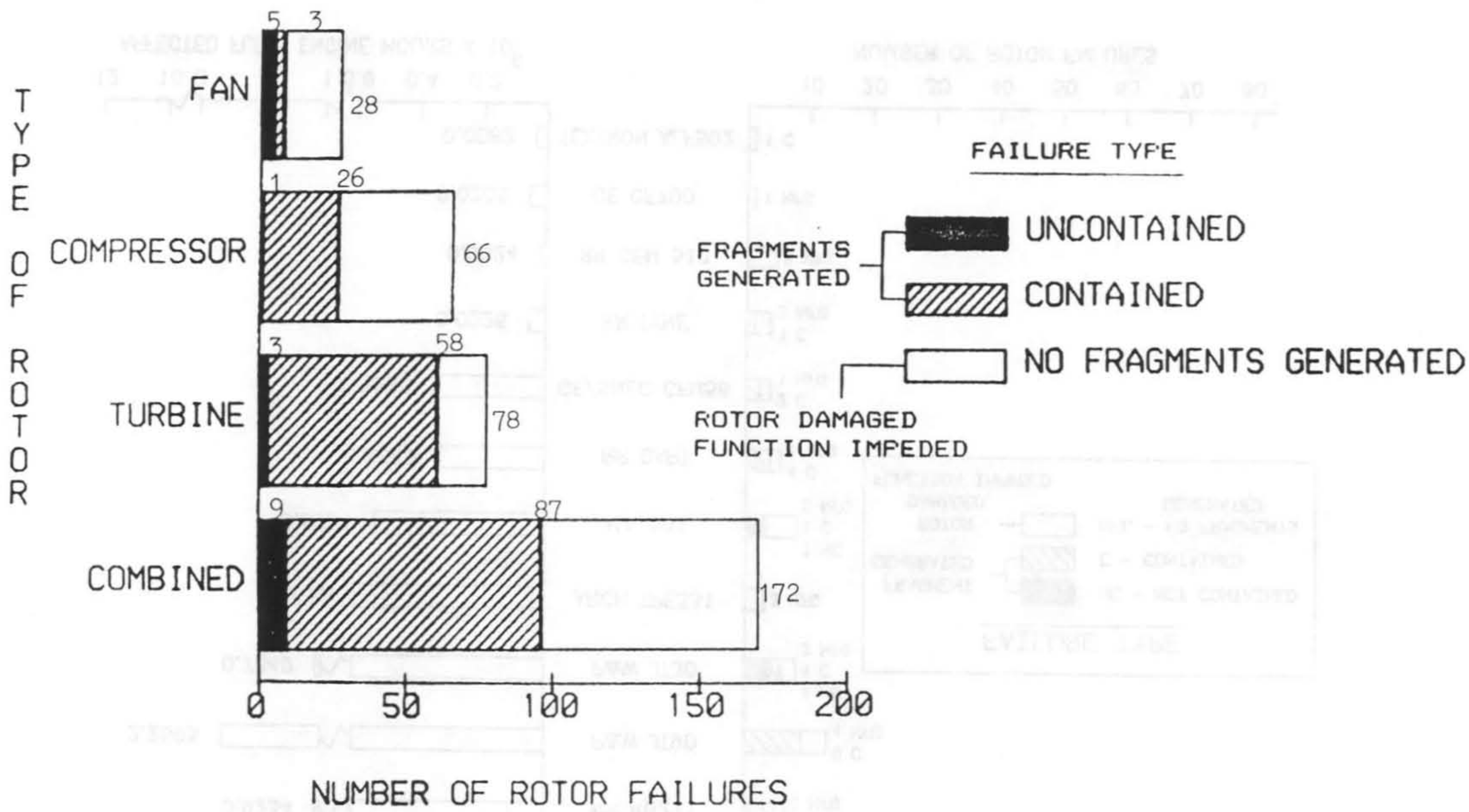


FIGURE 1. INCIDENCE OF ENGINE ROTOR FAILURES IN U.S. COMMERCIAL AVIATION - 1983

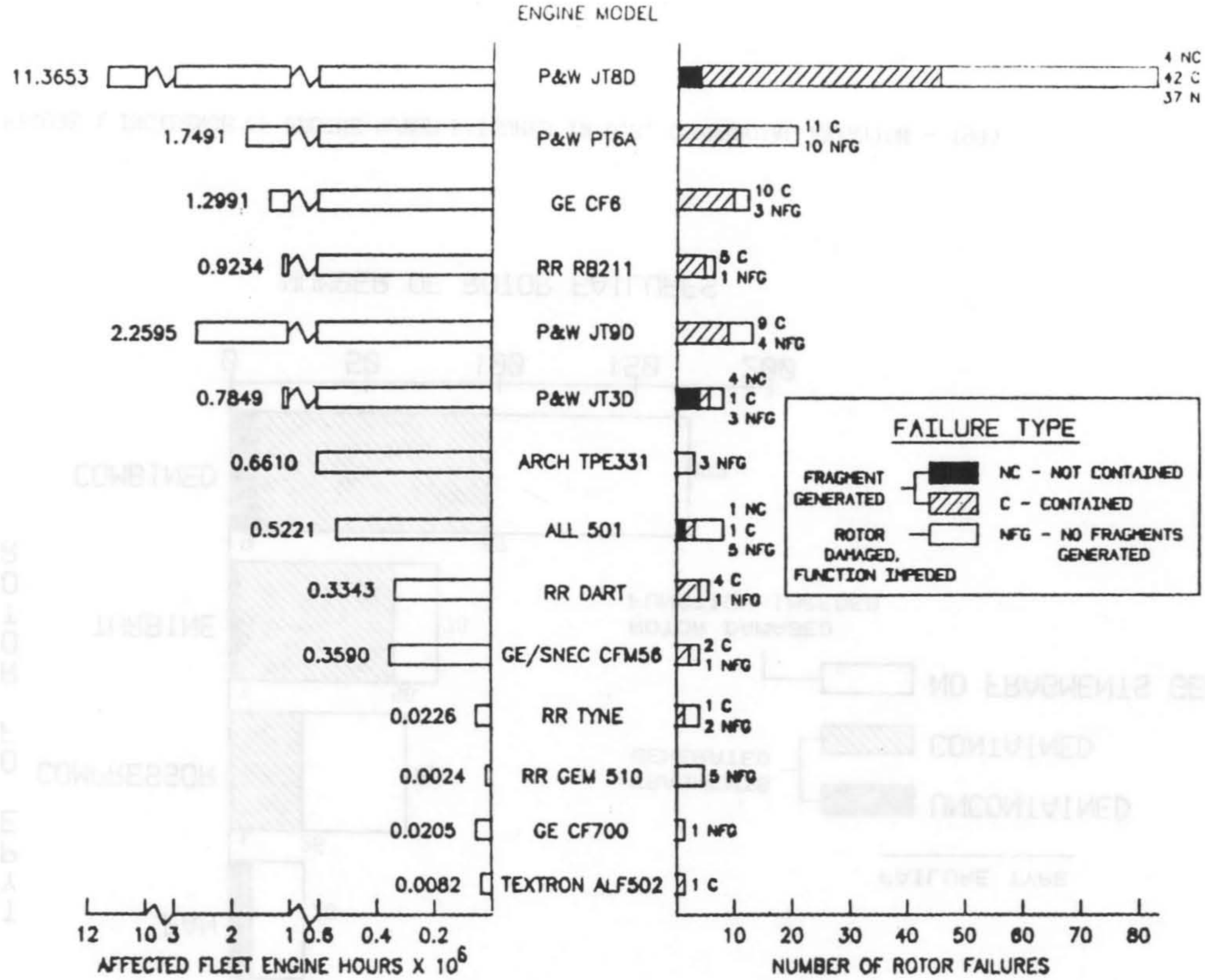


FIGURE 2. THE INCIDENCE OF ENGINE ROTOR FAILURES IN U.S. COMMERCIAL AVIATION ACCORDING TO AFFECTED ENGINE FLEET HOURS FOR EACH ENGINE MODEL - 1983

ENGINE ROTOR COMPONENT	TYPE OF FRAGMENT GENERATED									
	DISK		RIM		BLADE		SEAL		TOTAL	
	TF	UCF	TF	UCF	TF	UCF	TF	UCF	TF	UCF
FAN	2	2	0	0	5	2	1	1	8	5
COMPRESSOR	1	1	1	0	25	0	0	0	27	1
TURBINE	2	1	0	0	59	2	0	0	61	3
TOTAL	5	4	1	0	89	4	1	1	96	9

