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# Statistics on Aircraft Gas Turbine Engine Rotor Failures that Occurred in U.S. Commercial Aviation during 1988

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March 1992

Final Report

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| 16. Abstract<br><br><p>This report presents statistical information relating to gas turbine engine rotor failures which occurred during 1988 in U.S. commercial aviation service use. Four hundred and thirteen failures occurred in 1988. Rotor fragments were generated in 175 of the failures, and of these 14 were uncontained. The predominant failure involved blade fragments, 95 percent of which were contained. Five disk failures occurred and all were uncontained. Forty-two percent of the 413 failures occurred during the takeoff and climb stages of flight.</p> <p>This service data analysis is prepared on a calendar year basis and published yearly. The data are useful in support of flight safety analyses, proposed regulatory actions, certification standards, and cost benefit analyses.</p> <p style="text-align: right;">DOT/FAA CT-91/28    Statistics on aircraft gas turbine engine rotor failures that occurred in U.S. commercial aviation during 1988.</p> |                                                      |                                                                                                                                                                                |           |
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# TABLE OF CONTENTS

|                                                                        | Page |
|------------------------------------------------------------------------|------|
| EXECUTIVE SUMMARY                                                      | v    |
| INTRODUCTION                                                           | 1    |
| RESULTS                                                                | 2    |
| DISCUSSION AND CONCLUSIONS                                             | 12   |
| APPENDIX                                                               |      |
| A - Data of Engine Rotor Failures in U.S. Commercial Aviation for 1988 |      |

## LIST OF ILLUSTRATIONS

| Figure |                                                                                                                                       | Page |
|--------|---------------------------------------------------------------------------------------------------------------------------------------|------|
| 1      | Incidence of Engine Rotor Failures in U.S. Commercial Aviation - 1988                                                                 | 2    |
| 2      | Type and Number of Engine Rotor Failures in U.S. Commercial Aviation According to Affected Engine Model and Engine Fleet Hours - 1988 | 3    |
| 3      | The Incidence of Engine Rotor Failures in U.S. Commercial Aviation According to Engine Model and Component Affected - 1988            | 5    |
| 4      | Engine Rotor Failure Cause Categories - 1988                                                                                          | 6    |
| 5      | Flight Condition at Engine Rotor Failure - 1988                                                                                       | 7    |
| 6      | The Incidence of Uncontained Engine Rotor Failures in U.S. Commercial Aviation - 1963 through 1988                                    | 11   |

## LIST OF TABLES

| Table |                                                                                                             | Page |
|-------|-------------------------------------------------------------------------------------------------------------|------|
| 1     | Component and Fragment Type Distributions for Contained and Uncontained Engine Rotor Failures - 1988        | 4    |
| 2     | Gas Turbine Engine Failure Rates According to Engine Model and Type - 1988                                  | 9    |
| 3     | Uncontained Engine Rotor Failure Distributions According to Cause and Flight Conditions - 1976 through 1988 | 10   |

## 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 1988.

Four hundred thirteen rotor failures occurred in 1988. Rotor fragments were generated in 175 of the failures and, of these, 14 were uncontained. This represents an uncontained failure rate of 1.0 per million gas turbine engine powered aircraft flight hours, or 0.3 per million engine operating hours. Approximately 14.4 million and 45.6 million aircraft flight and engine operating hours, respectively, were logged in 1988.

Turbine rotor fragment-producing failures were approximately 1.7 times greater than that of the compressor rotor fragment-producing failures; 107 and 64 respectively, of the total. Fan rotor failures accounted for 4 of the fragment-producing failures experienced.

Blade fragments were generated in 165 of the rotor failures; 9 of these were uncontained. The remaining 5 of the 14 uncontained failures were produced by disk fragments.

Of the 278 failures with known causes (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--114 (41.0 percent); (2) secondary causes--73 (26.3 percent); and (3) design and life prediction problems--78 (28.1 percent). One hundred and seventy-five (42.4 percent) of the 413 rotor failures occurred during the takeoff and climb stages of flight. One hundred and one (101) (57.7 percent) of the 175 rotor fragment-producing failures and 7 (50.0 percent) of the 14 uncontained rotor failures occurred during these same stages of flight.

The incidence of engine rotor failures producing fragments has increased when compared to 1987 (170 in 1987 and 175 in 1988). The number of uncontained engine rotor failures reported has increased 17 percent in 1988 (12 in 1987 and 14 in 1988). This is due to the introduction of the Accident/Incident Data System (AIDS) as a source of uncontained failures. Without the introduction of this new source there would have only been 10 reported uncontained failures, a decrease of 17 percent when compared to 1987. The 13-year (1976 through 1988) average of uncontained engine rotor failures is 14.9.



## INTRODUCTION

This report is sponsored and co-authored by the Federal Aviation Administration (FAA) Technical Center, located at the Atlantic City International Airport, New Jersey. The FAA's Propulsion/Fuel Safety Program sponsors raw data reduction support from the Naval Air Propulsion Center.

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

The intent of this report is to present data as objectively as possible on gas turbine rotor failure occurrences in U.S. commercial aviation. Presented in this report are statistics on gas turbine engine utilization and failures that have occurred in U.S. commercial aviation during 1988. 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 disseminated this information in the Service Difficulty Reports (SDR) data base, the Accident/Incident Data System (AIDS), and the Air Carrier Aircraft Utilization and Propulsion Reliability Reports. The aircraft count was supplemented by the International Aircraft Operator Information System, a registry data system located out of Wichita State University. The FAA service data base contains only a fraction of the actual commercial helicopter fleet operating statistics. The number of turboshaft engines in use with the corresponding engine flight hours given herein are estimates derived primarily from statistics published by the Helicopter Association International in their helicopter annuals. 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 raw data used in this report are contained in appendix A. The results of an analysis of the data are shown in figures 1 through 6 and tables 1 through 3.

Figure 1 shows that 413 rotor failures occurred in 1988. Rotor fragments were generated in 175 of the failures experienced and, of these, 14 (8.0 percent of the fragment-producing failures) were uncontained. This represents an uncontained failure rate of 1.0 per million gas turbine engine powered aircraft flight hours, or 0.3 per million engine operating hours.

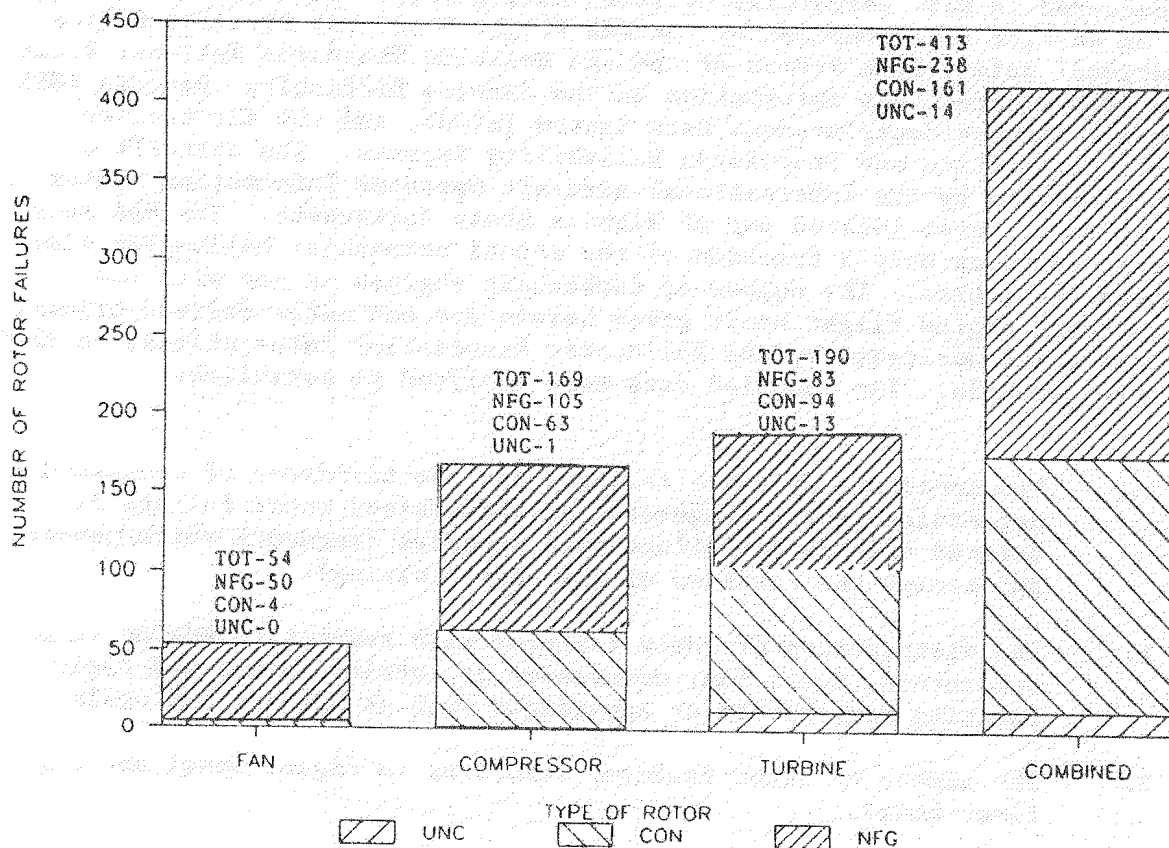


FIGURE 1. INCIDENCE OF ENGINE ROTOR FAILURES IN U.S. COMMERCIAL AVIATION - 1988

Approximately 14.4 million and 45.6 million aircraft flight and engine operating hours, respectively, were logged by the U.S. commercial aviation fleet in 1988. Gas turbine engine fleet operating hours relative to the number of rotor failures and type of engines in use are shown in figure 2.

