STATISTICS ON AIRCRAFT GAS TURBINE ENGINE ROTOR FAILURES THAT OCCURRED IN (U) NAVAL AIR PROPULSION CENTER TRENTON NJ PROPULSION ENGINEERING

UNCLASSIFIED R A DELUCIA ET AL MAR 87 NAPC-PE-154C F/G 21/5 NL
Statistics on Aircraft Gas Turbine Engine Rotor Failures that Occurred in U.S. Commercial Aviation During 1981

R.A. DeLucia
J.T. Salvina
T. Russo

Naval Air Propulsion Center
Trenton, New Jersey

March 1987
Final Report

This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

DISTRIBUTION STATEMENT A
Approved for public release; Distribution Unlimited

U.S. Department of Transportation
Federal Aviation Administration
NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

The United States Government does not endorse products or manufacturers. Trade or manufacturer's names appear herein solely because they are considered essential to the object of this report.
### Title and Subtitle
STATISTICS ON AIRCRAFT GAS TURBINE ENGINE ROTOR FAILURES THAT OCCURRED IN U.S. COMMERCIAL AVIATION during 1981.

### Author(s)
- R. A. DELUCIA
- J. T. SALVINO
- T. RUSSO

### Performing Organization Name and Address
Commanding Officer
Naval Air Propulsion Center
PO Box 7176
Trenton, NJ 08628-0176

### Sponsoring Agency Name and Address
Department of Transportation
Federal Aviation Administration
Technical Center
Atlantic City International Airport, NJ 08405

### Abstract
This report presents statistical information relating to gas turbine engine rotor failures which occurred during 1981 in commercial aviation service use. The predominant failure involved blade fragments, 83 percent of which were contained. Three disk failures occurred and all were uncontained. Fifty-seven percent of the 136 failures occurred during the takeoff and climb stages of flight.

This service data analysis is prepared on a calendar year basis and published yearly. The data is useful in support of flight safety analysis, proposed regulatory actions, certification standards and cost benefit analysis.

### Key Words
- Air Transportation
- Aircraft Hazards
- Aircraft Safety
- Gas Turbine Engine Rotor Failures
- Containment

### Distribution Statement
This Document is available to the U.S. Public through the National Technical Information Service, Springfield, Virginia 22161

### Security Classification (of this report)
NAC-P-154C

### Security Classification (of this page)
NAC-P-154C

### Number of Pages
23

### Price
$0.72
ACKNOWLEDGEMENTS

We thank the following Federal Aviation Administration personnel and offices for their cooperative effort in the preparation of this report:

- Mr. Bruce Fenton, Project Manager, Engine/Fuel Safety Branch, ACT-320, for his technical assistance.

- New England Region, Burlington, MA for providing verification of the uncontained engine rotor failure occurrences during calendar year 1981.

- Flight Standards National Field Office, Oklahoma City, OK, for providing the basic data used to prepare this report.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>vii</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>RESULTS</td>
<td>1</td>
</tr>
<tr>
<td>CONCLUSIONS</td>
<td>3</td>
</tr>
<tr>
<td>FIGURES 1 THROUGH 11</td>
<td>4</td>
</tr>
<tr>
<td>APPENDICES</td>
<td></td>
</tr>
<tr>
<td>A - DATA OF ENGINE ROTOR FAILURES IN U.S.</td>
<td>A-1</td>
</tr>
<tr>
<td>COMMERCIAL AVIATION FOR 1981</td>
<td></td>
</tr>
<tr>
<td>B - GAS TURBINE ENGINE FAILURE RATES ACCORDING TO ENGINE MODEL AND TYPE</td>
<td>B-1</td>
</tr>
<tr>
<td>C- DISTRIBUTION LIST</td>
<td>C-1</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Incidence of Engine Rotor Failure in U.S. Commercial Aviation - 1981</td>
</tr>
<tr>
<td>2</td>
<td>Gas Turbine Engine Fleet Operating Hours in U.S. Commercial Aviation</td>
</tr>
<tr>
<td></td>
<td>According to Number of Engines in Service - 1981</td>
</tr>
<tr>
<td>3</td>
<td>Component and Fragment Type Distributions for Contained and</td>
</tr>
<tr>
<td></td>
<td>Uncontained Rotor Engine Failures (Failures that Produced Fragments) - 1981</td>
</tr>
<tr>
<td>4</td>
<td>The Incidence of Engine Rotor Failure in U.S. Commercial</td>
</tr>
<tr>
<td></td>
<td>Aviation According to Engine Type Affected - 1981</td>
</tr>
<tr>
<td>5</td>
<td>Turbofan Engine Failure Rate According to Engine Model - 1981</td>
</tr>
<tr>
<td>6</td>
<td>Turboprop Engine Failure rate According to Engine Model - 1981</td>
</tr>
<tr>
<td>7</td>
<td>Turboshaft and Turboprop Engine Failure Rate According to Engine Model - 1981</td>
</tr>
<tr>
<td>8</td>
<td>Engine Rotor Failure Cause Categories - 1981</td>
</tr>
<tr>
<td>9</td>
<td>Flight Condition at Engine Rotor Failure - 1981</td>
</tr>
<tr>
<td>10</td>
<td>Uncontained Engine Rotor Failure Distributions According to</td>
</tr>
<tr>
<td>11</td>
<td>The Incidence of Uncontained Engine Rotor Failures in U.S.</td>
</tr>
<tr>
<td></td>
<td>Commercial Aviation - 1962 through 1981</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

This service data analysis is prepared on a calendar basis and published yearly. The data are useful in support of 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 U.S. commercial aviation during 1981.

One hundred and thirty-six rotor failures occurred in 1981. These failures accounted for approximately 2.7 percent of the 5095 shutdowns experienced by the U.S. commercial fleet. Rotor fragments were generated in 84 of the failures and, of these 16 were uncontained. This represents an uncontained failure rate of 2.1 per million gas turbine engine powered aircraft flight hours, or 0.8 per million engine operating hours. Approximately 7.5 million and 20.7 million aircraft flight and engine operating hours, respectively, were logged in 1981.

Turbine rotor fragment producing failures were approximately four times greater than that of the compressor rotor fragment producing failures; 62 and 15 respectively, of the total. Fan rotor failures accounted for 7 of the fragment producing failures experienced.

Blade failures were generated in 78 of the rotor failures; 13 of these were uncontained. The remaining 6 fragment generating failures were produced by disk, rim, or seal.

Total uncontained engine failure rates per million engine type flight hours were: turbofan 0.7 and turboprop 1.5. No uncontained rotor failures were reported for turboshaft and turbojet engines in 1981.

Of the 92 known causes of failures (because of the high percentage of unknown causes of rotor failures, the percentages were based on the total number of known causes), the causal factors were: (1) Secondary Causes 38 (41.3 percent); (2) Foreign Object Damage 35 (38.0 percent); (3) Design and Life Prediction Problems 16 (17.4 percent); and (4) Other 3 (3.3 percent). Seventy-eight (57.4 percent) of the 136 rotor failures occurred during the takeoff and climb stages of flight. Fifty-two (61.9 percent) of the 84 rotor fragment producing failures and 9 (56.3 percent) of the 16 uncontained rotor failures occurred during these same stages of flight.

CONCLUSION:

Although the incidence of engine rotor failures producing fragments has declined 20 percent (84 in 1981 compared to a 1975 through 1980 average of 105), the uncontained engine rotor failure rate has remained constant (16 in 1981 compared to a 1975 through 1980 average of 16).
INTRODUCTION

This report is sponsored by the Department of Transportation (DOT), Federal Aviation Administration (FAA), Technical Center, Engine/Fuel Safety Branch, located at the Atlantic City International Airport, New Jersey.