NOTES:
(1) FAILURES THAT PRODUCED FRAGMENTS

TF - TOTAL FAILURES
UCF - UNCONTAINED FAILURES

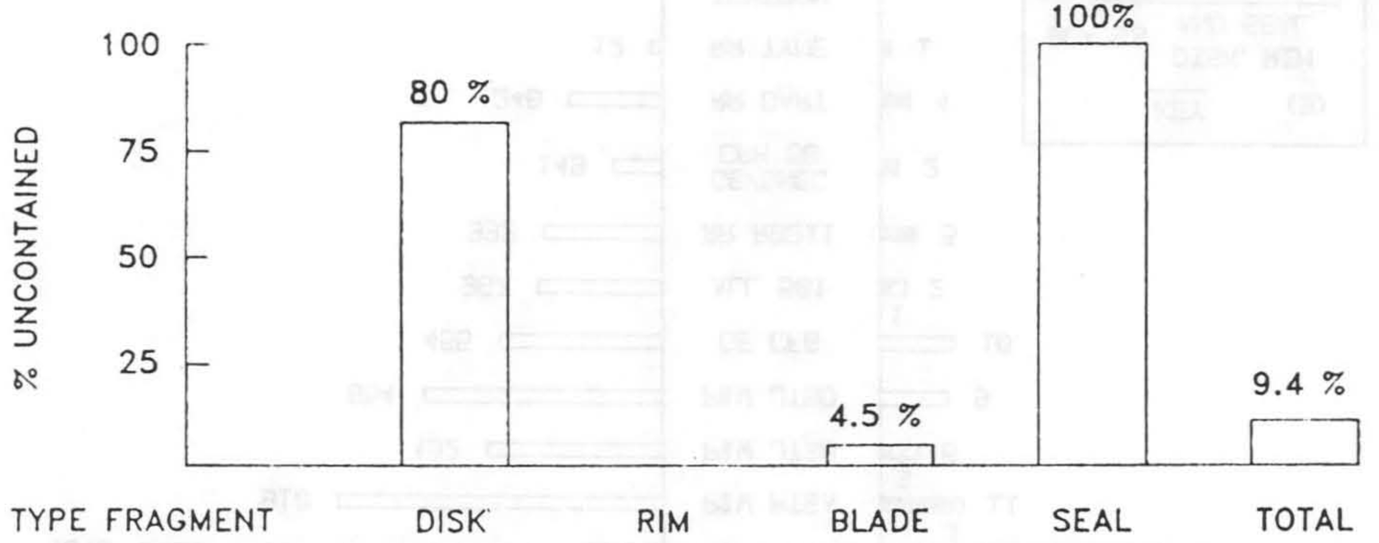
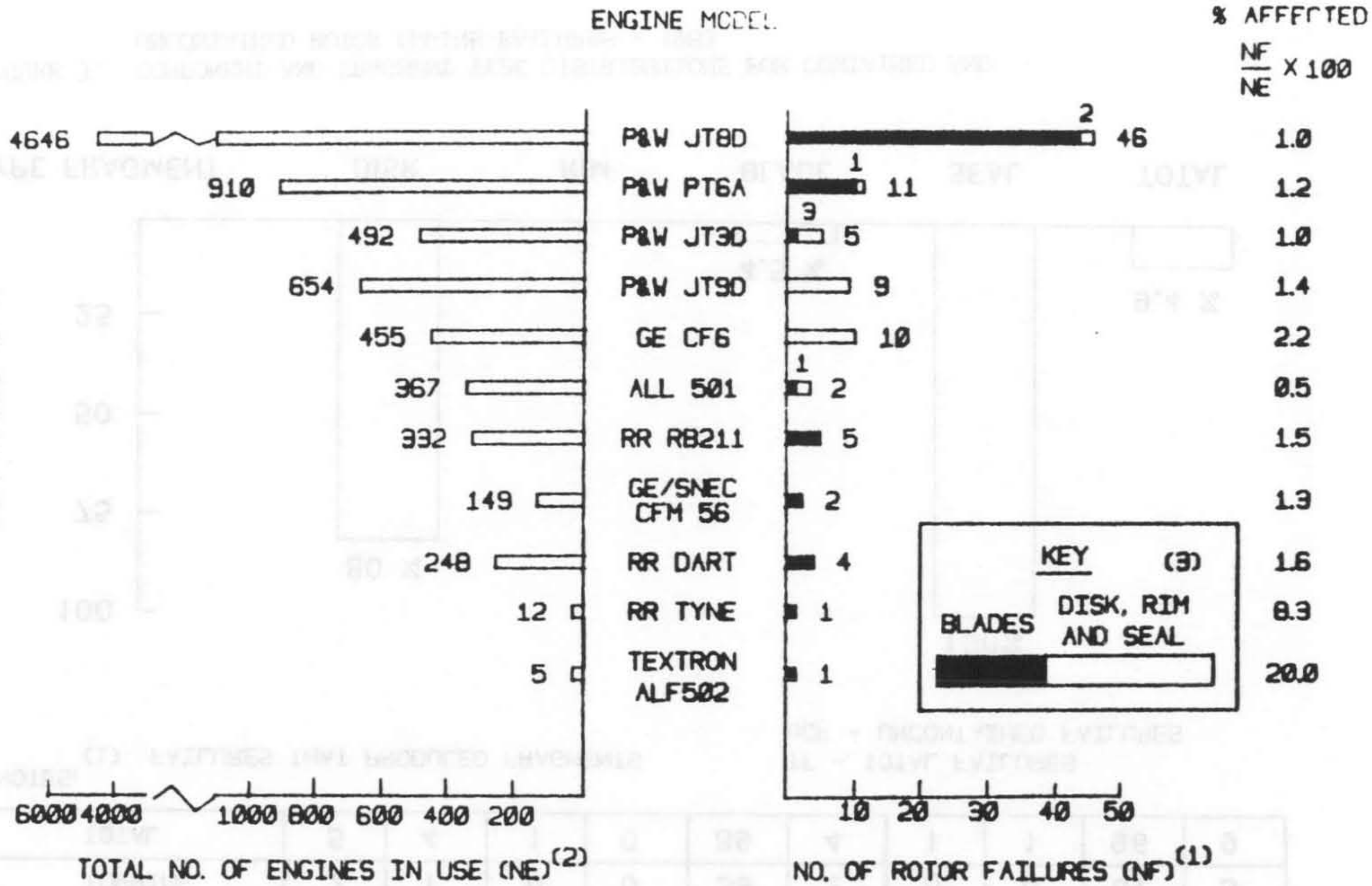