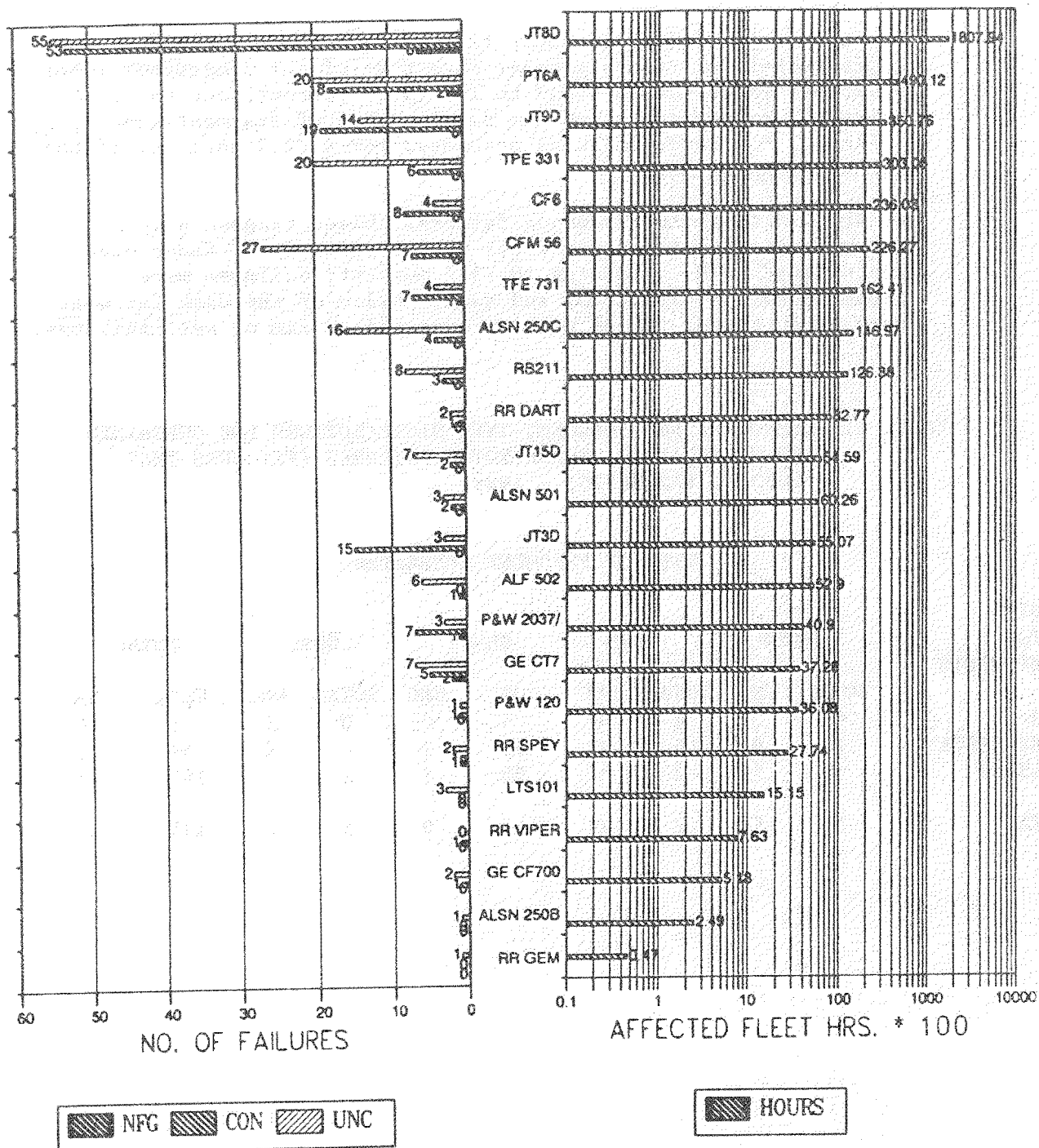


FIGURE 2. TYPE AND NUMBER OF ENGINE ROTOR FAILURES IN U.S. COMMERCIAL AVIATION ACCORDING TO AFFECTED ENGINE MODEL AND ENGINE FLEET HOURS - 1988

Table 1 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 failures generating fragments was approximately 1.7 times greater than that of the compressor rotor failures; these corresponded to 107 (61.1 percent) and 64 (36.6 percent), respectively, of the total number of fragment-generating failures. Fan rotor failures accounted for 4 (2.3 percent) of the failures experienced.
2. Of the 175 fragment-producing failures, blade fragments were generated in 165 (94.3 percent); 9 (5.5 percent) of these were uncontained. The remaining 10 (5.7 percent) failures were produced by the disk, rim, and seal. All 5 of the disk failures were uncontained. There were no uncontained rim or seal failures.

TABLE 1. COMPONENT AND FRAGMENT TYPE DISTRIBUTIONS FOR CONTAINED AND UNCONTAINED ENGINE ROTOR FAILURES (FAILURES THAT PRODUCED FRAGMENTS) - 1988

| ENGINE<br>ROTOR<br>COMPONENTS | TYPE OF FRAGMENT GENERATED |     |       |     |       |     |       |     |       |     |
|-------------------------------|----------------------------|-----|-------|-----|-------|-----|-------|-----|-------|-----|
|                               | DISK                       |     | RIM   |     | BLADE |     | SEAL  |     | TOTAL |     |
|                               | TOTAL                      | UNC | TOTAL | UNC | TOTAL | UNC | TOTAL | UNC | TOTAL | UNC |
| FAN                           | 0                          | 0   | 0     | 0   | 4     | 0   | 0     | 0   | 4     | 0   |
| COMPRESSOR                    | 0                          | 0   | 0     | 0   | 63    | 1   | 1     | 0   | 64    | 1   |
| TURBINE                       | 5                          | 5   | 2     | 0   | 98    | 8   | 2     | 0   | 107   | 13  |
| TOTAL                         | 5                          | 5   | 2     | 0   | 165   | 9   | 3     | 0   | 175   | 14  |

Figure 3 shows the rotor failure distribution among the engine models that were affected and the total number of models in use.

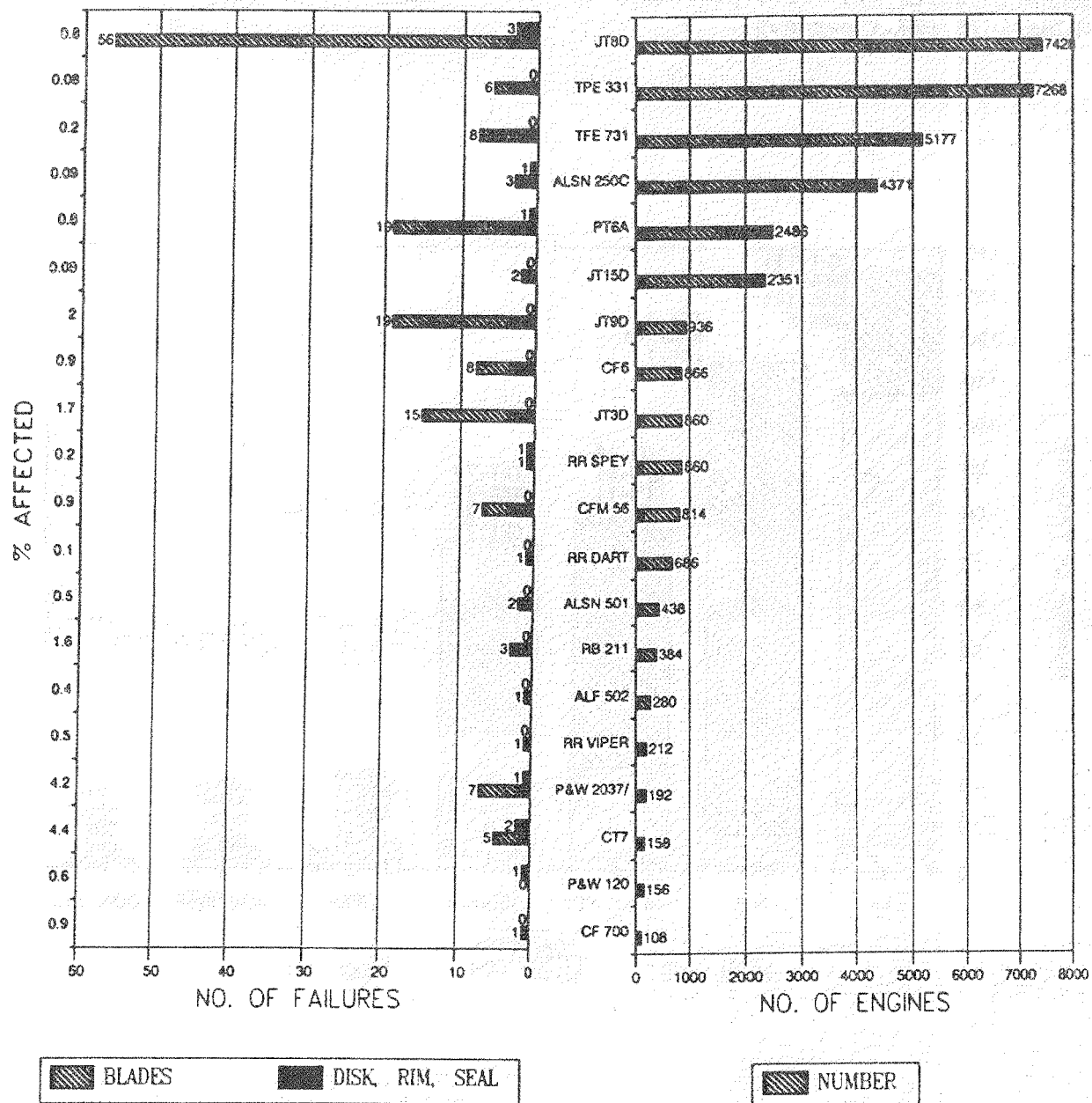


FIGURE 3. THE INCIDENCE OF ENGINE ROTOR FAILURES IN U.S. COMMERCIAL AVIATION ACCORDING TO ENGINE MODEL AND COMPONENT AFFECTED - 1988

Figure 4 shows what caused the rotor failures to occur. Of the 278 failures with known causes (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--114 (41.0 percent); (2) secondary causes--73 (26.3 percent); and (3) design and life prediction problems--78 (28.1 percent).

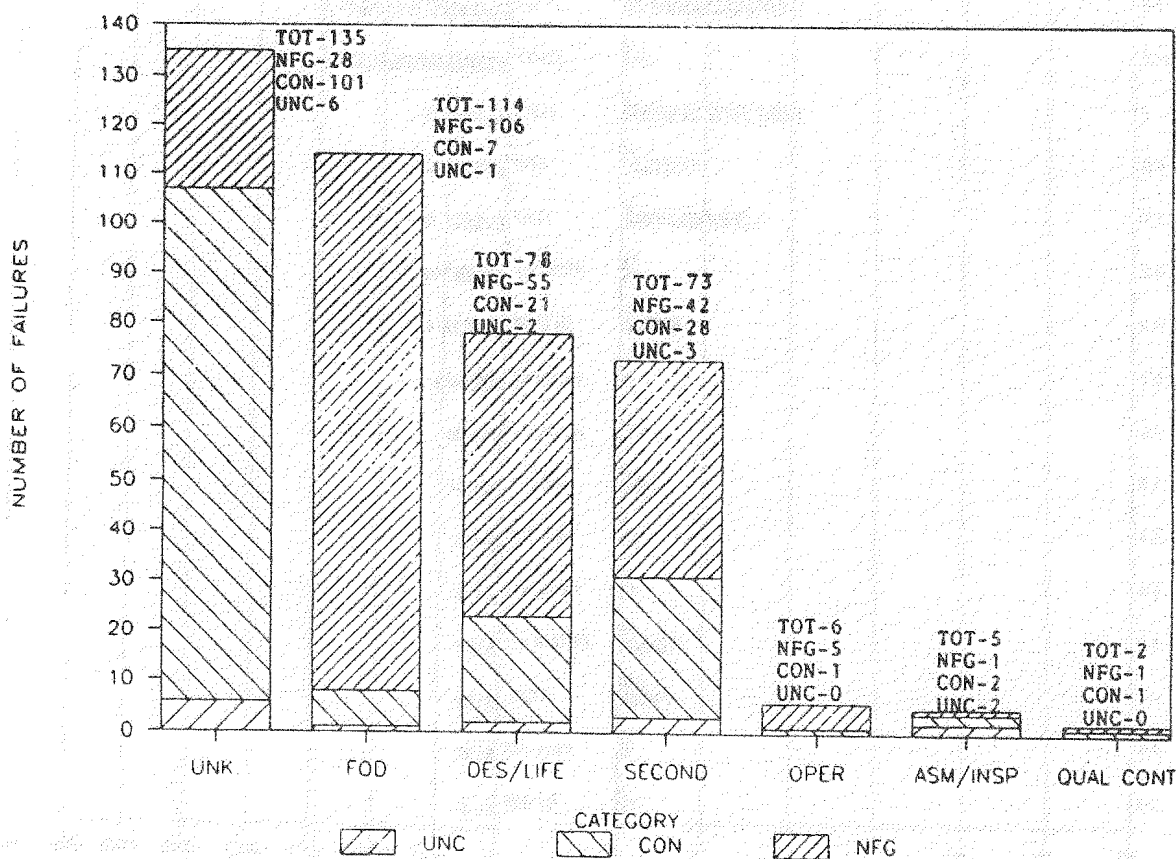


FIGURE 4. ENGINE ROTOR FAILURE CAUSE CATEGORIES - 1988

Figure 5 indicates the flight conditions that existed when the various rotor failures occurred. One hundred and seventy-five (42.4 percent) of the 413 rotor failures occurred during the takeoff and climb stages of flight. Ninety-eight (56.0 percent) of the rotor fragment-producing failures and 7 (50.0 percent) of the uncontained rotor failures occurred during these same stages of flight. The highest number of uncontained rotor failures, 4 (28.6 percent), happened during both the takeoff and cruising portions of the flight.