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.

The intent and purpose of this report is to present data as objectively as possible on rotor failure occurrences in U. S. commercial aviation.

Presented in this report are statistics on gas turbine engine failures that have occurred in U. S. commercial aviation during 1981. These statistics are based on data compiled from the Flight Standards Service Difficulty Reports that were published by the DOT, FAA. Independent cross checks to other accident data sources, such as the FAA New England Region Directorate, were made to substantiate the exact nature of an engine failure incident (i.e., contained or uncontained). The compiled data were analyzed to establish:

1. The incidence of rotor failures and the incidence of contained and uncontained rotor fragments; (An uncontained rotor failure is defined as a rotor failure that produces fragments which penetrate and escape the confines of the engine casing).
2. The distribution of rotor failures with respect to engine rotor components, i.e., fan, compressor or turbine rotors and their rotating attachments or appendages such as spacers and seals.
3. The type of rotor fragment (disk, rim or blade) typically generated at failure.
4. The cause of failure.
5. The engines involved by model (JT8D, JT9D, etc.) and by engine type (turboshaft/turboprop, and turbofan).
6. The flight conditions at the time of failure.
7. Engine failure rate according to engine fleet hours.

RESULTS

1. The data used for analysis are contained in appendix A. The results of these analyses are shown in Figures 1 through 8.

   a. Figure 1 shows that 136 rotor failures occurred in 1981. These rotor failures accounted for approximately 2.7 percent of the 5095 shutdowns experienced by the gas turbine powered U. S. commercial aircraft fleet during 1981. Rotor fragments were generated in 84 of the failures experienced and, of these, 16 (19.0 percent of the fragment producing failures) were uncontained. This represents an uncontained failure rate of 2.1 per million gas turbine engine powered aircraft flight hours, or 0.8 per million engine operating hours. Approximately 7.5 million and 20.7 million aircraft flight and engine operating hours, respectively, were logged by the U. S. commercial aviation fleet in 1981. Gas turbine engine fleet
operating hours according to the number and type of engines in use is shown in Figure 2.

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

(1) The incidence of turbine rotor fragment producing failures was approximately four times greater than that of the compressor rotor fragment producing failures; these corresponded to 62 (73.8 percent) and 15 (17.9 percent), respectively, of the total number of rotor failures. Fan rotor failures accounted for 7 (8.3 percent) of the fragment producing failures experienced.

(2) Blade fragments were generated in 78 (92.9 percent) of the rotor failures; 13 (16.7 percent) of these were uncontained. The remaining 6 (7.1 percent) rotor fragment failures were produced by disk, rim, or seal.

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

d. Figures 5, 6, and 7 illustrate engine failure rates per million engine flight hours according to engine model, engine type, and containment condition. The total engine failure rate per million engine type flight hours are: turbofan 3.7, turboprop 11.8, turboshaft 34.2, and turbojet 27.0. Total uncontained engine failure rates per million engine type flight hours were: turbofan 0.7 and turboprop 1.5. No uncontained rotor failures were reported for turboshaft and turbojet engines in 1981.

The data used to generate figures 5, 6, and 7 is contained in appendix B, page B-1.

e. Figure 8 shows what caused the rotor failures to occur. Of the 92 known causes of failure (because of the high percentage of unknown causes of rotor failure, the percentages were based on the total number of known causes), the causal factors were: (1) Secondary Causes 38 (41.3 percent); (2) Foreign Object Damage 35 (38.0 percent); (3) Design and Life Prediction Problems 16 (17.4 percent); and Other 3 (3.3 percent).

f. Figure 9 indicates the flight conditions that existed when the various rotor failures occurred. Seventy-eight (57.4 percent) of the 136 rotor failures occurred during the takeoff and climb stages of flight. Fifty-two (61.9 percent) of the rotor fragment producing failures and 9 (56.3 percent) of the uncontained rotor failures occurred during these same stages of flight. The highest number of uncontained rotor failures, 7 (43.8 percent) was experienced during climb.

g. Figure 10 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 1981. 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 8 times greater at "high" power than "low" power (namely 23 and 3). For "Design and Life Prediction Problems" the number of
"high" power uncontained failures was approximately three times greater than "low" power (namely 19 and 6); and for "Foreign Object Damage" the number of uncontained failures was six times greater at "high" power than "low" power (namely 6 and 1). This tabulation also indicates that of the 95 total uncontained incidences, blade failures accounted for 75.8 percent, disks failures 10.5 percent, rim failures 7.4 percent, and seal/spacer failures 6.3 percent.

h. Figure 11 shows the annual incidence of uncontained rotor failures in commercial aviation for the years 1962 through 1981. During 1981, the incidence of uncontained rotor failure increased by five over the previous year, 1980. Over the past six years, 1976 through 1981, an average of 16 uncontained rotor failures per year have occurred. During the same time period, the rate of uncontained rotor failures has remained relatively constant at an average of approximately one per million engine operating hours.

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

Structural life prediction and verification is being improved by the increased use of spin chamber testing by government and industry as a means of obtaining failure data for statistically significant samples. In addition, increased development and application of high sensitivity non-destructive inspection methods, should increase the probability of cracks being detected prior to failure. The capability to reduce the causes of failures from secondary effects, also is 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.

CONCLUSION

Although the incidence of engine rotor failures producing fragments has declined 20 percent (84 in 1981 compared to a 1975 through 1980 average of 105), the uncontained engine rotor failures has remained constant (16 in 1981 compared to a 1975 through 1980 average of 16).
NUMBER OF ROTOR FAILURES

FIGURE 1: INCIDENCE OF ENGINE ROTOR FAILURE IN U. S. COMMERCIAL AVIATION 1981
Figure 2: Gas turbine engine fleet operating hours in U.S. commercial aviation according to number of engines in service - 1981

Note: (1) Derived from yearly average of aircraft in use at end of each month
<table>
<thead>
<tr>
<th>ENGINE ROTOR COMPONENT</th>
<th>DISK</th>
<th>RIM</th>
<th>BLADE</th>
<th>SEAL</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TF</td>
<td>UCF</td>
<td>TF</td>
<td>UCF</td>
<td>TF</td>
</tr>
<tr>
<td>FAN</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>COMPRESSOR</td>
<td>1</td>
<td>1</td>
<td>12</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>TURBINE</td>
<td>2</td>
<td>2</td>
<td>59</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>78</td>
</tr>
</tbody>
</table>

(1) FAILURES THAT PRODUCED FRAGMENTS

TF - TOTAL FAILURES
UCF - UNCONTAINED FAILURES

FIGURE 3: COMPONENT AND FRAGMENT TYPE DISTRIBUTIONS FOR CONTAINED AND UNCONTAINED ROTOR ENGINE FAILURES
(FAILURES THAT PRODUCED FRAGMENTS) - 1981
FIGURE 4: THE INCIDENCE OF ENGINE ROTOR FAILURE IN U.S. COMMERCIAL AVIATION ACCORDING TO ENGINE TYPE AFFECTED - 1981

NOTES:
1. FAILURES THAT PRODUCED FRAGMENTS
2. YEARLY AVERAGE OF ENGINES IN USE AT END OF EACH MONTH
3. SEAL/SPACER FAILURES INCLUDED IN DISK/RIM COMPILATION
### Figure 5: Turbofan Engine Failure Rate According to Engine Model - 1981