FIGURE 3. COMPONENT AND FRAGMENT TYPE DISTRIBUTIONS FOR CONTAINED AND UNCONTAINED ROTOR ENGINE FAILURES - 1983



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 - 1983

MODEL	AVERAGE NUMBER IN USE	ENGINE FLIGHT HOURS x 10^6	NUMBER OF FAILURES				FAILURE RATES PER 10^6 ENGINE FLIGHT HOURS			
			C	NC	N	TOTAL	C	NC	N	TOTAL
TURBOFAN										
JT8D	4646	11.3653	42	4	37	83	3.7	0.4	3.3	7.3
JT3D	492	0.7849	1	4	3	8	1.3	5.1	3.8	10.2
JT9D	654	2.2595	9	0	4	13	4.0	0	1.8	5.8
CF6	455	1.2991	10	0	3	13	7.7	0	2.3	10.0
RB211	332	0.9234	5	0	1	6	5.4	0	1.1	6.5
CF700	31	0.0205	0	0	1	1	0	0	48.8	48.8
SPEY	85	0.1865	0	0	0	0	0	0	0	0
JT15D	3	0.0013	0	0	0	0	0	0	0	0
TFE731	7	0.0061	0	0	0	0	0	0	0	0
CFM56	149	0.3590	2	0	1	3	5.6	0	2.8	8.4
ALF502	5	0.0082	1	0	0	1	122.0	0	0	122.0
TOTAL	6859	17.2138	70	8	50	128	4.1	0.5	2.9	7.5
TURBOPROP										
PT6A	910	1.7491	11	0	10	21	6.3	0	5.7	12.0
501	387	0.5221	1	1	5	7	1.9	1.9	9.6	13.4
TPE331	335	0.6610	0	0	3	3	0	0	4.5	4.5
DART	248	0.3343	4	0	1	5	12.0	0	3.0	15.0
BASTAN	15	0.0256	0	0	0	0	0	0	0	0
TYNE	12	0.0226	1	0	2	3	44.2	0	88.5	132.7
TOTAL	1887	3.3147	17	1	21	39	5.1	0.3	6.3	11.8
TURBOSHAFT										
AST14	10	0.0213	0	0	0	0	0	0	0	0
250C	5	0.0037	0	0	0	0	0	0	0	0
LST101	7	0.0064	0	0	0	0	0	0	0	0
GEM610	4	0.0024	0	0	5	5	0	0	2083.3	2083.3
TOTAL	26	0.0338	0	0	5	5	0	0	147.9	147.9
TURBOJET										
JT4A	47	0.0257	0	0	0	0	0	0	0	0
AVON	3	0.0004	0	0	0	0	0	0	0	0
CJ610	7	0.0045	0	0	0	0	0	0	0	0
TOTAL	57	0.0306	0	0	0	0	0	0	0	0