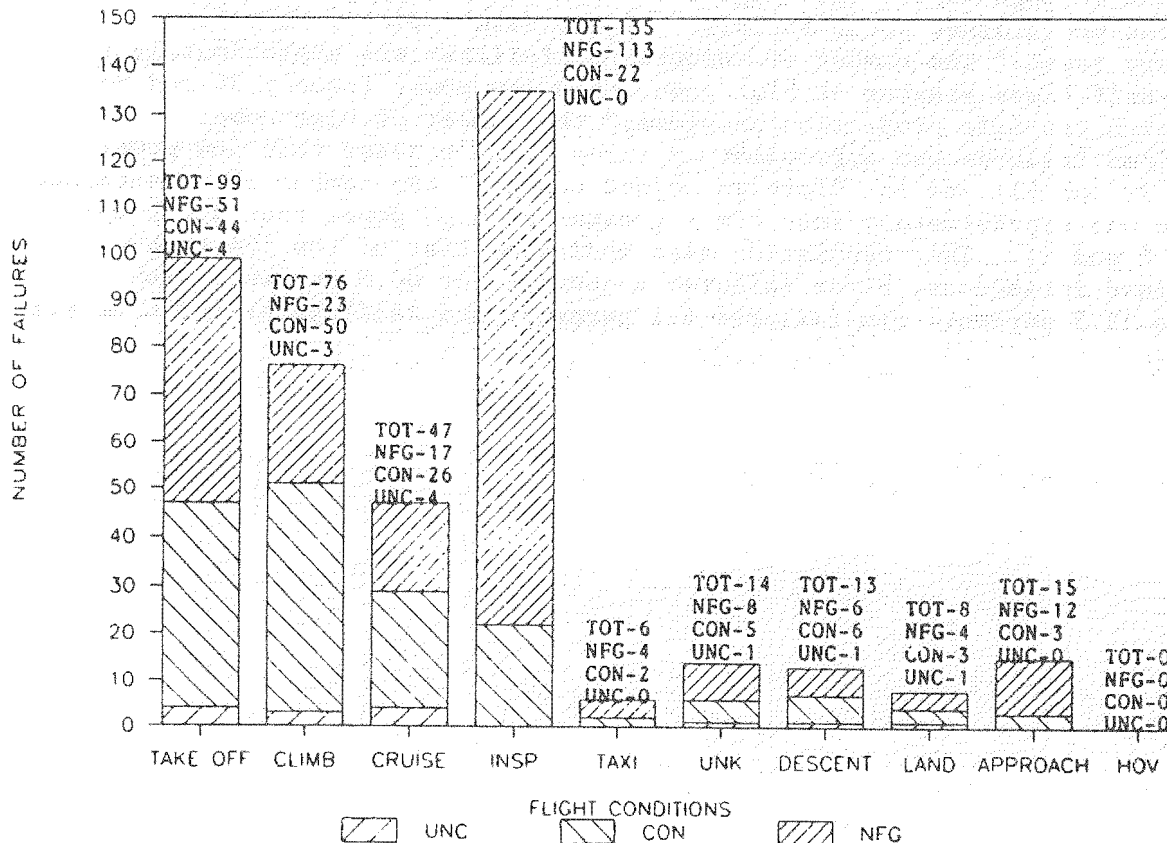


FIGURE 5. FLIGHT CONDITION AT ENGINE ROTOR FAILURE - 1988

Table 2 contains a compilation of engine failure rates per million engine flight hours according to engine model, engine type, and containment conditions. The engine failure rates per million flight hours by engine type are turbofan--8.4, turboprop--8.3, and turboshaft--26.3. Uncontained engine failure rates per million flight hours by engine type were turbofan--0.3, turboprop--0.4, and turboshaft--0.0.

Table 3 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 1988. 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 four and one-half times greater at high power than low power (namely 35 and 8). For "design and life prediction problems," the number of high power uncontained failures was approximately three times greater than low power (namely 32 and 9); and for "foreign object damage," the number of uncontained failures was approximately four times greater at high power than low power (namely 9 and 2). This tabulation also indicates that of the 194 total uncontained incidences, blade failures accounted for 66.5 percent; disk failures 23.2 percent; rim failures 4.1 percent; and seal/spacer failures 6.2 percent.

TABLE 2. GAS TURBINE ENGINE FAILURE RATES ACCORDING TO  
ENGINE MODEL AND TYPE - 1988

| TYPE/<br>MODEL        | AVERAGE<br>NUMBER<br>IN USE** | ENGINE<br>FLIGHT<br>HRS.x10 <sup>5</sup> | NUMBER OF FAILURES |    |     |       | FAILURE RATES / 10 <sup>5</sup><br>ENGINE FLIGHT HOURS |     |       |       |
|-----------------------|-------------------------------|------------------------------------------|--------------------|----|-----|-------|--------------------------------------------------------|-----|-------|-------|
|                       |                               |                                          | C*                 | NC | N*  | TOTAL | C                                                      | NC  | N     | TOTAL |
| TURBOFAN/<br>TURBOJET |                               |                                          |                    |    |     |       |                                                        |     |       |       |
| JT8D                  | 7428                          | 18.0794                                  | 53                 | 6  | 55  | 114   | 2.9                                                    | 0.3 | 3.0   | 6.2   |
| JT3D                  | 660                           | 0.5507                                   | 15                 | 0  | 3   | 18    | 27.2                                                   | 0.0 | 5.4   | 32.6  |
| JT9D                  | 936                           | 3.5076                                   | 19                 | 0  | 14  | 33    | 5.4                                                    | 0.0 | 4.0   | 9.4   |
| CF6                   | 866                           | 2.3603                                   | 8                  | 0  | 4   | 12    | 3.4                                                    | 0.0 | 1.7   | 5.1   |
| RB211                 | 384                           | 1.2638                                   | 3                  | 0  | 8   | 11    | 2.4                                                    | 0.0 | 6.3   | 8.7   |
| PW2037/2040           | 192                           | 0.4090                                   | 7                  | 1  | 3   | 11    | 17.1                                                   | 2.4 | 7.3   | 26.8  |
| SPEY                  | 860                           | 0.2774                                   | 1                  | 1  | 2   | 4     | 63.6                                                   | 3.6 | 7.2   | 14.4  |
| TFE731                | 5177                          | 1.6241                                   | 7                  | 1  | 4   | 12    | 4.3                                                    | 0.6 | 2.5   | 7.4   |
| CFM56                 | 814                           | 2.2627                                   | 7                  | 0  | 27  | 34    | 3.1                                                    | 0.0 | 11.9  | 15.0  |
| ALF502                | 280                           | 0.5290                                   | 0                  | 1  | 6   | 7     | 0.0                                                    | 1.9 | 11.3  | 13.2  |
| JT15D                 | 2351                          | 0.6459                                   | 2                  | 0  | 7   | 9     | 3.1                                                    | 0.0 | 10.8  | 13.9  |
| CF700                 | 108                           | 0.0518                                   | 1                  | 0  | 2   | 3     | 19.3                                                   | 0.0 | 38.6  | 57.9  |
| OTHERS                | 2358                          | 0.4244                                   | 0                  | 0  | 0   | 0     | 0.0                                                    | 0.0 | 0.0   | 0.0   |
| TOTAL                 | 22626                         | 32.0624                                  | 124                | 10 | 135 | 269   | 3.9                                                    | 0.3 | 4.2   | 8.4   |
| TURBOPROP             |                               |                                          |                    |    |     |       |                                                        |     |       |       |
| PT6A                  | 2486                          | 4.9012                                   | 18                 | 2  | 20  | 40    | 3.7                                                    | 0.4 | 4.1   | 8.2   |
| A501                  | 438                           | 0.6026                                   | 2                  | 0  | 3   | 5     | 3.3                                                    | 0.0 | 5.0   | 8.3   |
| TPE331                | 7268                          | 3.0305                                   | 6                  | 0  | 20  | 26    | 2.0                                                    | 0.0 | 6.6   | 8.6   |
| DART                  | 686                           | 0.8277                                   | 1                  | 0  | 2   | 3     | 1.2                                                    | 0.0 | 2.4   | 3.6   |
| PW120                 | 156                           | 0.3608                                   | 1                  | 0  | 1   | 2     | 2.8                                                    | 0.0 | 2.8   | 5.6   |
| CT7                   | 158                           | 0.3728                                   | 5                  | 2  | 7   | 14    | 13.4                                                   | 5.4 | 18.8  | 37.6  |
| A250B                 | 74                            | 0.0249                                   | 0                  | 0  | 1   | 1     | 0.0                                                    | 0.0 | 15.0  | 15.0  |
| OTHERS                | 460                           | 0.8501                                   | 0                  | 0  | 0   | 0     | 0.0                                                    | 0.0 | 0.0   | 0.0   |
| TOTAL                 | 11726                         | 10.9778                                  | 33                 | 4  | 54  | 91    | 3.0                                                    | 0.4 | 4.9   | 8.3   |
| TURBOSHAFT            |                               |                                          |                    |    |     |       |                                                        |     |       |       |
| A250C                 | 4300                          | 1.4448                                   | 4                  | 0  | 16  | 20    | 2.8                                                    | 0.0 | 11.1  | 13.8  |
| LTS 101               | 669                           | 0.2248                                   | 0                  | 0  | 32  | 32    | 0.0                                                    | 0.0 | 142.3 | 142.3 |
| GEM                   | 14                            | 0.0047                                   | 0                  | 0  | 1   | 1     | 0.0                                                    | 0.0 | 212.8 | 212.8 |
| OTHERS                | 1012                          | 0.3400                                   | 0                  | 0  | 0   | 0     | 0.0                                                    | 0.0 | 0.0   | 0.0   |
| TOTAL                 | 5995                          | 2.0143                                   | 4                  | 0  | 49  | 53    | 2.0                                                    | 0.0 | 24.3  | 26.3  |

C = CONTAINED NC = NOT CONTAINED  
N = FUNCTION IMPEDED, NO FRAGMENTS GENERATED

\*As reported by service difficulty reports only.

\*\*Estimated total number in use and engine flight hours for entire U.S. commercial fleet.