<table>
<thead>
<tr>
<th>Engine Model</th>
<th>JT8D</th>
<th>JT9D</th>
<th>JT9D</th>
<th>CF6</th>
<th>RB211</th>
<th>Spey</th>
<th>CF7</th>
<th>JT150</th>
<th>TFE731</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Flight Hours x 10^6</td>
<td>11.5</td>
<td>1.64</td>
<td>2.13</td>
<td>1.34</td>
<td>0.944</td>
<td>0.148</td>
<td>0.063</td>
<td>0.006</td>
<td>0.001</td>
<td>17.77</td>
</tr>
</tbody>
</table>

**Key:**
- **Total**
- **Not contained**
- **Contained**
- **No fragments generated**

**Notes:**
- The chart illustrates the engine failure rates per million engine flight hours for various engine models in 1981.
Figure 6: Turboprop engine failure rate according to engine model - 1981
Figure 7: Turboshaft and Turbojet Engine Failure Rate According to Engine Model - 1981
FIGURE 8: ENGINE ROTOR FAILURE CAUSE CATEGORIES - 1981
FIGURE 9: FLIGHT CONDITION AT ENGINE ROTOR FAILURE - 1981
<table>
<thead>
<tr>
<th>FLIGHT CONDITION</th>
<th>HI</th>
<th>LOW</th>
<th>UNK</th>
<th>HI</th>
<th>LOW</th>
<th>UNK</th>
<th>HI</th>
<th>LOW</th>
<th>UNK</th>
<th>HI</th>
<th>LOW</th>
<th>UNK</th>
<th>HI</th>
<th>LOW</th>
<th>UNK</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DISK</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>10</strong></td>
</tr>
<tr>
<td>FAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COM</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>10</strong></td>
</tr>
<tr>
<td>TUR</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>13</strong></td>
</tr>
<tr>
<td><strong>RIM</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>7</strong></td>
</tr>
<tr>
<td>FAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COM</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>7</strong></td>
</tr>
<tr>
<td>TUR</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>1</strong></td>
</tr>
<tr>
<td><strong>BLADE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>72</strong></td>
</tr>
<tr>
<td>FAN</td>
<td>6</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>19</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COM</td>
<td>5</td>
<td></td>
<td>3</td>
<td>5</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TUR</td>
<td>1</td>
<td>2</td>
<td>15</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SEAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>6</strong></td>
</tr>
<tr>
<td>FAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COM</td>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>6</strong></td>
</tr>
<tr>
<td>TUR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SUBTOTAL</strong></td>
<td>19</td>
<td>6</td>
<td>0</td>
<td>23</td>
<td>3</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td><strong>95</strong></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>25</td>
<td>27</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>21</td>
<td>7</td>
<td>2</td>
<td>73</td>
<td>17</td>
<td><strong>95</strong></td>
</tr>
</tbody>
</table>

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

**FIGURE 10: UNCONTAINED ENGINE ROTOR FAILURE DISTRIBUTIONS**
APPENDIX A

Data of Engine Rotor Failures in U. S. Commercial Aviation for 1981. Compiled from the Federal Aviation Administration Service Difficulty Reports.

DATA COMPILATION KEY

Component Code:
- F - Fan
- C - Compressor
- T - Turbine

Fragment Type Code:
- D - Disk
- R - Rim
- B - Blade
- S - Seal
- N - None

Cause Code:
1 - Design and Life Prediction Problems
2 - Secondary Causes
3 - Foreign Object Damage
4 - Quality Control
5 - Operational
6 - Assembly and Inspection Error
7 - Unknown

Containment Condition Code:
- C - Contained
- NC - Not Contained
- N - No Fragments Generated

Flight Condition Code:
1 - Insp/Maint
2 - Taxi/Grnd Hdl
3 - Takeoff
4 - Climb
5 - Cruise
6 - Descent
7 - Approach
8 - Landing
9 - Hovering
10 - Unknown
## CHARACTERISTICS OF ROTOR FAILURES - 1981

<table>
<thead>
<tr>
<th>SUB NO.</th>
<th>SUBMITTER</th>
<th>AIRCRAFT</th>
<th>ENGINE</th>
<th>COMPONENT</th>
<th>FRAGMENT</th>
<th>TYPE</th>
<th>CAUSE</th>
<th>CONDITION</th>
<th>CONTAINMENT</th>
<th>FLIGHT CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>03181036</td>
<td>EAL</td>
<td>B727</td>
<td>JT8D</td>
<td>F</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>06261020</td>
<td>ACL</td>
<td>B737</td>
<td>JT8D</td>
<td>F</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07161032</td>
<td>PAA</td>
<td>B727</td>
<td>JT8D</td>
<td>F</td>
<td>N</td>
<td>2</td>
<td>N</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01291032</td>
<td>AFL</td>
<td>B737</td>
<td>JT8D</td>
<td>F</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09111032</td>
<td>OZA</td>
<td>DC9</td>
<td>JT8D</td>
<td>F</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09171031</td>
<td>OZA</td>
<td>DC9</td>
<td>JT8D</td>
<td>F</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02111037</td>
<td>EAL</td>
<td>B727</td>
<td>JT8D</td>
<td>C</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03121037</td>
<td>ACL</td>
<td>B737</td>
<td>JT8D</td>
<td>C</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>05281025</td>
<td>USA</td>
<td>B727</td>
<td>JT8D</td>
<td>C</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09211030</td>
<td>NWA</td>
<td>B727</td>
<td>JT8D</td>
<td>C</td>
<td>N</td>
<td>2</td>
<td>N</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09151024</td>
<td>AFL</td>
<td>B737</td>
<td>JT8D</td>
<td>C</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01261033</td>
<td>AAL</td>
<td>B737</td>
<td>JT8D</td>
<td>C</td>
<td>S</td>
<td>2</td>
<td>C</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12071025</td>
<td>ACL</td>
<td>B737</td>
<td>JT8D</td>
<td>C</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04241025</td>
<td>ACL</td>
<td>B737</td>
<td>JT8D</td>
<td>C</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02131036</td>
<td>CAL</td>
<td>B727</td>
<td>JT8D</td>
<td>T</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>08141033</td>
<td>AFL</td>
<td>B737</td>
<td>JT8D</td>
<td>T</td>
<td>N</td>
<td>7</td>
<td>N</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>08221028</td>
<td>PSA</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>N</td>
<td>7</td>
<td>N</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>08271024</td>
<td>PSA</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>N</td>
<td>7</td>
<td>N</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09041023</td>
<td>PSA</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>N</td>
<td>7</td>
<td>N</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09041024</td>
<td>PSA</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>N</td>
<td>7</td>
<td>N</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09041025</td>
<td>PSA</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>N</td>
<td>7</td>
<td>N</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03031036</td>
<td>ACL</td>
<td>B737</td>
<td>JT8D</td>
<td>T</td>
<td>N</td>
<td>7</td>
<td>N</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11101024</td>
<td>FDE</td>
<td>B727</td>
<td>JT8D</td>
<td>T</td>
<td>N</td>
<td>2</td>
<td>N</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09251030</td>
<td>AFL</td>
<td>DC9</td>
<td>JT8D</td>
<td>F</td>
<td>B</td>
<td>3</td>
<td>C</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10091030</td>
<td>EAL</td>
<td>DC9</td>
<td>JT8D</td>
<td>C</td>
<td>D</td>
<td>1</td>
<td>NC</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12181024</td>
<td>HAL</td>
<td>DC9</td>
<td>JT8D</td>
<td>C</td>
<td>B</td>
<td>1</td>
<td>C</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02121019</td>
<td>AAL</td>
<td>B727</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02181013</td>
<td>TXI</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>1</td>
<td>C</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03231040</td>
<td>OZA</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>05231026</td>
<td>FAL</td>
<td>B737</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>1</td>
<td>C</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>06231034</td>
<td>REP</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>06241031</td>
<td>NWA</td>
<td>B727</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>06241032</td>
<td>BNF</td>
<td>B727</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07071030</td>
<td>FAL</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07231032</td>
<td>ACL</td>
<td>B737</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>NC</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07301009</td>
<td>PSA</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>08211029</td>
<td>REP</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0941033</td>
<td>PSA</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0191031</td>
<td>BNF</td>
<td>B727</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10261030</td>
<td>REP</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10281025</td>
<td>ACL</td>
<td>B737</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>1</td>
<td>C</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11031016</td>
<td>MID</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11121025</td>
<td>FDE</td>
<td>B727</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>NC</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11111020</td>
<td>DAL</td>
<td>B727</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12531026</td>
<td>MID</td>
<td>DC9</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12091024</td>
<td>NWA</td>
<td>B727</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CHARACTERISTICS OF ROTOR FAILURES - 1981