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

FIGURE 5. GAS TURBINE ENGINE FAILURE RATES ACCORDING TO ENGINE MODEL AND TYPE - 1983

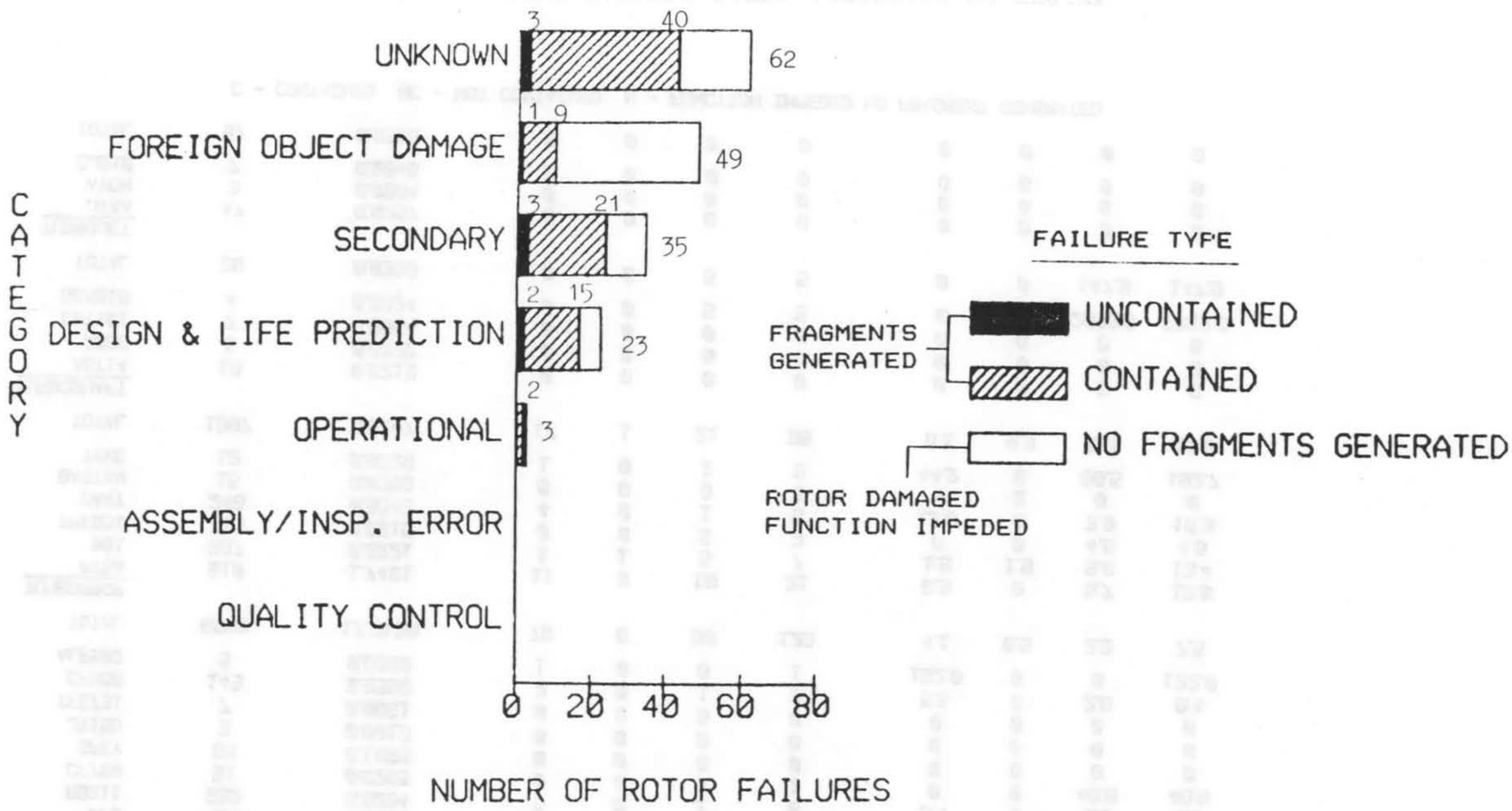


FIGURE 6. ENGINE ROTOR FAILURE CAUSE CATEGORIES - 1983

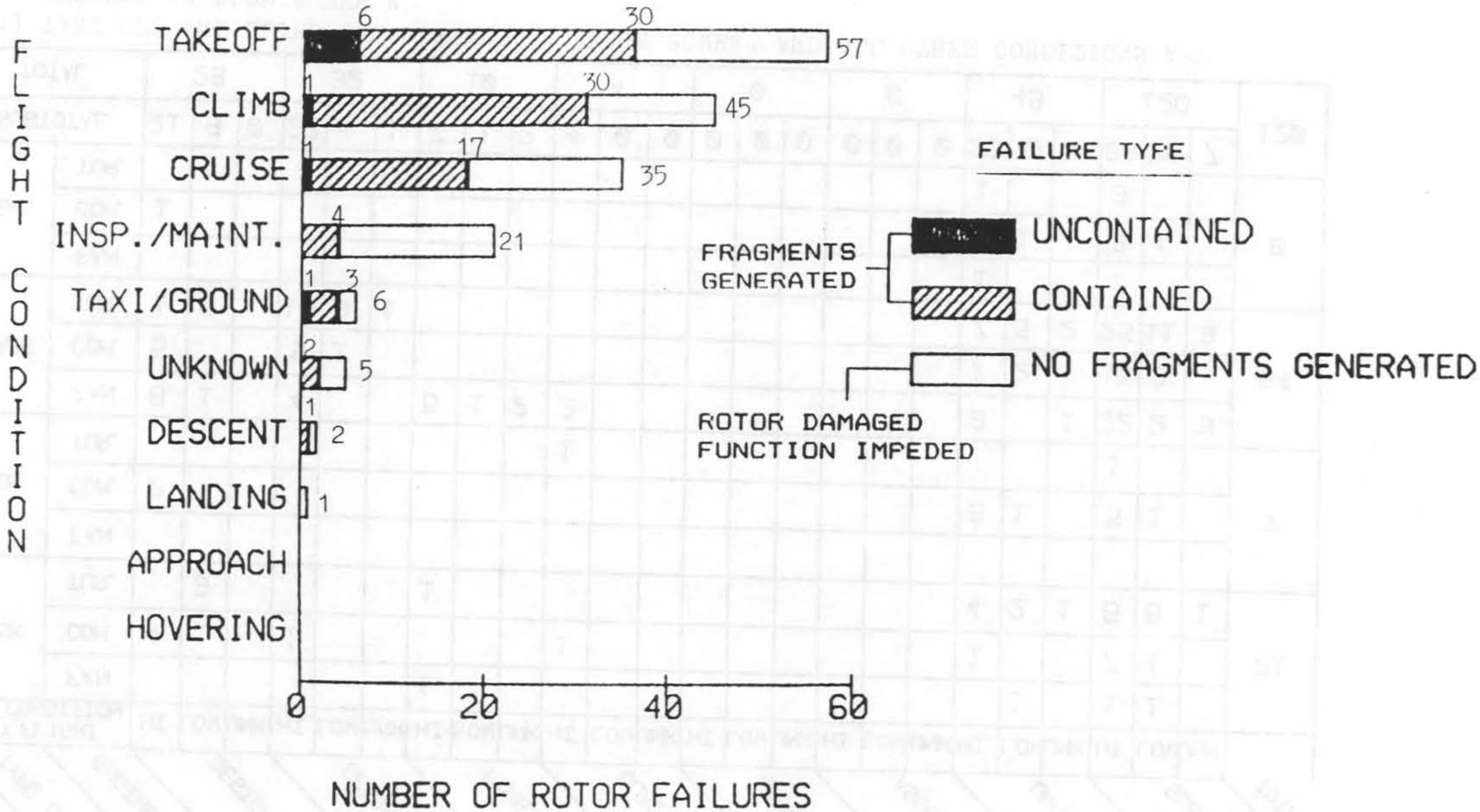


FIGURE 7.FLIGHT CONDITION AT ENGINE ROTOR FAILURE - 1983

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
(1) FLIGHT CONDITION		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							1													1		1	1		21
	COM.	4	1		1						1									1			7	1		
	TUR.		3					1												4	2	1	5	5	1	
RIM	FAN																									7
	COM.	2																		3	1		5	1		
	TUR.										1												1			
BLADE	FAN	8	1		4			5	1	2	2									3		1	22	2	3	84
	COM.	5			3	1														7	2		15	3		
	TUR.	1	3		17	3	1													7	5	2	25	11	3	
SEAL	FAN																			1			1			8
	COM.	1																		2	1		3	1		
	TUR.				2															1			3			
SUBTOTAL		21	8	0	27	4	1	7	1	2	4	0	0	0	0	0	0	0	0	29	12	4	88	25	7	120
TOTAL		29			32			10			4			0			0			45			120			