TABLE 3. UNCONTAINED ENGINE ROTOR FAILURE DISTRIBUTIONS ACCORDING TO CAUSE AND FLIGHT CONDITIONS - 1976 THROUGH 1988

| TYPE OF FRAGMENT GENERATED      |              | DISK |      |      | RIM |      |      | BLADE |      |      | SEAL |      |      |         |       |
|---------------------------------|--------------|------|------|------|-----|------|------|-------|------|------|------|------|------|---------|-------|
| ENGINE ROTOR COMPONENT          |              | FAN  | COMP | TURB | FAN | COMP | TURB | FAN   | COMP | TURB | FAN  | COMP | TURB | SUB TOT | TOTAL |
| CAUSE                           | FLIGHT COND. |      |      |      |     |      |      |       |      |      |      |      |      |         |       |
| DESIGN/LIFE PREDICTION PROBLEMS | HI           | 1    | 5    | 0    | 0   | 3    | 0    | 9     | 10   | 3    | 0    | 1    | 0    | 32      | 41    |
|                                 | LOW          | 0    | 1    | 3    | 0   | 0    | 0    | 1     | 0    | 4    | 0    | 0    | 0    | 9       |       |
|                                 | UNK          | 0    | 0    | 0    | 0   | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 0       |       |
| SECONDARY CAUSES                | HI           | 0    | 1    | 1    | 0   | 0    | 0    | 5     | 4    | 21   | 0    | 0    | 3    | 35      | 46    |
|                                 | LOW          | 0    | 0    | 1    | 0   | 0    | 0    | 0     | 2    | 5    | 0    | 0    | 0    | 8       |       |
|                                 | UNK          | 0    | 0    | 0    | 0   | 0    | 0    | 1     | 0    | 2    | 0    | 0    | 0    | 3       |       |
| FOREIGN OBJECT DAMAGE           | HI           | 1    | 0    | 1    | 0   | 0    | 0    | 6     | 0    | 1    | 0    | 0    | 0    | 9       | 13    |
|                                 | LOW          | 0    | 0    | 0    | 0   | 0    | 0    | 2     | 0    | 0    | 0    | 0    | 0    | 2       |       |
|                                 | UNK          | 0    | 0    | 0    | 0   | 0    | 0    | 2     | 0    | 0    | 0    | 0    | 0    | 2       |       |
| QUALITY CONTROL                 | HI           | 0    | 1    | 0    | 0   | 0    | 1    | 2     | 0    | 0    | 0    | 0    | 0    | 4       | 4     |
|                                 | LOW          | 0    | 0    | 0    | 0   | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 0       |       |
|                                 | UNK          | 0    | 0    | 0    | 0   | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 0       |       |
| OPERATIONAL                     | HI           | 0    | 0    | 0    | 0   | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 0       | 0     |
|                                 | LOW          | 0    | 0    | 0    | 0   | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 0       |       |
|                                 | UNK          | 0    | 0    | 0    | 0   | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 0       |       |
| ASSEMBLY/ INSP. REPORTS         | HI           | 0    | 0    | 1    | 0   | 0    | 0    | 0     | 0    | 1    | 0    | 0    | 0    | 2       | 3     |
|                                 | LOW          | 0    | 0    | 1    | 0   | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 1       |       |
|                                 | UNK          | 0    | 0    | 0    | 0   | 0    | 0    | 0     | 0    | 0    | 0    | 0    | 0    | 0       |       |
| UNKNOWN                         | HI           | 1    | 2    | 11   | 0   | 3    | 0    | 6     | 10   | 14   | 1    | 2    | 3    | 53      | 87    |
|                                 | LOW          | 1    | 0    | 11   | 0   | 1    | 0    | 0     | 2    | 12   | 0    | 1    | 1    | 29      |       |
|                                 | UNK          | 0    | 0    | 1    | 0   | 0    | 0    | 1     | 0    | 3    | 0    | 0    | 0    | 5       |       |
| SUBTOTAL                        | HI           | 3    | 9    | 14   | 0   | 6    | 1    | 28    | 24   | 40   | 1    | 3    | 6    | 135     | 194   |
|                                 | LOW          | 1    | 1    | 16   | 0   | 1    | 0    | 3     | 4    | 21   | 0    | 1    | 1    | 49      |       |
|                                 | UNK          | 0    | 0    | 1    | 0   | 0    | 0    | 4     | 0    | 5    | 0    | 0    | 0    | 10      |       |
| TOTAL                           |              |      | 45   |      |     | 8    |      | 129   |      |      |      | 12   |      | 194     |       |

\* Takeoff and climb are defined as "High Power" and all other conditions are defined as "Low Power".

Figure 6 shows the annual incidence of uncontained rotor failures in commercial aviation for the years 1963 through 1988. During 1988, the incidence of uncontained rotor failures increased by two over the previous year (This is due to the fact that the FAA's Accident/Incident Data System was used as a data source. Otherwise a decrease of two uncontained failures would have been noted.). Over the past 13 years, 1976 through 1988, an average of 14.9 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 operating hours.

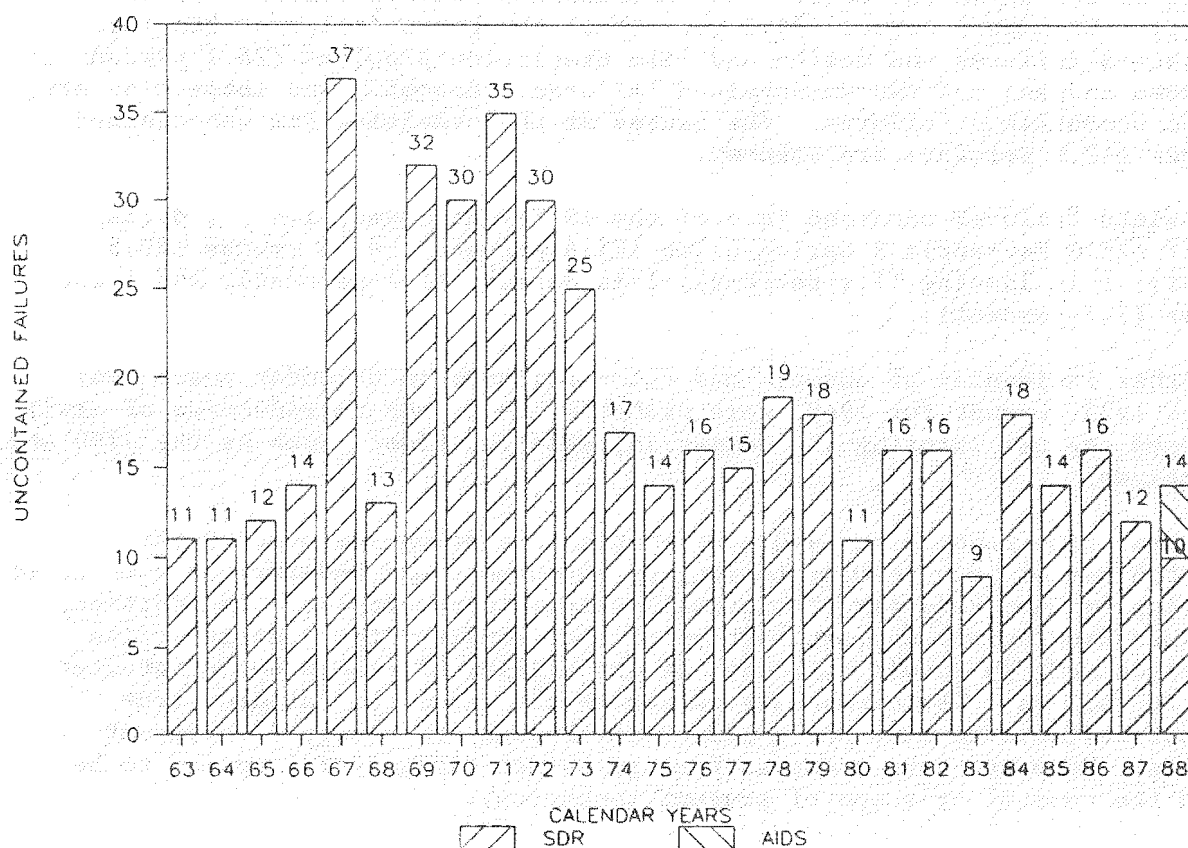


FIGURE 6. THE INCIDENCE OF UNCONTAINED ENGINE ROTOR FAILURES IN U.S. COMMERCIAL AVIATION, 1963 through 1988

## DISCUSSION AND CONCLUSIONS

The incidence of engine rotor fragment-producing failures has remained relatively constant when comparing 1988 to 1987 (170 in 1987 and 175 in 1988). The uncontained engine rotor failures has increased 17 percent (14 in 1988 and 12 in 1987), due, in part, to the introduction of the AIDS as a data source. The 13-year (1976 through 1988) average of uncontained engine rotor failures is 14.9.

Of the 14 uncontained events that occurred during 1988, 13 (92.9 percent) involved turbine rotors, and 1 (7.1 percent) involved compressor rotors. There were no uncontained fan rotor failures reported.

The predominant cause of failure was attributed to foreign object damage (41.0 percent of the known failures). One uncontained failure occurred in this category. Secondary causes (26.3 percent of the known failures) had three uncontained failures and design and life prediction problems (28.1 percent of the known causes) had two uncontained failures. Assembly and inspection error had two uncontained failures. The causes of the remaining six uncontained failures (42.9 percent) are unknown.

Uncontained failures occurred in 6 of the 10 flight modes; i.e., 4 during takeoff (28.6 percent); 3 during climb (21.4 percent); 4 in cruise (28.6 percent); 1 in landing (7.1 percent); 1 in descent (7.1 percent), and 1 was unknown (7.1 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 predictions and verification are 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.

## APPENDIX A

Data of Engine Rotor Failures in U.S. Commercial  
Aviation for 1988. Compiled from the  
Federal Aviation Administration  
Service Difficulty Reports and the  
Accident Incident Data System.