<table>
<thead>
<tr>
<th>SR NO.</th>
<th>SUBMITTER</th>
<th>AIRCRAFT</th>
<th>ENGINE</th>
<th>COMPONENT</th>
<th>TYPE</th>
<th>CAUSE</th>
<th>CONDITION</th>
<th>CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>01191024</td>
<td>NWA</td>
<td>B727</td>
<td>JT8D</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td>3</td>
</tr>
<tr>
<td>01261032</td>
<td>CAL</td>
<td>DC10</td>
<td>CF6</td>
<td>F</td>
<td>N</td>
<td>2</td>
<td>N</td>
<td>2</td>
</tr>
<tr>
<td>03101038</td>
<td>PAA</td>
<td>DC10</td>
<td>CF6</td>
<td>F</td>
<td>N</td>
<td>2</td>
<td>N</td>
<td>1</td>
</tr>
<tr>
<td>03031035</td>
<td>CAL</td>
<td>DC10</td>
<td>CF6</td>
<td>F</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>5</td>
</tr>
<tr>
<td>09161029</td>
<td>UAL</td>
<td>DC10</td>
<td>CF6</td>
<td>F</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>3</td>
</tr>
<tr>
<td>01191023</td>
<td>AFL</td>
<td>DC10</td>
<td>CF6</td>
<td>C</td>
<td>N</td>
<td>7</td>
<td>N</td>
<td>2</td>
</tr>
<tr>
<td>07211030</td>
<td>WRL</td>
<td>DC10</td>
<td>CF6</td>
<td>F</td>
<td>B</td>
<td>3</td>
<td>NC</td>
<td>4</td>
</tr>
<tr>
<td>06231033</td>
<td>UAL</td>
<td>DC10</td>
<td>CF6</td>
<td>C</td>
<td>B</td>
<td>1</td>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td>07071029</td>
<td>PAA</td>
<td>DC10</td>
<td>CF6</td>
<td>C</td>
<td>B</td>
<td>3</td>
<td>C</td>
<td>6</td>
</tr>
<tr>
<td>05061026</td>
<td>PAA</td>
<td>DC10</td>
<td>CF6</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>04231029</td>
<td>UAL</td>
<td>DC10</td>
<td>CF6</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td>3</td>
</tr>
<tr>
<td>04161034</td>
<td>WAL</td>
<td>DC10</td>
<td>CF6</td>
<td>T</td>
<td>B</td>
<td>1</td>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td>07211029</td>
<td>UAL</td>
<td>DC10</td>
<td>CF6</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>07271030</td>
<td>CAL</td>
<td>DC10</td>
<td>CF6</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>10021027</td>
<td>PAA</td>
<td>DC10</td>
<td>CF6</td>
<td>T</td>
<td>R</td>
<td>7</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>10081033</td>
<td>PAA</td>
<td>DC10</td>
<td>CF6</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td>10091029</td>
<td>AFL</td>
<td>DC10</td>
<td>CF6</td>
<td>T</td>
<td>D</td>
<td>3</td>
<td>NC</td>
<td>3</td>
</tr>
<tr>
<td>05131029</td>
<td>TWA</td>
<td>DC8</td>
<td>JT3D</td>
<td>F</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>4</td>
</tr>
<tr>
<td>04171033</td>
<td>UAC</td>
<td>DC8</td>
<td>JT3D</td>
<td>C</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>3</td>
</tr>
<tr>
<td>10021028</td>
<td>CAP</td>
<td>DC8</td>
<td>JT3D</td>
<td>C</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>5</td>
</tr>
<tr>
<td>06241028</td>
<td>STD</td>
<td>DC8</td>
<td>JT3D</td>
<td>T</td>
<td>B</td>
<td>5</td>
<td>C</td>
<td>3</td>
</tr>
<tr>
<td>02231039</td>
<td>ILA</td>
<td>DC8</td>
<td>JT3A</td>
<td>T</td>
<td>N</td>
<td>7</td>
<td>N</td>
<td>5</td>
</tr>
<tr>
<td>03231039</td>
<td>ABX</td>
<td>SN601</td>
<td>JT15D</td>
<td>C</td>
<td>B</td>
<td>3</td>
<td>C</td>
<td>6</td>
</tr>
<tr>
<td>06181019</td>
<td>TWA</td>
<td>B747</td>
<td>JT9D</td>
<td>F</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>3</td>
</tr>
<tr>
<td>07161033</td>
<td>UAL</td>
<td>B747</td>
<td>JT9D</td>
<td>F</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>7</td>
</tr>
<tr>
<td>07421032</td>
<td>PAA</td>
<td>B747</td>
<td>JT9D</td>
<td>F</td>
<td>N</td>
<td>2</td>
<td>N</td>
<td>5</td>
</tr>
<tr>
<td>10131033</td>
<td>NWA</td>
<td>DC10</td>
<td>JT9D</td>
<td>C</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>5</td>
</tr>
<tr>
<td>10091031</td>
<td>FTL</td>
<td>B747</td>
<td>JT9D</td>
<td>F</td>
<td>B</td>
<td>1</td>
<td>NC</td>
<td>4</td>
</tr>
<tr>
<td>08171031</td>
<td>WRL</td>
<td>B747</td>
<td>JT9D</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>07171022</td>
<td>PAA</td>
<td>B747</td>
<td>JT9D</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>NC</td>
<td>2</td>
</tr>
<tr>
<td>01211012</td>
<td>NWA</td>
<td>B747</td>
<td>JT9D</td>
<td>T</td>
<td>B</td>
<td>1</td>
<td>C</td>
<td>3</td>
</tr>
</tbody>
</table>

THE FOLLOWING INCIDENCES DID NOT OCCUR IN THE UNITED STATES BUT INVOLVED U.S. REGISTERED AIRCRAFT SUBMITTED BY FAA

<table>
<thead>
<tr>
<th>DATE</th>
<th>SUBMITTER</th>
<th>AIRCRAFT</th>
<th>ENG/ENG/SN</th>
<th>COMPONENT</th>
<th>TYPE</th>
<th>CAUSE</th>
<th>CONDITION</th>
<th>FLIGHT CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/31/81</td>
<td>NWA</td>
<td>DC10</td>
<td>JT9D/686165</td>
<td>F</td>
<td>B</td>
<td>7</td>
<td>NC</td>
<td>7</td>
</tr>
<tr>
<td>10/14/81</td>
<td>FTL</td>
<td>B747</td>
<td>JT9D/689156</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>NC</td>
<td>7</td>
</tr>
<tr>
<td>11/11/81</td>
<td>UNKNOWN</td>
<td>B747</td>
<td>JT9D/685764</td>
<td>F</td>
<td>B</td>
<td>3</td>
<td>NC</td>
<td>7</td>
</tr>
<tr>
<td>11/17/81</td>
<td>NWA</td>
<td>DC10</td>
<td>JT9D/618870</td>
<td>F</td>
<td>B</td>
<td>3</td>
<td>NC</td>
<td>7</td>
</tr>
</tbody>
</table>
## CHARACTERISTICS OF ROTOR FAILURES - 1981