(1) TAKE OFF 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 1983

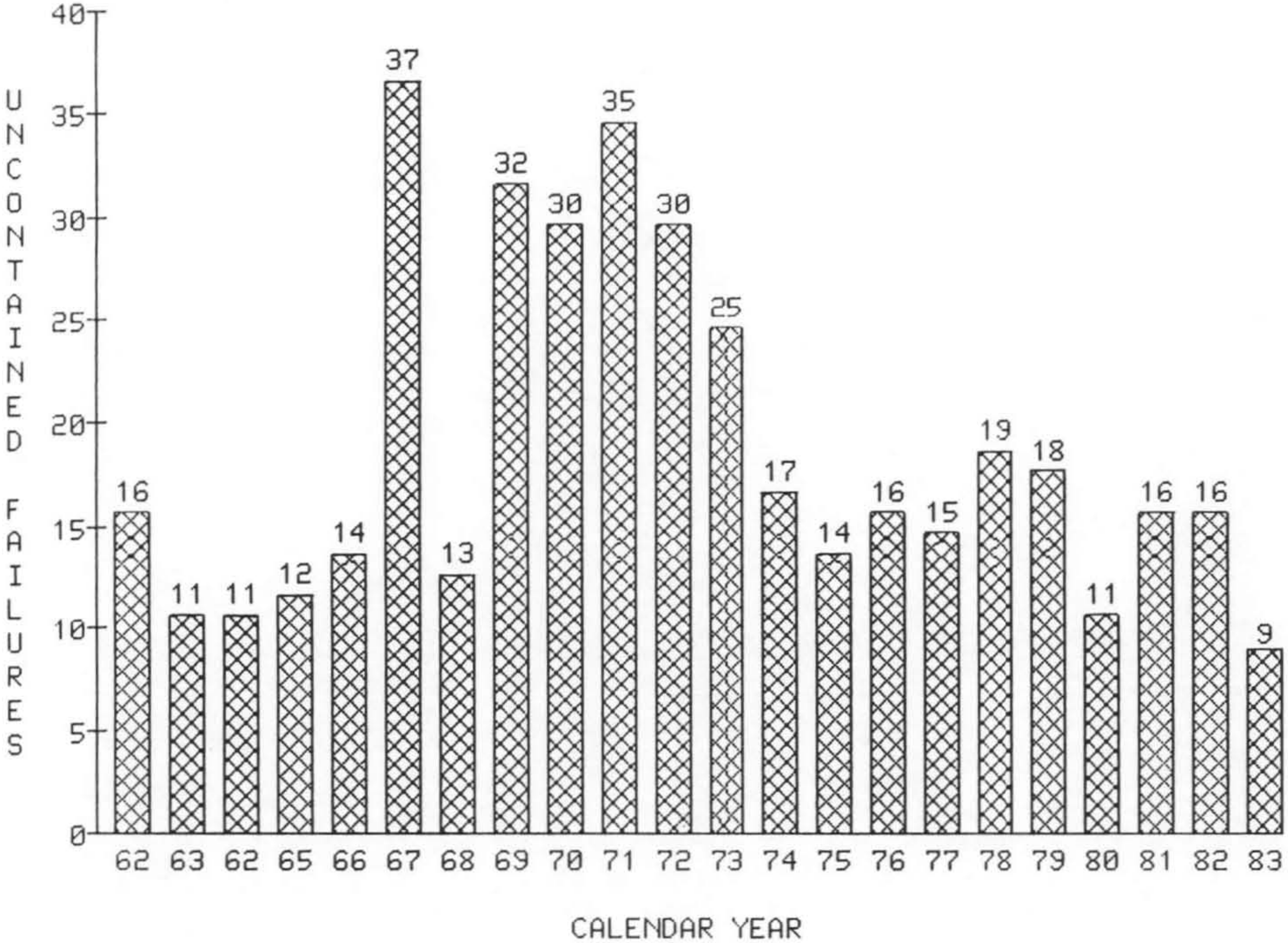


FIGURE 9. THE INCIDENCE OF UNCONTAINED ENGINE ROTOR FAILURES IN U.S. COMMERCIAL AVIATION 1962 THROUGH 1983

APPENDIX A

Data of Rotor Failures in U.S. Commercial

Aviation for 1983 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 - 1983

SDR NO.	SUBMITTER	AIRCRAFT	ENG/LOC	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
02013031	HAL	DC9	JT8D	C	B	2	C	6
02083025	HAL	DC9	JT8D	C	B	3	C	5
02093023	HAL	DC9	JT8D	C	B	3	C	1
02253036	TWA	B727	JT8D	T	B	7	C	4
03293027	SWA	B737	JT8D	T	B	7	C	3
04083032	VAL	B727	JT8D UNK	T	B	2	NC	3
04153036	PAA	B737	JT8D	T	B	7	C	3
05103040	USA	DC9	JT8D	T	B	7	C	3
05113024	EAL	B727	JT8D	C	B	2	C	5
05103038	PEX	B737	JT8D	C	B	3	C	2
05183008	PEX	B737	JT8D	T	B	7	C	3
05203036	PAI	B737	JT8D	T	B	2	C	3
06033040	REP	DC9	JT8D	T	B	7	C	4
06103003	NIA	B727	JT8D	T	B	1	C	3
06103032	TAG	B727	JT8D	T	B	7	C	4
06243036	TWA	B727	JT8D	F	B	1	C	5
06223020	PEX	B737	JT8D	C	B	2	C	3
06223022	PAI	B727	JT8D NO.3	T	B	2	NC	3
07013020	UAL	B727	JT8D NO.1	T	D	7	NC	3
07013021	UAL	B727	JT8D	T	B	7	C	3
07083017	MID	DC9	JT8D	T	B	7	C	4
07203007	TWA	B727	JT8D	T	B	2	C	4
08043023	NWA	B727	JT8D NO.2	F	B	1	NC	3
08223003	PSA	DC9	JT8D	T	B	1	C	3
08303035	PEX	B737	JT8D	C	B	3	C	3
08303037	USA	DC9	JT8D	C	B	2	C	3
08313032	REP	DC9	JT8D	C	B	7	C	3
09123039	UAL	B737	JT8D	T	B	1	C	3
09263013	USA	DC9	JT8D	T	B	1	C	3
09203039	NWA	B727	JT8D	T	B	1	C	4
09303082	REP	DC9	JT8D	C	B	2	C	3
10033055	REP	DC9	JT8D	F	B	1	C	3
10033056	REP	DC9	JT8D	C	B	7	C	3
09293022	FDE	B727	JT8D	T	B	7	C	3
10133001	USA	DC9	JT8D	T	B	1	C	3
10133003	USA	DC9	JT8D	T	B	7	C	3
10143023	RYAN	B727	JT8D	T	B	7	C	3
11103070	USA	DC9	JT8D	T	B	7	C	5
11153050	WAA	B737	JT8D	T	B	1	C	3
11213022	EAL	DC9	JT8D	T	B	7	C	4
11253050	REP	DC9	JT8D	T	B	2	C	5
11293041	IAS	B727	JT8D	T	B	7	C	4
10253002	UAL	B727	JT8D	C	R	2	C	5
12213048	UAL	B737	JT8D	T	B	7	C	3