### 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

#### Report Source - Number

S - SDR  
A - AIDS  
X - Other

# CHARACTERISTICS OF ROTOR FAILURES - 1988

| <u>REPORT NO.</u> | <u>SUBMIT.</u> | <u>AIRCRAFT.</u> | <u>ENGINE/<br/>POSITION</u> | <u>COMPNT</u> | <u>FRAG.<br/>TYPE</u> | <u>CAUSE</u> | <u>CONTN.<br/>COND.</u> | <u>FLT.<br/>COND.</u> |
|-------------------|----------------|------------------|-----------------------------|---------------|-----------------------|--------------|-------------------------|-----------------------|
| S-880205022       | NWAA           | B747             | JT9D                        | T             | B                     | 1            | C                       | 4                     |
| S-880205162       | PAAA           | B747             | JT9D                        | F             | B                     | 3            | C                       | 8                     |
| S-880129008       | NWAA           | DC10             | JT9D                        | T             | B                     | 7            | C                       | 4                     |
| S-880226114       | FTLA           | B747             | JT9D                        | T             | B                     | 7            | C                       | 4                     |
| S-880308031       | TWAA           | B747             | JT9D                        | T             | B                     | 1            | C                       | 5                     |
| S-880311020       | TWAA           | B747             | JT9D                        | C             | B                     | 7            | C                       | 4                     |
| S-880419008       | TWAA           | B747             | JT9D                        | T             | B                     | 7            | C                       | 4                     |
| S-880429153       | PAAA           | B747             | JT9D                        | C             | B                     | 7            | C                       | 3                     |
| S-880509047       | PAAA           | B747             | JT9D                        | C             | B                     | 7            | C                       | 5                     |
| S-880708156       | PAAA           | B747             | JT9D                        | T             | B                     | 7            | C                       | 4                     |
| S-880822075       | NWAA           | B747             | JT9D                        | C             | B                     | 7            | C                       | 3                     |
| S-881014020       | PAAA           | A310             | JT9D                        | T             | B                     | 7            | C                       | 3                     |
| S-881209023       | PAAA           | B747             | JT9D                        | T             | B                     | 7            | C                       | 4                     |
| S-881209025       | PAAA           | B747             | JT9D                        | C             | B                     | 7            | C                       | 3                     |
| S-881216026       | TWAA           | B747             | JT9D                        | C             | B                     | 7            | C                       | 4                     |
| S-890106001       | PAAA           | A310             | JT9D                        | C             | B                     | 1            | C                       | 5                     |
| S-890113118       | NWAA           | DC10             | JT9D                        | T             | B                     | 1            | C                       | 3                     |
| S-890327257       | PAAA           | B747             | JT9D                        | C             | B                     | 7            | C                       | 4                     |
| S-890327259       | PAAA           | B747             | JT9D                        | C             | B                     | 7            | C                       | 3                     |
| S-880401059       | PAAA           | B747             | JT9D                        | C             | N                     | 7            | N                       | 4                     |
| S-880419010       | TWAA           | B747             | JT9D                        | C             | N                     | 2            | N                       | 10                    |
| S-880418095       | TWAA           | B767             | JT9D                        | T             | N                     | 3            | N                       | 6                     |
| S-880425070       | PAAA           | B747             | JT9D                        | F             | N                     | 1            | N                       | 1                     |
| S-880624021       | NWAA           | B747             | JT9D                        | T             | N                     | 2            | N                       | 6                     |
| S-880729043       | NWAA           | DC10             | JT9D                        | C             | N                     | 2            | N                       | 6                     |
| S-880826061       | PAAA           | A310             | JT9D                        | F             | N                     | 2            | N                       | 5                     |
| S-881028024       | NWAA           | DC10             | JT9D                        | C             | N                     | 2            | N                       | 5                     |
| S-881104018       | UALA           | B747             | JT9D                        | F             | N                     | 3            | N                       | 3                     |
| S-881115101       | PAAA           | B747             | JT9D                        | F             | N                     | 3            | N                       | 4                     |
| S-881207002       | GL25           | UNKNOWN          | JT9D                        | F             | N                     | 7            | N                       | 1                     |
| S-881216027       | UALA           | B747             | JT9D                        | F             | N                     | 3            | N                       | 3                     |
| S-890127042       | TWAA           | B767             | JT9D                        | F             | N                     | 3            | N                       | 5                     |
| S-880701179       | NWAA           | B747             | JT9D                        | F             | N                     | 7            | N                       | 1                     |
| S-880129004       | SWAA           | B737             | CFM56                       | C             | B                     | 2            | C                       | 5                     |
| S-880603012       | UALA           | DC8              | CFM56                       | C             | B                     | 1            | C                       | 4                     |
| S-880816039       | PAIA           | B737             | CFM56                       | T             | B                     | 7            | C                       | 1                     |
| S-880816056       | PAIA           | B737             | CFM56                       | T             | B                     | 7            | C                       | 1                     |
| S-880830023       | CALA           | B737             | CFM56                       | T             | B                     | 2            | C                       | 4                     |
| S-880930013       | PAIA           | B737             | CFM56                       | T             | B                     | 7            | C                       | 1                     |
| S-881107108       | DALA           | DC8              | CFM56                       | C             | B                     | 1            | C                       | 4                     |
| S-880520003       | RAXA           | DC8              | CFM56                       | C             | N                     | 1            | N                       | 1                     |
| S-880520005       | RAXA           | DC8              | CFM56                       | C             | N                     | 1            | N                       | 1                     |
| S-880520007       | RAXA           | DC8              | CFM56                       | C             | N                     | 1            | N                       | 1                     |
| S-880627072       | PAIA           | B737             | CFM56                       | T             | N                     | 7            | N                       | 1                     |
| S-880712015       | SW07           | DC8              | CFM56                       | C             | N                     | 1            | N                       | 1                     |
| S-880712014       | SW07           | DC8              | CFM56                       | C             | N                     | 7            | N                       | 1                     |
| S-880811033       | SW07           | DC8              | CFM56                       | C             | N                     | 1            | N                       | 1                     |

# CHARACTERISTICS OF ROTOR FAILURES - 1988

| REPORT NO.  | SUBMIT. | AIRCRAFT | ENGINE/<br>POSITION | COMPNT | FRAG.<br>TYPE | CAUSE | CONTN.<br>COND. | FLT.<br>COND. |
|-------------|---------|----------|---------------------|--------|---------------|-------|-----------------|---------------|
| S-880811036 | SW07    | DC8      | CFM56               | C      | N             | 3     | N               | 1             |
| S-880811037 | SW07    | DC8      | CFM56               | C      | N             | 1     | N               | 1             |
| S-880902037 | RAXA    | DC8      | CFM56               | C      | N             | 1     | N               | 1             |
| S-880913062 | SW07    | DC8      | CFM56               | C      | N             | 7     | N               | 1             |
| S-880916017 | SWAA    | B737     | CFM56               | T      | N             | 5     | N               | 3             |
| S-881004128 | SW05    | DC8      | CFM56               | C      | N             | 1     | N               | 1             |
| S-881004129 | SW05    | DC8      | CFM56               | C      | N             | 1     | N               | 1             |
| S-881004090 | SW05    | DC8      | CFM56               | C      | N             | 1     | N               | 1             |
| S-881028029 | RAXA    | DC8      | CFM56               | C      | N             | 1     | N               | 1             |
| S-881109061 | SW07    | DC8      | CFM56               | C      | N             | 7     | N               | 1             |
| S-881014021 | USAA    | B737     | CFM56               | T      | N             | 2     | N               | 4             |
| S-881021068 | AWXA    | B737     | CFM56               | T      | N             | 3     | N               | 1             |
| S-881021069 | AWXA    | B737     | CFM56               | T      | N             | 3     | N               | 1             |
| S-881121136 | IPXA    | DC8      | CFM56               | C      | N             | 3     | N               | 7             |
| S-881205123 | FTLA    | DC8      | CFM56               | C      | N             | 3     | N               | 4             |
| S-881212136 | AWXA    | B737     | CFM56               | F      | N             | 3     | N               | 3             |
| S-881216045 | IPXA    | DC8      | CFM56               | C      | N             | 3     | N               | 1             |
| S-881216047 | IPXA    | DC8      | CFM56               | C      | N             | 3     | N               | 1             |
| S-890113175 | PAIA    | B737     | CFM56               | F      | N             | 3     | N               | 3             |
| S-890123067 | SWAA    | B737     | CFM56               | C      | N             | 3     | N               | 3             |
| S-880129036 | PAYA    | DHC7102  | PT6A                | T      | B             | 5     | C               | 5             |
| S-880211037 | SJSA    | DHC6300  | PT6A                | C      | B             | 7     | C               | 3             |
| S-880325176 | PCAA    | STC262   | PT6A                | C      | B             | 7     | C               | 2             |
| S-880329142 | SWO3    | PA31T    | PT6A                | T      | B             | 7     | C               | 3             |
| S-880415159 | HNAA    | DHC7102  | PT6A                | C      | B             | 7     | C               | 3             |
| S-880426002 | GLBA    | BEECH99  | PT6A                | T      | B             | 7     | C               | 10            |
| S-880706016 | RAYA    | EMB110   | PT6A                | T      | B             | 7     | C               | 3             |
| S-880816002 | SALA    | SD360    | PT6A                | T      | B             | 1     | C               | 3             |
| S-880822083 | PAYA    | DHC7102  | PT6A                | T      | R             | 1     | C               | 5             |
| S-880831099 | RAYA    | EMB110   | PT6A                | T      | B             | 7     | C               | 3             |
| S-880902168 | PCAA    | SD330    | PT6A                | T      | B             | 7     | C               | 2             |
| S-881028043 | PAYA    | DHC7102  | PT6A/2              | T      | B             | 7     | NC              | 5             |
| S-881104002 | PLGA    | 1900C    | PT6A                | F      | B             | 7     | C               | 3             |
| S-881109017 | NM08    | 212      | PT6A                | F      | B             | 1     | C               | 5             |
| S-881007002 | HNAA    | DHC7102  | PT6A                | C      | B             | 2     | C               | 4             |
| S-881027003 | S003    | E90      | PT6A                | C      | B             | 7     | C               | 4             |
| S-881118004 | CR0A    | SD330    | PT6A                | C      | B             | 7     | C               | 4             |
| S-881207003 | EA11    | B200     | PT6A                | T      | B             | 7     | C               | 4             |
| S-890123048 | PCAA    | SD330    | PT6A                | T      | B             | 7     | C               | 1             |
| S-880125012 | SWJA    | SD360    | PT6A                | T      | N             | 2     | N               | 1             |
| S-880125011 | SWJA    | SD360    | PT6A                | T      | N             | 2     | N               | 1             |
| S-880212029 | HALA    | DHC7102  | PT6A                | C      | N             | 7     | N               | 2             |
| S-880304011 | SIMI    | SD360    | PT6A                | C      | N             | 2     | N               | 7             |
| S-880309003 | EA03    | C99      | PT6A                | C      | N             | 2     | N               | 1             |
| S-880525070 | COMA    | EMB110   | PT6A                | T      | N             | 7     | N               | 8             |
| S-880608003 | SO11    | B200     | PT6A                | T      | N             | 1     | N               | 1             |
| S-880617088 | PCAA    | SD330    | PT6A                | C      | N             | 3     | N               | 5             |