<table>
<thead>
<tr>
<th>SER NO.</th>
<th>SUBMITTER</th>
<th>AIRCRAFT</th>
<th>ENGINE</th>
<th>COMPONENT</th>
<th>FRAGMENT TYPE</th>
<th>CAUSE</th>
<th>CONDITION</th>
<th>CONTAINMENT</th>
<th>FLIGHT CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>10221033</td>
<td>TWA</td>
<td>L1011</td>
<td>RB211</td>
<td>C</td>
<td>N</td>
<td>6</td>
<td>N</td>
<td></td>
<td>N</td>
</tr>
<tr>
<td>08031030</td>
<td>TWA</td>
<td>L1011</td>
<td>RB211</td>
<td>T</td>
<td>N</td>
<td>2</td>
<td>N</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>06301030</td>
<td>EAI</td>
<td>L1011</td>
<td>RB211</td>
<td>F</td>
<td>B</td>
<td>3</td>
<td>C</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>04091034</td>
<td>TWA</td>
<td>L1011</td>
<td>RB211</td>
<td>C</td>
<td>B</td>
<td>1</td>
<td>C</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>05240124</td>
<td>EAL</td>
<td>L1011</td>
<td>RB211</td>
<td>C</td>
<td>B</td>
<td>1</td>
<td>C</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>10071024</td>
<td>TWA</td>
<td>L1011</td>
<td>RB211</td>
<td>C</td>
<td>B</td>
<td>1</td>
<td>C</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>11201028</td>
<td>EAL</td>
<td>L1011</td>
<td>RB211</td>
<td>C</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>02040134</td>
<td>EAL</td>
<td>L1011</td>
<td>RB211</td>
<td>C</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>08031031</td>
<td>TWA</td>
<td>L1011</td>
<td>RB211</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>08281032</td>
<td>DAL</td>
<td>L1011</td>
<td>RB211</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>N</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>09231031</td>
<td>TWA</td>
<td>L1011</td>
<td>RB211</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>08031032</td>
<td>DAL</td>
<td>L1011</td>
<td>RB211</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>08251032</td>
<td>DAL</td>
<td>CL44</td>
<td>TYNE</td>
<td>C</td>
<td>N</td>
<td>7</td>
<td>N</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>08121033</td>
<td>ZAN</td>
<td>G159</td>
<td>DART</td>
<td>C</td>
<td>N</td>
<td>1</td>
<td>N</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>03111032</td>
<td>PAL</td>
<td>YS11A</td>
<td>DART</td>
<td>T</td>
<td>N</td>
<td>2</td>
<td>N</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>02031034</td>
<td>RAM</td>
<td>STC24</td>
<td>DART</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>N</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>03171040</td>
<td>RAM</td>
<td>SWT</td>
<td>DART</td>
<td>T</td>
<td>B</td>
<td>1</td>
<td>C</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>08271026</td>
<td>SWT</td>
<td>CV600</td>
<td>DART</td>
<td>C</td>
<td>N</td>
<td>7</td>
<td>N</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>08041014</td>
<td>USA</td>
<td>BA111</td>
<td>SPEY</td>
<td>C</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>10221032</td>
<td>USA</td>
<td>BA111</td>
<td>SPEY</td>
<td>C</td>
<td>R</td>
<td>7</td>
<td>C</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>03111031</td>
<td>USA</td>
<td>BA111</td>
<td>SPEY</td>
<td>C</td>
<td>B</td>
<td>3</td>
<td>C</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>04031033</td>
<td>USA</td>
<td>BA111</td>
<td>SPEY</td>
<td>C</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>04031034</td>
<td>USA</td>
<td>BA111</td>
<td>SPEY</td>
<td>C</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>07071033</td>
<td>USA</td>
<td>BA111</td>
<td>SPEY</td>
<td>C</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>06261022</td>
<td>USA</td>
<td>BA111</td>
<td>SPEY</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>09241055</td>
<td>BRT</td>
<td>99</td>
<td>PT6A</td>
<td>C</td>
<td>B</td>
<td>3</td>
<td>C</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>07161038</td>
<td>PLG</td>
<td>99</td>
<td>PT6A</td>
<td>C</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>09251048</td>
<td>BRT</td>
<td>99</td>
<td>PT6A</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>09201052</td>
<td>BRT</td>
<td>99</td>
<td>PT6A</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>N</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>10221031</td>
<td>MMA</td>
<td>DC7</td>
<td>PT6A</td>
<td>T</td>
<td>N</td>
<td>5</td>
<td>N</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>04201037</td>
<td>MTR</td>
<td>SD330</td>
<td>PT6A</td>
<td>T</td>
<td>N</td>
<td>2</td>
<td>N</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>10051058</td>
<td>AWA</td>
<td>DHC7103</td>
<td>PT6A</td>
<td>T</td>
<td>N</td>
<td>2</td>
<td>N</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>10201034</td>
<td>COH</td>
<td>SA226</td>
<td>TPE331</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>06161047</td>
<td>SUN</td>
<td>SA226</td>
<td>TPE331</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>04091048</td>
<td>RIO</td>
<td>SA226</td>
<td>TPE331</td>
<td>T</td>
<td>D</td>
<td>1</td>
<td>N</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>11061030</td>
<td>RIO</td>
<td>SA226</td>
<td>TPE331</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>10221059</td>
<td>RIO</td>
<td>SA226</td>
<td>TPE331</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>10521060</td>
<td>RIO</td>
<td>SA226</td>
<td>TPE331</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>09211031</td>
<td>TIA</td>
<td>L382</td>
<td>501</td>
<td>C</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>06161030</td>
<td>TIA</td>
<td>L382</td>
<td>501</td>
<td>C</td>
<td>N</td>
<td>7</td>
<td>N</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>07241030</td>
<td>TIA</td>
<td>L382</td>
<td>501</td>
<td>C</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>
## CHARACTERISTICS OF ROTOR FAILURES - 1981

<table>
<thead>
<tr>
<th>SDR NO.</th>
<th>SUBMITTER</th>
<th>AIRCRAFT ENGINE</th>
<th>COMPONENT</th>
<th>TYPE</th>
<th>CAUSE</th>
<th>CONDITION</th>
<th>FLIGHT CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>05061024</td>
<td>FIA</td>
<td>L188 501</td>
<td>C</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>4</td>
</tr>
<tr>
<td>08171030</td>
<td>REP</td>
<td>STCAP60 501</td>
<td>C</td>
<td>N</td>
<td>3</td>
<td>N</td>
<td>1</td>
</tr>
<tr>
<td>04061004</td>
<td>ISA</td>
<td>CV340 501</td>
<td>T</td>
<td>N</td>
<td>2</td>
<td>N</td>
<td>4</td>
</tr>
<tr>
<td>03191013</td>
<td>AIA</td>
<td>L382 501</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td>2</td>
</tr>
<tr>
<td>03201019</td>
<td>AIA</td>
<td>L382 501</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>03271026</td>
<td>SRA</td>
<td>L382 501</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td>1</td>
</tr>
<tr>
<td>03301036</td>
<td>SRA</td>
<td>L382 501</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td>8</td>
</tr>
<tr>
<td>08211025</td>
<td>TIA</td>
<td>L382 501</td>
<td>T</td>
<td>B</td>
<td>2</td>
<td>NC</td>
<td>4</td>
</tr>
<tr>
<td>08261038</td>
<td>AIG</td>
<td>206 250C20</td>
<td>T</td>
<td>B</td>
<td>7</td>
<td>C</td>
<td>5</td>
</tr>
</tbody>
</table>
## APPENDIX B