02033023	AAL	B727	JT8D	T	B	7	C	4

CHARACTERISTICS OF ROTOR FAILURES - 1983

SDR NO.	SUBMITTER	AIRCRAFT	ENG/LOC	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
09203049	REP	DC9	JT8D	C	B	7	C	3
10143024	PEX	B737	JT8D	C	-	7	-	5
11103029	UAL	B737	JT8D	F	---	3	---	8
07123021	OZA	DC9	JT8D	F	---	3	---	3
12293031	AFL	B737	JT8D	F	---	3	---	3
04083014	WAL	B727	JT8D	C	---	2	---	1
01263033	PSA	DC9	JT8D	F	---	3	---	1
02013030	HAL	DC9	JT8D	C	---	5	---	2
02283029	PSA	DC9	JT8D	C	---	7	---	3
03043028	HAL	DC9	JT8D	C	---	3	---	1
03293010	GRA	DC9	JT8D	F	---	3	---	3
03293016	JAM	DC9	JT8D	F	---	3	---	1
03293017	JAM	DC9	JT8D	F	---	3	---	1
04223004	HAL	DC9	JT8D	C	---	2	---	6
05103030	REP	DC9	JT8D	F	---	3	---	3
05103037	JAM	DC9	JT8D	C	---	3	---	1
05103039	REP	DC9	JT8D	C	---	3	---	5
05183002	WAL	B727	JT8D	C	---	7	---	4
06223021	EAL	B727	JT8D	C	---	3	---	3
07083009	PSA	DC9	JT8D	C	---	7	---	3
07083012	HAL	DC9	JT8D	C	---	3	---	1
07143025	TSA	B737	JT8D	C	---	3	---	3
08033029	PSA	DC9	JT8D	F	---	3	---	10
08103043	RFP	B727	JT8D	T	---	7	---	5
08153032	PAA	B727	JT8D	T	---	7	---	5
08223009	WAL	B727	JT8D	C	---	3	---	3
08313035	REP	DC9	JT8D	T	---	7	---	3
09133017	SWA	B737	JT8D	C	---	3	---	4
09263022	HAL	DC9	JT8D	C	---	7	---	5
11213026	ACL	B737	JT8D	T	---	2	---	5
11253051	EMA	DC9	JT8D	C	---	7	---	5
11253053	HAL	DC9	JT8D	F	---	3	---	4
11253061	NWA	B727	JT8D	T	---	7	---	4
11253062	EAL	B727	JT8D	C	---	2	---	3
11293040	SWA	B737	JT8D	C	---	3	---	3
08243034	FAL	DC9	JT8D	F	---	3	---	3
10283009	JAM	B737	JT8D	C	---	3	---	1
12293017	JAM	DC9	JT8D	F	---	3	---	1
01243015	NWA	B747	JT9D	T	B	7	C	4
04153033	TWA	B747	JT9D	C	B	3	C	4
06223014	NWA	DC10	JT9D	T	B	1	C	4
08163030	NWA	DC10	JT9D	T	B	2	C	3
09203047	TWA	B747	JT9D	T	B	2	C	4
10133002	UAL	B747	JT9D	C	B	3	C	5
10113035	NWA	B747	JT9D	C	B	3	C	4
10203043	TWA	B747	JT9D	T	B	1	C	5
09093015	NWA	B747	JT9D	T	B	2	C	5
01073009	PAA	B747	JT9D	F	---	3	---	3
09133027	NWA	DC10	JT9D	C	---	3	---	4