# CHARACTERISTICS OF ROTOR FAILURES - 1988

| <u>REPORT NO.</u> | <u>SUBMIT.</u> | <u>AIRCRAFT</u> | <u>ENGINE/<br/>POSITION</u> | <u>COMPNT</u> | <u>FRAG.<br/>TYPE</u> | <u>CAUSE</u> | <u>CONTN.<br/>COND.</u> | <u>FLT.<br/>COND.</u> |
|-------------------|----------------|-----------------|-----------------------------|---------------|-----------------------|--------------|-------------------------|-----------------------|
| S-880715115       | PCAA           | SD330           | PT6A                        | C             | N                     | 3            | N                       | 5                     |
| S-880729269       | WTAA           | SD360           | PT6A                        | C             | N                     | 3            | N                       | 3                     |
| S-880801017       | WTAA           | SD360           | PT6A                        | T             | N                     | 2            | N                       | 3                     |
| S-880824067       | SW01           | C99             | PT6A                        | C             | N                     | 2            | N                       | 3                     |
| S-880919150       | SO19           | UNKNOWN         | PT6A                        | T             | N                     | 1            | N                       | 1                     |
| S-881003037       | WTAA           | SD360           | PT6A                        | C             | N                     | 5            | N                       | 3                     |
| S-881025013       | SW01           | C99             | PT6A                        | C             | N                     | 7            | N                       | 3                     |
| S-881103019       | WTAA           | EMB110          | PT6A                        | C             | N                     | 3            | N                       | 7                     |
| S-881007003       | CAIA           | SD360           | PT6A                        | C             | N                     | 2            | N                       | 5                     |
| S-881017296       | NMO1           | 212             | PT6A                        | F             | N                     | 3            | N                       | 3                     |
| S-881220029       | BHAA           | 1900C           | PT6A                        | T             | N                     | 2            | N                       | 2                     |
| S-880119045       | SO11           | UNKNOWN         | PT6A                        | F             | N                     | 1            | N                       | 1                     |
| S-880115019       | AALA           | B727            | JT8D                        | C             | B                     | 3            | C                       | 4                     |
| S-880119096       | SW05           | DC9             | JT8D                        | C             | B                     | 7            | C                       | 1                     |
| S-880129010       | NWAA           | B727            | JT8D                        | T             | B                     | 2            | C                       | 3                     |
| S-880128029       | DALA           | B727            | JT8D                        | T             | B                     | 7            | C                       | 4                     |
| S-880205247       | TWAA           | B727            | JT8D                        | T             | B                     | 2            | C                       | 10                    |
| S-880209054       | SU19           | UNKNOWN         | JT8D                        | T             | B                     | 2            | C                       | 1                     |
| S-880212003       | UALA           | B727            | JT8D                        | T             | B                     | 1            | C                       | 3                     |
| S-880219011       | USAA           | DC9             | JT8D                        | T             | B                     | 7            | C                       | 4                     |
| S-880224048       | WP09           | UNKNOWN         | JT8D                        | C             | B                     | 7            | C                       | 1                     |
| S-880304012       | USAA           | B737            | JT8D                        | T             | B                     | 7            | C                       | 5                     |
| S-880325025       | AALA           | DC9             | JT8D                        | T             | B                     | 7            | C                       | 4                     |
| S-880401006       | NWAA           | DC9             | JT8D                        | T             | B                     | 1            | C                       | 3                     |
| S-880401019       | USAA           | UNKNOWN         | JT8D                        | T             | B                     | 7            | C                       | 3                     |
| S-880412010       | WP09           | UNKNOWN         | JT8D                        | C             | B                     | 7            | C                       | 1                     |
| S-880412014       | WP09           | UNKNOWN         | JT8D                        | C             | B                     | 7            | C                       | 1                     |
| S-880422007       | NWAA           | DC9             | JT8D                        | T             | B                     | 1            | C                       | 3                     |
| S-880422003       | UALA           | B737            | JT8D/2                      | T             | B                     | 1            | NC                      | 3                     |
| S-880415005       | AWXA           | B737            | JT8D                        | C             | B                     | 2            | C                       | 4                     |
| S-880429002       | DALA           | B727            | JT8D                        | T             | B                     | 2            | C                       | 3                     |
| S-880429053       | HALA           | DC9             | JT8D                        | C             | B                     | 7            | C                       | 4                     |
| S-880520044       | TWAA           | DC9             | JT8D                        | T             | B                     | 1            | C                       | 4                     |
| S-880523110       | EALA           | B727            | JT8D                        | T             | B                     | 7            | C                       | 4                     |
| S-880527349       | MRKA           | B737            | JT8D                        | T             | B                     | 7            | C                       | 3                     |
| S-880603014       | AALA           | B727            | JT8D                        | T             | B                     | 7            | C                       | 3                     |
| S-880603023       | USAA           | DC9             | JT8D                        | C             | B                     | 7            | C                       | 4                     |
| S-880606080       | EALA           | B727            | JT8D                        | T             | B                     | 7            | C                       | 4                     |
| S-880624028       | NWAA           | DC9             | JT8D                        | T             | B                     | 1            | C                       | 3                     |
| S-880624031       | NWAA           | DC9             | JT8D                        | T             | B                     | 2            | C                       | 4                     |
| S-880708007       | FTLA           | B727            | JT8D/3                      | T             | B                     | 2            | NC                      | 10                    |
| S-880715035       | USAA           | DC9             | JT8D                        | C             | B                     | 3            | C                       | 4                     |
| S-880715045       | EMAA           | DC9             | JT8D                        | T             | B                     | 7            | C                       | 3                     |
| S-880808082       | HALA           | DC9             | JT8D                        | T             | B                     | 7            | C                       | 4                     |
| S-880822117       | NWAA           | B727            | JT8D                        | C             | B                     | 3            | C                       | 6                     |
| S-880816013       | DALA           | B727            | JT8D                        | F             | B                     | 1            | C                       | 3                     |

# CHARACTERISTICS OF ROTOR FAILURES - 1988

| <u>REPORT NO.</u> | <u>SUBMIT.</u> | <u>AIRCRAFT</u> | <u>ENGINE/<br/>POSITION</u> | <u>COMPNT</u> | <u>FRAG.<br/>TYPE</u> | <u>CAUSE</u> | <u>CONTN.<br/>COND.</u> | <u>FLT.<br/>COND.</u> |
|-------------------|----------------|-----------------|-----------------------------|---------------|-----------------------|--------------|-------------------------|-----------------------|
| S-880830031       | CALA           | B727            | JT8D                        | C             | B                     | 3            | C                       | 3                     |
| S-880830020       | TAGA           | B727            | JT8D                        | T             | B                     | 7            | C                       | 4                     |
| S-880902040       | NWAA           | DC9             | JT8D/2                      | C             | B                     | 1            | NC                      | 3                     |
| S-880902018       | NWAA           | DC9             | JT8D                        | T             | B                     | 1            | C                       | 4                     |
| S-880909107       | CALA           | B727            | JT8D                        | T             | B                     | 2            | C                       | 5                     |
| S-880916018       | SWAA           | B737            | JT8D                        | T             | B                     | 7            | C                       | 5                     |
| S-881011015       | EIAA           | B727            | JT8D                        | T             | B                     | 7            | C                       | 3                     |
| S-881014024       | IPXA           | B727            | JT8D                        | T             | B                     | 2            | C                       | 3                     |
| S-881028012       | USAA           | DC9             | JT8D                        | T             | B                     | 7            | C                       | 3                     |
| S-881028094       | UALA           | B737            | JT8D                        | T             | B                     | 7            | C                       | 3                     |
| S-881114033       | FDEA           | B727            | JT8D/3                      | T             | D                     | 2            | NC                      | 3                     |
| S-881114006       | CALA           | B727            | JT8D                        | T             | B                     | 7            | C                       | 4                     |
| S-881007018       | SWAA           | B737            | JT8D                        | C             | B                     | 7            | C                       | 4                     |
| S-881021118       | CALA           | B727            | JT8D                        | T             | B                     | 7            | C                       | 4                     |
| S-881202051       | BNFA           | B737            | JT8D                        | T             | B                     | 7            | C                       | 3                     |
| S-881216057       | MIDA           | B737            | JT8D                        | T             | B                     | 7            | C                       | 4                     |
| S-881216022       | AALA           | DC9             | JT8D                        | T             | B                     | 7            | C                       | 3                     |
| S-881223033       | MIDA           | B737            | JT8D                        | T             | B                     | 7            | C                       | 6                     |
| S-881230023       | UALA           | B727            | JT8D                        | C             | B                     | 2            | C                       | 10                    |
| S-881230005       | ASAA           | DC9             | JT8D                        | T             | B                     | 1            | C                       | 4                     |
| S-890127124       | MRKA           | B737            | JT8D                        | T             | B                     | 7            | C                       | 6                     |
| S-890113142       | NWAA           | B727            | JT8D                        | C             | B                     | 2            | C                       | 3                     |
| S-890118010       | PAAA           | B727            | JT8D                        | T             | B                     | 7            | C                       | 7                     |
| S-880129099       | DALA           | B727            | JT8D                        | F             | N                     | 1            | N                       | 1                     |
| S-880129070       | AWXA           | B737            | JT8D                        | F             | N                     | 3            | N                       | 3                     |
| S-880205240       | TWAA           | DC9             | JT8D                        | F             | N                     | 3            | N                       | 4                     |
| S-880219145       | PAAA           | B727            | JT8D                        | F             | N                     | 3            | N                       | 5                     |
| S-880219159       | EIAA           | B727            | JT8D                        | C             | N                     | 3            | N                       | 3                     |
| S-880317113       | SW07           | B727            | JT8D                        | F             | N                     | 3            | N                       | 1                     |
| S-880401114       | MIDA           | DC9             | JT8D                        | C             | N                     | 3            | N                       | 6                     |
| S-880421038       | SO19           | UNKNOWN         | JT8D                        | F             | N                     | 1            | N                       | 1                     |
| S-880523054       | FDEA           | B727            | JT8D                        | F             | N                     | 3            | N                       | 1                     |
| S-880602074       | SW07           | UNKNOWN         | JT8D                        | F             | N                     | 3            | N                       | 1                     |
| S-880602047       | SW07           | B727            | JT8D                        | F             | N                     | 3            | N                       | 1                     |
| S-880603024       | AALA           | DC9             | JT8D                        | F             | N                     | 3            | N                       | 3                     |
| S-880603041       | EALA           | B727            | JT8D                        | T             | N                     | 2            | N                       | 3                     |
| S-880603133       | BNFA           | B727            | JT8D                        | C             | N                     | 3            | N                       | 1                     |
| S-880718003       | RJEF           | B737            | JT8D                        | F             | N                     | 3            | N                       | 3                     |
| S-880802049       | EALA           | DC9             | JT8D                        | C             | N                     | 3            | N                       | 3                     |
| S-880729055       | TWAA           | DC9             | JT8D                        | C             | N                     | 3            | N                       | 3                     |
| S-880801097       | EALA           | DC9             | JT8D                        | F             | N                     | 3            | N                       | 3                     |
| S-880825176       | USAA           | B737            | JT8D                        | F             | N                     | 3            | N                       | 3                     |
| S-880826005       | CALA           | B727            | JT8D                        | C             | N                     | 3            | N                       | 3                     |
| S-880826080       | CALA           | DC9             | JT8D                        | C             | N                     | 3            | N                       | 3                     |
| S-880830130       | CALA           | B727            | JT8D                        | C             | N                     | 3            | N                       | 5                     |
| S-880902106       | SWAA           | B737            | JT8D                        | F             | N                     | 3            | N                       | 3                     |
| S-880906078       | PAIA           | B737            | JT8D                        | F             | N                     | 3            | N                       | 5                     |