### GAS TURBINE ENGINE FAILURE RATES ACCORDING TO ENGINE MODEL AND TYPE

<table>
<thead>
<tr>
<th>MODEL</th>
<th>NO. IN USE</th>
<th>AVG FLIGHT HOURS X10^6</th>
<th>NO. OF FAILURES</th>
<th>FAILURE RATES PER 10^6 ENGINE FLIGHT HRS.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td>NC</td>
</tr>
<tr>
<td><strong>TURBOFAN</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JT8D</td>
<td>4484</td>
<td>11.5</td>
<td>22</td>
<td>3</td>
</tr>
<tr>
<td>JT3D</td>
<td>958</td>
<td>1.64</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>JT9D</td>
<td>621</td>
<td>2.13</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>CF6</td>
<td>451</td>
<td>1.34</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>RB211</td>
<td>298</td>
<td>0.944</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>CF7</td>
<td>77</td>
<td>0.063</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SPEY</td>
<td>70</td>
<td>0.148</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>JT15D</td>
<td>11</td>
<td>0.006</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>TFE731</td>
<td>4</td>
<td>0.001</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>6974</strong></td>
<td><strong>17.772</strong></td>
<td><strong>53</strong></td>
<td><strong>12</strong></td>
</tr>
<tr>
<td><strong>TURBOPROP</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PT6A</td>
<td>682</td>
<td>1.27</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>501</td>
<td>478</td>
<td>0.685</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>TPE331</td>
<td>229</td>
<td>0.45</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>DART</td>
<td>186</td>
<td>0.216</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>BASTAN</td>
<td>28</td>
<td>0.046</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>250B</td>
<td>19</td>
<td>0.021</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TYNE</td>
<td>11</td>
<td>0.018</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1633</strong></td>
<td><strong>2.706</strong></td>
<td><strong>14</strong></td>
<td><strong>4</strong></td>
</tr>
<tr>
<td><strong>TURBOSHAFT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AST14</td>
<td>14</td>
<td>0.028</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>250C</td>
<td>4</td>
<td>0.0008</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>T58</td>
<td>1</td>
<td>0.0004</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>19</strong></td>
<td><strong>0.0292</strong></td>
<td><strong>1</strong></td>
<td><strong>0</strong></td>
</tr>
<tr>
<td><strong>TURBOJET</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JT4A</td>
<td>73</td>
<td>0.0351</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AVON</td>
<td>6</td>
<td>0.002</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>79</strong></td>
<td><strong>0.0371</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
</tr>
</tbody>
</table>

B-1
**APPENDIX C**

**DISTRIBUTION LIST**

<table>
<thead>
<tr>
<th>Civil Aviation Authority</th>
<th>DOT-FAA AEU-500 (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aviation House</td>
<td>American Embassy</td>
</tr>
<tr>
<td>129 Kingsway</td>
<td>APO New York, NY 09667</td>
</tr>
<tr>
<td>London WC2B 6NN England</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Embassy of Australia</th>
<th>University of California (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil Air Attache</td>
<td>Service Dept Institute of</td>
</tr>
<tr>
<td>1601 Mass. Ave. NW</td>
<td>Transportation Standard Lib</td>
</tr>
<tr>
<td>Washington, DC 20036</td>
<td>412 McLaughlin Hall</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scientific &amp; Tech. Info FAC (1)</th>
<th>British Embassy (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATTN: NASA Rep.</td>
<td>Civil Air Attache ATS</td>
</tr>
<tr>
<td>P.O. Box 8757 BWI Airport</td>
<td>3100 Mass Ave. NW</td>
</tr>
<tr>
<td>Baltimore, MD 21240</td>
<td>Washington, DC 20008</td>
</tr>
</tbody>
</table>

| Northwestern University (1)      | Director DuCentre Exp DE LA (1) |
|----------------------------------| Navigation Aerineene          |
| Trisnet Repository               | 941 Orly, France              |
| Transportation Center Library    |                              |
| Evanston, ILL 60201              |                              |

| ANE-40 (2)                       | ACT-61A (2)                   |
| ASO-52C4 (2)                     | AAL-400 (2)                   |
| APM-13 Nigro (2)                 | M-493.2 (5)                   |
| AEA-61 (3)                       | Bldg. 10A                    |
| ADL-32 North (1)                 | APM-1 (1)                     |
| AES-3 (1)                        | APA-300 (1)                   |
| ANM-60 (2)                       | AGL-60 (2)                    |
|                                  | ASW-53B (2)                   |
|                                  | AAC-64D (2)                   |
|                                  | ACE-66 (2)                    |
|                                  | ADL-1 (1)                     |
|                                  | ALG-300 (1)                   |
|                                  | ACT-5 (1)                     |

**C-1**
FAA, Chief, Civil Aviation Assistance Group (1)
Madrid, Spain
c/o American Embassy
APO-New York 09285-0001

Dick Tobiason (1)
ATA of America
1709 New York Avenue, NW
Washington, DC 20006

Al Astorga (1)
Federal Aviation Administration (CAAC)
American Embassy, Box 38
APO-New York 09285-0001

Burton Chesterfield, DMA-603 (1)
DOT Transportation Safety Inst.
6500 South McArthur Blvd.
Oklahoma City, OK 73125

Dick Tobiason (1)
ATA of America
1709 New York Avenue, NW
Washington, DC 20006

Al Astorga (1)
Federal Aviation Administration (CAAC)
American Embassy, Box 38
APO-New York 09285-0001

Burton Chesterfield, DMA-603 (1)
DOT Transportation Safety Inst.
6500 South McArthur Blvd.
Oklahoma City, OK 73125

Dick Tobiason (1)
ATA of America
1709 New York Avenue, NW
Washington, DC 20006

Al Astorga (1)
Federal Aviation Administration (CAAC)
American Embassy, Box 38
APO-New York 09285-0001

Burton Chesterfield, DMA-603 (1)
DOT Transportation Safety Inst.
6500 South McArthur Blvd.
Oklahoma City, OK 73125
APPENDIX C

Civil Aviation Authority (5)
Aviation House
129 Kingsway
London WC2B 6NN
ENGLAND

Embassy of Australia
Civil Air Attache
1601 Massachusetts Avenue, NW.
Washington, DC 20036

Scientific and Technical Information FAC
ATTN: NASA Representative
P.O. Box 8757 BWI Airport
Baltimore, MD 21240

Northwestern University
Trisnet Repository
Transportation Center Library
Evanston, IL 60201

DOT/Federal Aviation Administration (5)
AEU-500
American Embassy
APO New York, NY 09667

University of California
Service Department Institute of
Transportation Standard Lab
412 McLaughlin Hall
Berkeley, CA 94720

British Embassy
Civil Air Attache ATS
3100 Massachusetts Avenue, NW.
Washington, DC 20008

DOT/Federal Aviation Administration (5)
ANE-40
12 New England Executive Park
Burlington, MA 01803