CHARACTERISTICS OF ROTOR FAILURES - 1983

SDR NO.	SUBMITTER	AIRCRAFT	ENG/LOC	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
11213021	TWA	B747	JT9D	F	---	3	---	3
11253074	FTL	B747	JT9D	F	---	3	---	4
10063061	ASR	WSTLND30	GEMMK510	C	---	1	---	1
10063062	ASR	WSTLND30	GEMMK510	C	---	1	---	1
09233042	ASR	WSTLND30	GEMMK510	C	---	1	---	1
09233043	ASR	WSTLND30	GEMMK510	C	---	1	---	1
08033144	ASR	WSTLND30	GEMMK510	C	---	3	---	5
02153027	TWA	L1011	RB211	C	B	2	C	10
09193044	DAL	L1011	RB211	T	B	7	C	4
09193048	TWA	L1011	RB211	C	B	2	C	5
10203006	TWA	L1011	RB211	C	B	2	C	4
08223006	TWA	L1011	RB211	T	B	1	C	4
02233052	EAL	L1011	RB211	C	---	3	---	3
09303069	AMW	SA226	TPE331	T	---	2	---	1
08223048	PIO	SA227	TPE331	C	---	3	---	5
04223087	CAC	SA227	TPE331	T	---	2	---	5
06103006	WRNO	CL44	TYNE515	C	B	7	C	5
02153025	AET	CL44	TYNE515	T	---	7	---	5
02243029	WRNO	CL44	TYNE515	C	---	7	---	5
02023015	ACZ	FH227	DART532	T	B	1	C	1
03293022	BRI	FH227	DART532	T	B	7	C	1
04223014	SMB	CV600	DART529	T	B	7	C	5
08233036	ABX	YS11A	DART542	T	B	5	C	2
10203008	WRT	CV600	DART542	T	---	1	---	1
05113027	AWA	DHC7	PT6A	T	B	2	C	3
30803025	EAM	SD330	PT6A	T	B	2	C	3
04153096	RAY	EMB110	PT6A	T	D	7	C	4
08153041	CCD	B99	PT6A	C	B	7	C	2
10143036	PLG	B99	PT6A	C	B	7	C	5
04153028	MTR	SD330	PT6A	T	B	7	C	2
06103012	MTR	SD330	PT6A	T	B	2	C	5
08313033	RMA	DHC7	PT6A	C	B	3	C	4
10283005	RMA	DHC7	PT6A	T	B	2	C	10
11283091	CCD	B99	PT6A	T	B	7	C	5
07083049	RMA	DHC630	PT6A	T	B	7	C	4
03213033	PCA	NORD262	PT6A	C	---	3	---	5
03293019	PCA	NORD262	PT6A	C	---	3	---	1
05033025	MTR	SD330	PT6A	T	---	2	---	3
08293016	RMA	DHC7	PT6A	C	---	3	---	4
10132013	AWA	DHC7	PT6A	C	---	2	---	10
04153076	RAY	EMB110	PT6A	T	---	7	---	4
03093105	PCA	NORD262	PT6A	C	---	3	---	1
03033015	MVA	SD330	PT6A	T	---	7	---	5
05163062	MVA	SD330	PT6A	C	---	7	---	4
12063072	RMA	DHC7	PT6A	T	---	7	---	4
05033020	ASP	CV580	501	T	B	1	C	5
05183001	REP	CV580	501 UNK	C	D	1	NC	2
03243029	FLA	L188	501	T	---	2	---	5
10143027	CRA	CV580	501	C	---	3	---	3

CHARACTERISTICS OF ROTOR FAILURES - 1983

SDR NO.	SUBMITTER	AIRCRAFT	ENG/LOC	COMPONENT	FRAGMENT TYPE	CAUSE	CONTAINMENT CONDITION	FLIGHT CONDITION
10203010	FLA	L188	501	C	---	7	---	5
11043001	PQA	CV580	501	T	---	7	---	3
11043007	PQA	CV580	501	C	---	2	---	4
04083027	JCS	B707	JT3D NO.2	F	B	2	NC	3
04083029	UAL	DC8	JT3D NO.1	F	D	3	NC	4
06103013	UAL	DC8	JT3D	F	B	3	C	3
08163031	UAL	DC8	JT3D NO.1	E	S	7	NC	3
05033029	UAL	DC8	JT3D NO.1	F	D	7	NC	5
05103035	GIA	B707	JT3D	F	---	3	---	3
06063045	NIA	DC8	JT3D	T	---	7	---	5
08243034	FAL	B737	JT3D	F	---	3	---	3
12213053	AWA	146200A	ALF502	T	B	2	C	2
04153044	DAL	DC8	CFM56	T	B	5	C	4
06243044	UAL	DC8	GFM56	T	B	7	C	3
08123033	UAL	DC8	CFM56	T	---	2	---	5
04153042	FDE	MD20	CF700	F	---	3	---	4
02023018	PAA	DC10	CF6	T	B	7	C	4
05103032	UAL	DC10	CF6	C	B	7	C	4
07123029	UAL	DC10	CF6	C	B	7	C	4
07133029	PAA	DC10	CF6	C	B	7	C	4
07203008	WAL	DC10	CF6	T	B	7	C	4
08033030	UAL	DC10	CF6	T	B	1	C	4
08083020	PAA	DC10	CF6	T	B	7	C	4
08153030	AAL	DC10	CF6	T	B	7	C	4
09203040	PAA	DC10	CF6	T	B	7	C	5
11153047	UAL	DC10	CF6	T	B	2	C	4
08153029	UAL	DC10	CF6	F	---	3	---	10
09133015	WAL	DC10	CF6	C	---	1	---	1
09133025	AAL	DC10	CF6	F	---	3	---	4

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Statistics on aircraft gas turbine engine rotor failures that occurred in U.S. commercial aviation during 1983.