# CHARACTERISTICS OF ROTOR FAILURES - 1988

| <u>REPORT NO.</u> | <u>SUBMIT.</u> | <u>AIRCRAFT</u> | <u>ENGINE/<br/>POSITION</u> | <u>COMPNT</u> | <u>FRAG.<br/>TYPE</u> | <u>CAUSE</u> | <u>CONTN.<br/>COND.</u> | <u>FLT.<br/>COND.</u> |
|-------------------|----------------|-----------------|-----------------------------|---------------|-----------------------|--------------|-------------------------|-----------------------|
| S-880926155       | HALA           | DC9             | JT8D                        | C             | N                     | 3            | N                       | 3                     |
| S-881003139       | PAIA           | B727            | JT8D                        | F             | N                     | 3            | N                       | 3                     |
| S-881005019       | SW05           | B727            | JT8D                        | F             | N                     | 3            | N                       | 1                     |
| S-881021013       | PAIA           | B727            | JT8D                        | T             | N                     | 7            | N                       | 3                     |
| S-881028102       | SWAA           | B737            | JT8D                        | T             | N                     | 2            | N                       | 1                     |
| S-881028101       | SWAA           | B737            | JT8D                        | T             | N                     | 2            | N                       | 1                     |
| S-881028104       | SWAA           | B737            | JT8D                        | T             | N                     | 2            | N                       | 1                     |
| S-881028105       | SWAA           | B737            | JT8D                        | T             | N                     | 2            | N                       | 1                     |
| S-881028103       | SWAA           | B737            | JT8D                        | T             | N                     | 2            | N                       | 1                     |
| S-881107138       | SWXA           | DC9             | JT8D                        | F             | N                     | 3            | N                       | 3                     |
| S-881109007       | BNFA           | B727            | JT8D                        | F             | N                     | 3            | N                       | 3                     |
| S-881007198       | NWAA           | DC9             | JT8D                        | F             | N                     | 3            | N                       | 3                     |
| S-881017222       | SWAA           | B737            | JT8D                        | T             | N                     | 2            | N                       | 1                     |
| S-881017224       | SWAA           | B737            | JT8D                        | T             | N                     | 2            | N                       | 1                     |
| S-881017220       | SWAA           | B737            | JT8D                        | T             | N                     | 2            | N                       | 1                     |
| S-881017228       | SWAA           | B737            | JT8D                        | T             | N                     | 2            | N                       | 1                     |
| S-881017226       | SWAA           | B737            | JT8D                        | T             | N                     | 2            | N                       | 1                     |
| S-881021073       | PAIA           | B737            | JT8D                        | C             | N                     | 3            | N                       | 3                     |
| S-881121005       | MIDA           | B737            | JT8D                        | F             | N                     | 3            | N                       | 3                     |
| S-881205025       | MIDA           | B737            | JT8D                        | F             | N                     | 3            | N                       | 1                     |
| S-881205021       | MIDA           | DC9             | JT8D                        | F             | N                     | 3            | N                       | 4                     |
| S-881205115       | SWAA           | B737            | JT8D                        | T             | N                     | 2            | N                       | 1                     |
| S-881209003       | AALA           | B737            | JT8D                        | F             | N                     | 3            | N                       | 3                     |
| S-881209009       | UALA           | B737            | JT8D                        | C             | N                     | 3            | N                       | 5                     |
| S-881223037       | MIDA           | B737            | JT8D                        | F             | N                     | 3            | N                       | 1                     |
| S-881230065       | HALA           | DC9             | JT8D                        | T             | N                     | 7            | N                       | 10                    |
| S-890127192       | EALA           | DC9             | JT8D                        | T             | N                     | 7            | N                       | 4                     |
| S-890130039       | MIDA           | DC9             | JT8D                        | F             | N                     | 3            | N                       | 1                     |
| S-890120165       | MRKA           | B737            | JT8D                        | C             | N                     | 3            | N                       | 10                    |
| S-890213003       | USAA           | DC9             | JT8D                        | C             | N                     | 3            | N                       | 4                     |
| S-890425070       | MWEA           | DC9             | JT8D                        | F             | N                     | 3            | N                       | 4                     |
| S-880506028       | ASPA           | STCAP           | 501D13                      | T             | B                     | 7            | C                       | 3                     |
| S-880722012       | SPAA           | STCAP           | 501D13                      | C             | B                     | 7            | C                       | 3                     |
| S-880226137       | SRAA           | L382            | 501D22                      | T             | N                     | 3            | N                       | 4                     |
| S-881017278       | MRKA           | L382            | 501D22                      | C             | N                     | 3            | N                       | 3                     |
| S-890207092       | MRKA           | L382            | 501D22                      | C             | N                     | 3            | N                       | 10                    |
| S-880112116       | WP15           | HS1257          | TFE731                      | T             | B                     | 7            | C                       | 4                     |
| S-880211030       | EA21           | LEAR35          | TFE731                      | T             | B                     | 7            | C                       | 5                     |
| S-880411043       | EA21           | LEAR36          | TFE731                      | T             | B                     | 7            | C                       | 1                     |
| S-880628013       | EA17           | BAE128          | TFE731                      | T             | B                     | 7            | C                       | 4                     |
| S-880906154       | GL23           | FALCON50        | TFE731                      | T             | B                     | 7            | C                       | 1                     |
| S-881206032       | SO17           | LEAR35          | TFE731                      | T             | B                     | 7            | C                       | 1                     |
| S-881026077       | GL03           | HS1257          | TFE731                      | T             | B                     | 7            | C                       | 4                     |
| S-881025004       | SW03           | HS1257          | TFE731                      | T             | N                     | 7            | N                       | 4                     |
| S-880927004*      | BAQA           | LEAR35A         | TFE731                      | C             | N                     | 3            | N                       | 3                     |
| S-880927004*      | BAQA           | LEAR35A         | TFE731                      | C             | N                     | 3            | N                       | 3                     |

\* 2 Engines Affected, Same Aircraft

# CHARACTERISTICS OF ROTOR FAILURES - 1988

| <u>REPORT NO.</u> | <u>SUBMIT.</u> | <u>AIRCRAFT</u> | <u>ENGINE/<br/>POSITION</u> | <u>COMPNT</u> | <u>FRAG.<br/>TYPE</u> | <u>CAUSE</u> | <u>CONTN. COND.</u> | <u>FLT. COND.</u> |
|-------------------|----------------|-----------------|-----------------------------|---------------|-----------------------|--------------|---------------------|-------------------|
| S-881206033       | SO17           | LEAR35          | TFE731                      | T             | N                     | 1            | N                   | 1                 |
| S-880112068       | NM01           | AS350D          | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880121083       | GL13           | BK117A3         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880204095       | EA27           | BK117A1         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880204090       | EA27           | BK117A1         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880310104       | GL13           | UNKNOWN         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880322159       | EA27           | BK117A3         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880328041       | EA25           | Bel1222         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880329051       | EA25           | AS350D          | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880427054       | NM07           | BK117A3         | LTS101                      | T             | N                     | 5            | N                   | 1                 |
| S-880426032       | WP15           | AS350D          | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880608039       | EA11           | Bel1222U        | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880705134       | SO17           | Bel1222         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880720026       | NM07           | BK117A3         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880728075       | NM07           | BK117A3         | LTS101                      | C             | N                     | 3            | N                   | 1                 |
| S-880728077       | NM07           | BK117A3         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880728094       | NM07           | BK117A3         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880802086       | NM07           | BK117A3         | LTS101                      | C             | N                     | 3            | N                   | 1                 |
| S-880811005       | NM07           | BK117A3         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880818047       | CZYA           | BK117A3         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880818048       | CZYA           | BK117A3         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880824096       | NE01           | AS350D          | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880824052       | WP01           | Bel1222         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880823117       | SW03           | Bel1222         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880809018       | NM07           | BK117A3         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-881004072       | SW99           | Bel1222         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-881025045       | EA25           | AS350D          | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-881109016       | EA17           | Bel1222U        | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-881110063       | CE01           | Bel1222U        | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-881026072       | GL13           | BK117A3         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-881026073       | GL13           | BK117A3         | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-881206066       | NM01           | AS350D          | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-881222040       | EA25           | AS350D          | LTS101                      | T             | N                     | 1            | N                   | 1                 |
| S-880112112       | SW99           | CL600           | ALF502/2                    | T             | B                     | 7            | NC                  | 5                 |
| S-880129051       | AALA           | BAC1462         | ALF502                      | C             | N                     | 3            | N                   | 4                 |
| S-880511006       | EA11           | CL600           | ALF502                      | C             | N                     | 2            | N                   | 4                 |
| S-881121129       | WTAA           | BAC1462         | ALF502                      | F             | N                     | 3            | N                   | 1                 |
| S-881223014       | WTAA           | BAC1462         | ALF502                      | C             | N                     | 3            | N                   | 7                 |
| S-890127005       | ASPA           | BAC1462         | ALF502                      | T             | N                     | 2            | N                   | 3                 |
| S-890123070       | WTAA           | BAC1462         | ALF502                      | C             | N                     | 3            | N                   | 10                |
| S-880225039       | REXA           | SF340A          | CT75A/1                     | T             | D                     | 7            | NC                  | 8                 |
| S-880226001       | ANAA           | SF340A          | CT75A                       | T             | B                     | 2            | C                   | 5                 |
| S-880226007       | COMA           | SF340A          | CT75A                       | T             | B                     | 7            | C                   | 5                 |
| S-880415060       | BHAA           | SF340A          | CT75A                       | T             | S                     | 3            | C                   | 5                 |

# CHARACTERISTICS OF ROTOR FAILURES - 1988

| <u>REPORT NO.</u> | <u>SUBMIT.</u> | <u>AIRCRAFT</u> | <u>ENGINE/<br/>POSITION</u> | <u>COMPNT</u> | <u>FRAG.<br/>TYPE</u> | <u>CAUSE</u> | <u>CONTN.<br/>COND.</u> | <u>FLT.<br/>COND.</u> |
|-------------------|----------------|-----------------|-----------------------------|---------------|-----------------------|--------------|-------------------------|-----------------------|
| S-880624044       | PLGA           | SF340A          | CT75A                       | T             | B                     | 7            | C                       | 3                     |
| S-880916019       | MTRA           | SF340A          | CT75A/1                     | T             | B                     | 3            | NC                      | 4                     |
| S-881202028       | MTRA           | SF340A          | CT75A                       | C             | B                     | 6            | C                       | 1                     |
| S-880115011       | NE63           | SF340A          | CT75A                       | C             | N                     | 4            | N                       | 4                     |
| S-880422005       | ANAA           | SF340A          | CT75A                       | C             | N                     | 2            | N                       | 5                     |
| S-880617106       | AMWA           | SF340A          | CT75A                       | T             | N                     | 7            | N                       | 4                     |
| S-880617097       | PLGA           | SF340A          | CT75A                       | C             | N                     | 3            | N                       | 3                     |
| S-880624047       | PLGA           | SF340A          | CT75A                       | T             | N                     | 7            | N                       | 3                     |
| S-880902028       | AMWA           | SF340A          | CT75A                       | C             | N                     | 3            | N                       | 3                     |
| S-881114037       | MTRA           | SF340A          | CT75A                       | T             | N                     | 2            | N                       | 7                     |
| S-880412065       | NM07           | Bell1206B       | 250C20                      | C             | B                     | 3            | C                       | 10                    |
| S-880823015       | WP13           | Bell1206L       | 250C20                      | C             | B                     | 7            | C                       | 1                     |
| S-880927019       | SW03           | Bell1206B       | 250C20                      | C             | B                     | 7            | C                       | 5                     |
| S-881220042       | SW05           | UNKNOWN         | 250C20                      | T             | R                     | 4            | C                       | 1                     |
| S-881206070       | SW09           | Bell1206L       | 250C28                      | T             | N                     | 7            | N                       | 8                     |
| S-880706045       | SW05           | AS355F          | 250C20                      | C             | N                     | 7            | N                       | 1                     |
| S-880706029       | SW05           | AS355F          | 250C20                      | C             | N                     | 3            | N                       | 1                     |
| S-880706027       | SW05           | AS355F          | 250C20                      | C             | N                     | 1            | N                       | 1                     |
| S-880811038       | NM07           | AS355F          | 250C20                      | C             | N                     | 3            | N                       | 1                     |
| S-880927027       | SW03           | BO105S          | 250C20                      | C             | N                     | 3            | N                       | 7                     |
| S-880928030       | NM07           | AS335F          | 250C20                      | C             | N                     | 2            | N                       | 1                     |
| S-881025047       | NM01           | Bell1206B       | 250C20                      | C             | N                     | 2            | N                       | 1                     |
| S-881123067       | SW03           | Bell1206B       | 250C20                      | T             | N                     | 1            | N                       | 1                     |
| S-881123076       | SW03           | Bell1206L       | 250C28                      | T             | N                     | 1            | N                       | 1                     |
| S-881123069       | EU70           | Bell1206B       | 250C20                      | C             | N                     | 7            | N                       | 1                     |
| S-881123077       | SW03           | Bell1206L       | 250C28                      | T             | N                     | 1            | N                       | 1                     |
| S-881123066       | SW03           | Bell1206L       | 250C28                      | T             | N                     | 1            | N                       | 1                     |
| S-881123056       | SW03           | Bell1206L       | 250C28                      | T             | N                     | 1            | N                       | 1                     |
| S-881213043       | SW03           | Bell1206L       | 250C28                      | C             | N                     | 1            | N                       | 1                     |
| S-881213038       | SW03           | Bell1206L       | 250C28                      | T             | N                     | 1            | N                       | 1                     |
| S-880317148       | ORLA           | N22B            | 250B17                      | C             | N                     | 3            | N                       | 5                     |
| S-880122067       | UALA           | DC10            | CF6                         | C             | B                     | 2            | C                       | 5                     |
| S-880527142       | FDEA           | DC10            | CF6                         | T             | B                     | 2            | C                       | 5                     |
| S-880816053       | FDEA           | DC10            | CF6                         | C             | B                     | 7            | C                       | 3                     |
| S-880902045       | UALA           | DC10            | CF6                         | C             | B                     | 6            | C                       | 4                     |
| S-880930008       | UALA           | DC10            | CF6                         | T             | B                     | 1            | C                       | 4                     |
| S-881007011       | UALA           | DC10            | CF6                         | T             | B                     | 2            | C                       | 4                     |
| S-890113127       | UALA           | DC10            | CF6                         | C             | B                     | 7            | C                       | 3                     |
| S-880314066       | EALA           | A300            | CF6                         | T             | B                     | 7            | C                       | 4                     |
| S-880801095       | EALA           | DC10            | CF6                         | C             | N                     | 3            | N                       | 4                     |
| S-880802044       | EALA           | DC10            | CF6                         | C             | N                     | 3            | N                       | 4                     |
| S-880816049       | FDEA           | DC10            | CF6                         | T             | N                     | 6            | N                       | 3                     |
| S-881125058       | PAAA           | A300            | CF6                         | F             | N                     | 3            | N                       | 1                     |
| S-881110050       | SW15           | NA265           | CF700                       | C             | B                     | 2            | C                       | 8                     |
| S-880622098       | SW15           | NA265           | CF700                       | F             | N                     | 3            | N                       | 1                     |
| S-8811100010      | SW15           | NA265           | CF700                       | C             | N                     | 3            | N                       | 3                     |
| S-880129025       | RAXA           | DC8             | JT3D                        | T             | B                     | 2            | C                       | 3                     |