DOT/Federal Aviation Administration (5)
ASO-52C4
P.O. Box 20636
Atlanta, GA 30320

DOT/Federal Aviation Administration (5)
ANM-60
17900 Pacific Highway South
C-68966
Seattle, WA 98168

DOT/Federal Aviation Administration (5)
AMS-3
800 Independence Avenue, SW.
Washington, DC 20591

DOT/Federal Aviation Administration (5)
APM-1
800 Independence Avenue, SW.
Washington, DC 20591

Department of Transportation (5)
Office of the Secretary
M-493.2, Building 10A
400 7th Street, SW.
Washington, DC 20590

DOT/Federal Aviation Administration (5)
APM-13
800 Independence Avenue, SW.
Washington, DC 20591

DOT/Federal Aviation Administration (5)
APM-1
800 Independence Avenue, SW.
Washington, DC 20591

DOT/Federal Aviation Administration (5)
APM-1
800 Independence Avenue, SW.
Washington, DC 20591
DOT/FAA National Headquarters
APA-300
800 Independence Avenue, SW.
Washington, DC 20591

DOT/FAA Great Lakes Region (2)
AGL-60
O'Hare Office Center
2300 East Devon Avenue
Des Plaines, IL 60018

DOT/FAA Southwest Region (2)
ASW-53B
P.O. Box 1689
Fort Worth, TX 76101

DOT/FAA Mike Monroney Aeronautical Center (2)
AAC-64D
P.O. Box 25082
Oklahoma City, OK 73125

DOT/FAA Central Region (2)
ACE-66
601 East 12th Street
Federal Building
Kansas City, MO 64106

DOT/FAA National Headquarters
ADL-1
800 Independence Avenue, SW.
Washington, DC 20591

DOT/FAA National Headquarters
ALG-300
800 Independence Avenue, SW.
Washington, DC 20591

DOT/FAA Technical Center
Public Affairs Staff, ACT-5
Atlantic City Int'l Airport, NJ 08405

DOT/FAA National Headquarters
ASF-1
800 Independence Avenue, SW.
Washington, DC 20591

DOT/FAA National Headquarters
ASF-100
800 Independence Avenue, SW.
Washington, DC 20591

DOT/FAA National Headquarters
ASF-200
800 Independence Avenue, SW.
Washington, DC 20591

DOT/FAA National Headquarters
ASF-300
800 Independence Avenue, SW.
Washington, DC 20591

DOT/FAA National Headquarters
AST-1
800 Independence Avenue, SW.
Washington, DC 20591

DOT/FAA National Headquarters
ADL-2A
800 Independence Avenue, SW.
Washington, DC 20591

DOT/FAA National Headquarters
AVS-1
800 Independence Avenue, SW.
Washington, DC 20591

DOT/FAA National Headquarters
AFS-1
800 Independence Avenue, SW.
Washington, DC 20591

DOT/FAA National Headquarters
ASF-200
800 Independence Avenue, SW.
Washington, DC 20591

DOT/FAA National Headquarters
AWS-1
800 Independence Avenue, SW.
Washington, DC 20591
<table>
<thead>
<tr>
<th>Region</th>
<th>Address</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOT/FAA Northwest Mountain Region</td>
<td>17900 Pacific Highway South, C-68966, Seattle, WA 98168</td>
<td>Federal Aviation Administration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Atlanta ACO, 1075 Inner Loop Road, College Park, GA 30337</td>
</tr>
<tr>
<td>DOT/FAA Southern Region</td>
<td>1075 Pacific Highway South, C-68966, Seattle, WA 98168</td>
<td>Federal Aviation Administration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boston ACO, 12 New England Executive Park, Burlington, MA 01803</td>
</tr>
<tr>
<td>DOT/FAA Southwest Region</td>
<td>1075 Pacific Highway South, C-68966, Seattle, WA 98168</td>
<td>Federal Aviation Administration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brussels ACO, c/o American Embassy, APO New York, NY 09667</td>
</tr>
<tr>
<td>DOT/FAA Southwest Region</td>
<td>1075 Pacific Highway South, C-68966, Seattle, WA 98168</td>
<td>Federal Aviation Administration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chicago ACO, Room 232, 2300 East Devon Avenue, Des Plaines, IL 60018</td>
</tr>
<tr>
<td>DOT/FAA Southwest Region</td>
<td>1075 Pacific Highway South, C-68966, Seattle, WA 98168</td>
<td>Federal Aviation Administration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Denver ACO, 10455 East 25th Avenue, Suite 307, Aurora, CO 98168</td>
</tr>
<tr>
<td>DOT/FAA Southwest Region</td>
<td>1075 Pacific Highway South, C-68966, Seattle, WA 98168</td>
<td>Mr. Frank Taylor, 3542 Church Road, Ellicott City, MD 21043</td>
</tr>
<tr>
<td>DOT/FAA Southwest Region</td>
<td>1075 Pacific Highway South, C-68966, Seattle, WA 98168</td>
<td>Federal Aviation Administration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anchorage ACO, 701 C Street, Box 14, Anchorage, AK 99513</td>
</tr>
<tr>
<td>Federal Aviation Administration</td>
<td>1075 Pacific Highway South, C-68966, Seattle, WA 98168</td>
<td>Mr. A. R. Tobiason, ATA of America, 1709 New York Avenue, NW, Washington, DC 20006</td>
</tr>
<tr>
<td>Chief, Civil Aviation Assistance Group</td>
<td></td>
<td>Federal Aviation Assistance Group</td>
</tr>
<tr>
<td>Madrid, Spain</td>
<td></td>
<td>Madrid ACO, 3542 Church Road, Ellicott City, MD 21043</td>
</tr>
<tr>
<td>c/o American Embassy</td>
<td></td>
<td>American Embassy, 1709 New York Avenue, NW, Washington, DC 20006</td>
</tr>
<tr>
<td>APO New York</td>
<td></td>
<td>Box 14, Anchorage, AK 99513</td>
</tr>
<tr>
<td>DOT Transportation Safety Institute</td>
<td></td>
<td>Mr. Al Astorga, DOT Transportation Safety Institute, 1709 New York Avenue, NW, Washington, DC 20006</td>
</tr>
<tr>
<td>Mr. Burton Chesterfield</td>
<td></td>
<td>6500 South MacArthur Boulevard, Oklahoma City, OK 73125</td>
</tr>
<tr>
<td>DOT/FAA Southwest Region</td>
<td></td>
<td>701 C Street, Box 14, Anchorage, AK 99513</td>
</tr>
<tr>
<td>Federal Aviation Administration</td>
<td></td>
<td>701 C Street, Box 14, Anchorage, AK 99513</td>
</tr>
</tbody>
</table>
Dr. Allen E. Fuhs
Department of Aeronautics
Naval Post Graduate School
Monterey, CA 93940

Major Hudson
Air Force Inspection and Safety
SEDM
Norton Air Force Base, CA 92499

Y. Funatsu
All Nippon Airways
1-6-6, Tokyo International Airport
Ohta-KU, Tokyo 144
JAPAN

Mr. J. P. Jamieson
National Gas Turbine Establishment
Pyestock, Farnborough
Hants GU14 OLS
ENGLAND

Henry A. Gill
Lockheed California Company
Building 88, B-6
P.O. Box 551
Burbank, CA 91520

Dr. C. W. Kauffman
The University of Michigan
Gas Dynamics Laboratories
Aerospace Engineering Building
Ann Arbor, MI 48109

Mr. David J. Goldsmith
Eastern Airlines
Miami International Airport
Miami, FL 33148