# CHARACTERISTICS OF ROTOR FAILURES - 1988

| REPORT NO.  | SUBMIT. | AIRCRAFT | ENGINE/<br>POSITION | COMPNT | FRAG.<br>TYPE | CAUSE | CONTN.<br>COND. | FLT.<br>COND. |
|-------------|---------|----------|---------------------|--------|---------------|-------|-----------------|---------------|
| S-880205030 | RAXA    | DC8      | JT3D                | C      | B             | 7     | C               | 4             |
| S-880212004 | RAXA    | DC8      | JT3D                | C      | B             | 7     | C               | 8             |
| S-880226020 | RAXA    | DC8      | JT3D                | C      | B             | 7     | C               | 5             |
| S-880304006 | FWTA    | B707     | JT3D                | T      | B             | 7     | C               | 5             |
| S-880328014 | RAXA    | DC8      | JT3D                | T      | B             | 2     | C               | 3             |
| S-880415003 | RAXA    | DC8      | JT3D                | C      | B             | 7     | C               | 7             |
| S-880429048 | HALA    | DC8      | JT3D                | T      | B             | 7     | C               | 5             |
| S-880205030 | RAXA    | DC8      | JT3D                | C      | B             | 7     | C               | 3             |
| S-880816017 | RAXA    | DC8      | JT3D                | C      | B             | 7     | C               | 5             |
| S-881007088 | RAXA    | DC8      | JT3D                | C      | B             | 7     | C               | 6             |
| S-881007008 | RAXA    | DC8      | JT3D                | C      | B             | 7     | C               | 5             |
| S-881202031 | RAXA    | DC8      | JT3D                | T      | B             | 7     | C               | 4             |
| S-881223002 | ARWA    | DC8      | JT3D                | C      | B             | 7     | C               | 5             |
| S-880617001 | RAXA    | DC8      | JT3D                | C      | B             | 7     | C               | 5             |
| S-881021020 | TIEA    | DC8      | JT3D                | F      | N             | 3     | N               | 4             |
| S-880129054 | RAXA    | DC8      | JT3D                | C      | N             | 7     | N               | 10            |
| S-880212233 | SRAA    | B707     | JT3D                | T      | N             | 2     | N               | 4             |
| S-880325011 | AMTA    | L1011    | RB211               | C      | B             | 2     | C               | 5             |
| S-880404145 | TAEA    | L1011    | RB211               | T      | B             | 7     | C               | 5             |
| S-881003260 | TWAA    | L1011    | RB211               | T      | B             | 1     | C               | 1             |
| S-880212163 | TWAA    | L1011    | RB211               | F      | N             | 7     | N               | 4             |
| S-880212274 | DALA    | L1011    | RB211               | C      | N             | 3     | N               | 3             |
| S-880318052 | HALA    | L1011    | RB211               | T      | N             | 7     | N               | 2             |
| S-880401004 | TAEA    | L1011    | RB211               | C      | N             | 3     | N               | 2             |
| S-880419001 | TWAA    | L1011    | RB211               | C      | N             | 3     | N               | 7             |
| S-880729046 | EALA    | B757     | RB211               | C      | N             | 2     | N               | 5             |
| S-881223001 | TAEA    | L1011    | RB211               | C      | N             | 7     | N               | 1             |
| S-890206045 | AMTA    | L1011    | RB211               | F      | N             | 5     | N               | 3             |
| S-880429032 | PAIA    | F28MK4   | SPEY/2              | T      | D             | 7     | NC              | 5             |
| S-880816015 | PAIA    | F28MK4   | SPEY                | C      | B             | 1     | C               | 4             |
| S-880205153 | FLEA    | BAC111   | SPEY                | C      | N             | 7     | N               | 3             |
| S-881014080 | FLEA    | BAC111   | SPEY                | T      | N             | 7     | N               | 3             |
| S-880913123 | EA03    | DC125    | VIP522              | T      | B             | 7     | C               | 3             |
| S-880411022 | EU51    | HS748    | DART                | T      | B             | 7     | C               | 3             |
| S-880226033 | BRIA    | FH227C   | DART                | C      | N             | 3     | N               | 6             |
| S-880415068 | BRIA    | FH227C   | DART                | C      | N             | 7     | N               | 5             |
| S-880307060 | EA25    | WEST30   | GEM510              | C      | N             | 3     | N               | 1             |
| S-880202106 | QXEA    | SA227    | TPE331              | T      | B             | 7     | C               | 3             |
| S-880718119 | NAXA    | 3101     | TPE331              | T      | B             | 7     | C               | 1             |
| S-880721051 | DHLA    | SA227    | TPE331              | C      | B             | 7     | C               | 1             |
| S-880721052 | DHLA    | SA227    | TPE331              | C      | B             | 7     | C               | 1             |
| S-880818003 | DHLA    | SA227    | TPE331              | C      | B             | 7     | C               | 1             |
| S-880310011 | RAIX    | SA227    | TPE331              | T      | B             | 2     | C               | 6             |
| S-880721050 | MEJA    | SA227    | TPE331              | T      | N             | 7     | N               | 4             |
| S-880225046 | QXEA    | SA227    | TPE331              | C      | N             | 3     | N               | 6             |
| S-880531086 | WWMX    | SA227    | TPE331              | C      | N             | 3     | N               | 4             |
| S-880622080 | BSAA    | SA226    | TPE331              | C      | N             | 3     | N               | 5             |

# CHARACTERISTICS OF ROTOR FAILURES - 1988

| REPORT NO.      | SUBMIT. | AIRCRAFT | ENGINE/<br>POSITION | COMPNT | FRAG.<br>TYPE | CAUSE | CONTN.<br>COND. | FLT.<br>COND. |
|-----------------|---------|----------|---------------------|--------|---------------|-------|-----------------|---------------|
| S-880902092     | VNAA    | 3101     | TPE331              | C      | N             | 3     | N               | 7             |
| S-880909086     | VNAA    | 3101     | TPE331              | C      | N             | 3     | N               | 8             |
| S-880916078     | VNAA    | 3101     | TPE331              | C      | N             | 3     | N               | 7             |
| S-881007031     | NAXA    | 3101     | TPE331              | C      | N             | 3     | N               | 10            |
| S-881031305     | VNAA    | 3101     | TPE331              | C      | N             | 3     | N               | 1             |
| S-881114249     | VNAA    | 3101     | TPE331              | C      | N             | 3     | N               | 3             |
| S-881114250     | VNAA    | 3101     | TPE331              | C      | N             | 3     | N               | 1             |
| S-881017112     | VNAA    | 3101     | TPE331              | C      | N             | 3     | N               | 1             |
| S-881017053     | VNAA    | 3101     | TPE331              | C      | N             | 3     | N               | 7             |
| S-881020018     | MALA    | SA227    | TPE331              | C      | N             | 3     | N               | 7             |
| S-881020015     | MALA    | SA227    | TPE331              | C      | N             | 3     | N               | 8             |
| S-881031305     | VNAA    | 3101     | TPE331              | C      | N             | 3     | N               | 1             |
| S-890106046     | FBAA    | 2282     | TPE331              | C      | N             | 3     | N               | 7             |
| S-890113241     | CPLA    | 3101     | TPE331              | C      | N             | 3     | N               | 3             |
| S-890118038     | NAXA    | 3101     | TPE331              | T      | N             | 5     | N               | 10            |
| S-890123052     | VNAA    | 3101     | TPE331              | C      | N             | 3     | N               | 3             |
| S-880129039     | DALA    | B757     | PW2037              | T      | S             | 2     | C               | 4             |
| S-880205020     | NWAA    | B757     | PW2037              | C      | B             | 1     | C               | 4             |
| S-880205001     | NWAA    | B757     | PW2037              | C      | B             | 2     | C               | 6             |
| S-880304014     | DALA    | B757     | PW2037              | C      | B             | 2     | C               | 4             |
| S-880624017     | NWAA    | B757     | PW2037              | T      | B             | 2     | C               | 4             |
| S-880722010     | DALA    | B757     | PW2037/1            | T      | B             | 2     | NC              | 6             |
| S-880822110     | NWAA    | B757     | PW2037              | C      | B             | 2     | C               | 7             |
| S-881028001     | DALA    | B757     | PW2037              | C      | B             | 2     | C               | 3             |
| S-881202046     | NWAA    | B757     | PW2037              | C      | N             | 2     | N               | 4             |
| S-881209020     | IPXA    | B757     | PW2040              | F      | N             | 3     | N               | 3             |
| S-890103146     | IPXA    | B757     | PW2040              | F      | N             | 3     | N               | 3             |
| S-880823023     | GL07    | 550      | JT15D               | T      | B             | 7     | C               | 1             |
| S-880426047     | GL07    | 550      | JT15D               | T      | B             | 7     | C               | 10            |
| S-880818058     | S001    | 550      | JT15D               | F      | N             | 2     | N               | 1             |
| S-880818059     | GL25    | 550      | JT15D               | F      | N             | 2     | N               | 1             |
| S-880315042     | EA21    | 500      | JT15D               | T      | N             | 7     | N               | 5             |
| S-881110023     | GL25    | 550      | JT15D               | F      | N             | 2     | N               | 1             |
| S-881011043     | SW99    | 552      | JT15D               | T      | N             | 2     | N               | 1             |
| S-881207014     | GL07    | 550      | JT15D               | T      | N             | 2     | N               | 1             |
| S-881116021     | SW99    | 550      | JT15D               | T      | N             | 2     | N               | 1             |
| S-880725088     | EMXA    | DC8      | PW120               | C      | S             | 7     | C               | 1             |
| S-880520020     | HNAA    | DHC8     | PW120               | C      | N             | 2     | N               | 5             |
| A-880405022179C | NE01    | B737     | JT8D/2              | T      | D             | 6     | NC              | 3             |
| A-880627027329G | SO01    | IAI1124  | TFE731              | T      | B             | 6     | NC              | 4             |
| A-880504019679C | CE03    | DC9      | JT8D/2              | T      | D             | 7     | NC              | 4             |
| A-881024060959C | NE01    | BEECH200 | PT6/2               | T      | B             | 7     | NC              | 5             |

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CT-91/28

Statistics on aircraft gas turbine engine rotor failures that occurred in U.S. commercial aviation during 1988.