FAA National Headquarters
Mr. H. Branting, AWS-120
800 Independence Avenue, SW.
Washington, DC 20591

Mr. Stanley Gray
Mechanical Technology Inc.
968 Albany Shaker Road
Latham, NY 12110

Mr. Richard J. Linn
American Airlines
MD 4H14
P.O. Box 61616
Dallas/Fort Worth Airport, TX 75261

G. Haigh
Air Canada
Air Canada Base, Montreal
International Airport
Quebec, CANADA H4Y 1 C2

Captain A. S. Mattox, Jr.
Allied Pilots Association
12723 Brewater Circle
Woodbridge, VA 22191

M. Hardy
United Airlines
SFOEG, MOC
San Francisco International Airport
California 94128

Mr. Charles McGuire
Department of Transportation
400 7th Street, SW. (P-5)
Washington, DC 20590

W. Hock
Grumman Aerospace Corporation
B 14 035
111 Stewart Avenue
Bethpage, NY 11714

J. J. O'Donnell
Airline Pilots Association
1625 Massachusetts Avenue, NW.
Washington, DC 20036

LCDR William Holland
Department of the Navy
NAVAIR 518
Naval Air Systems Command
Washington, DC 20361

Dean Oliva
Lockheed
Department 7475/Building 229A
P.O. Box 551, Plant 2
Burbank, CA 91520
Dr. Robert C. Oliver
Institute for Defense Analyses
1801 North Bauregard Street
Alexandria, VA 22311

Professor Valentinas Sernas
Rutgers University
College of Engineering
P.O. Box 909
Piscataway, NJ 08854

Mr. George Opdyke
AVCO Lycoming Division
550 South Main Street
Stratford, CT 06497

S. Sokolsky
Aerospace Corporation
P.O. Box 91957
Los Angeles, CA 90009

Dr. Robert H. Page
Texas A&M University
College of Engineering
College Station, TX 77884

Dr. Warren C. Strahle
Georgia Institute of Technology
School of Aerospace Engineering
Atlanta, GA 30332

Mr. Roy E. Pardue
Lockheed/Georgia Company
86 South Cubb Drive
Marietta, GA 30063

Mr. Dick Stutz
Sikorsky Aircraft
Engineering Department
Stratford, CT 06602

Mr. Tom Peacock
Douglas Aircraft Company
3855 Lakewood Boulevard
Longbeach, CA 90846

Mr. A. F. Taylor
Cranfield Institute of Technology
Cranfield, Bedford, MK 43 OAL
ENGLAND

Mr. William Rodenbaugh
General Electric Company
Manager, Operational Planning
1000 Western Avenue
Lynn, MA 01910

Dr. F. F. Tolle
Boeing Military Airplane Company
P.O. Box 3707
M/S 4152
Seattle, WA 98124

C. C. Randall, P.E.
Lockheed Georgia Company
D72-47 Zone 418
Marietta, GA 30063

M. Trimble
Delta Airlines
DEAT 568
Atlanta International Airport
Atlanta, GA 30320

M. Rippen
Pratt and Whitney Aircraft
Government Products Division
P.O. Box 2691
West Palm Beach, FL 33402

Mr. T. Ted Tsue
Boeing Aerospace Company
P.O. Box 3999
M/S 45-07
Seattle, WA 98124

E. T. Rookey
Northrop Corporation
Aircraft Division
One Northrop Avenue
Hawthorne, CA 90250

Trans World Airlines, Inc.
Kansas City International Airport
2-280
P.O. Box 20126
Kansas City, MO 64195
Mr. Harry L. Lemasters  
Structures Technology, MS 163-09  
Pratt and Whitney Aircraft  
400 Main Street  
East Hartford, CT 06108  

Mr. A. B. Wassell  
Rolls-Royce Ltd.  
P.O. Box 31  
Derby DE2 8BJ  
ENGLAND  

Mr. J. Fresco  
Societe Turbomeca  
Siege Social, Bureaux et Usine  
Bordes, Bizanos  
FRANCE 64320  

Mr. T. Dickey  
Stratford Division  
Avco Lycoming  
550 South Main Street  
Stratford, CT 06497  

Mr. Ronald G. Jackson  
Product Support  
Rolls-Royce, Inc.  
1895 Phoenix Boulevard  
Altanta, GA 30349  

Dr. John R. Fagan, M.S. T15  
Allison Gas Turbine Division  
General Motors Corporation  
P.O. Box 420  
Indianapolis, IN 46210-0420  

Mr. Kenneth M. Johnson, Jr.  
Williamsport Division  
Avco Lycoming  
652 Oliver Street  
Williamsport, PA 17701  

Mr. Brad Stumpke  
Mail Drop 34511  
General Electric Company  
1000 Western Avenue  
Lynn, MA 01910  

Mr. Alan J. Lea, 01MD4  
Pratt and Whitney Canada, Inc.  
P.O. Box 10  
Longueuil, Quebec J4K4X9  
CANADA  

Mr. Richard Barnard  
Sikorsky Aircraft Division  
United Technologies Corporation  
North Main Street  
Stratford, CT 06602  

Mr. Martyn Hexter  
Pratt and Whitney Canada, Inc.  
90 Dundas Street West  
Mississauga, Ontario L5A 3Q4  
CANADA  

Mr. Chet Lewis  
Boeing Commercial Airplane Company  
Mail Stop 9W-61  
P.O. Box 3707  
Seattle, WA 98124  

Mr. Martyn Hexter  
Pratt and Whitney Canada, Inc.  
90 Dundas Street West  
Mississauga, Ontario L5A 3Q4  
CANADA  

Mr. Frank M. Shallene  
Bell Helicopter Textron  
P.O. Box 482  
Fort Worth, TX 76101  

Mr. John T. Moehring  
General Electric Company  
Flight Safety Section, Mail Drop J60  
One Neuman Way  
Cincinnati, OH 45215  

Mr. Peter Dahm  
Helicopter and Transport Division  
Messerschmitt-Bolkon-Blohm GMBH  
P.O. Box 801140 DX2, 8000 Munich 80  
FEDERAL REPUBLIC OF GERMANY  

Mr. Glenn Pittard  
Garrett Turbine Engine Company  
111 South 34th Street  
P.O. Box 5217  
Phoenix, AZ 85010  

Mr. James B. Harbison  
Boeing Vertol Company  
MS 32-17  
P.O. Box 16858  
Philadelphia, PA 19142
Mr. Richard H. Johnson
Department E80, MC 36-41
Douglas Aircraft
3855 Lakewood Boulevard
Long Beach, CA 90846

Mr. John M. Kowalonek
Sikorsky Aircraft Division
United Technologies Corporation
North Main Street
Stratford, CT 06602

Mr. Emmett A. Witmer
Massachusetts Institute of Technology
Cambridge, MA 02139

Mr. P. B. Gardner
Industrial Ceramics Division
Norton Company
One New Bond Street
Worcester, MA 01606

Mr. Jack A. Mitteer
Product Support
McDonnell Douglas Helicopter Company
5000 East McDowell Road
Mesa, AZ 85205

Captain Edwin R. Arbon
Flight Operations Safety
Flight Safety Foundation, Inc.
5510 Columbia Pike
Arlington, VA 22204-3194

Mr. Donald F. Thielke
Vice President, Safety Engineering
Flight Engineers' International Assoc.
905 16th Street, NW.
Washington, DC 20006

Mr. Barry Scott
P.O. Box 25
Moffett Field, CA 94035

Mr. A. T. Weaver, M.S. 165-30
Pratt and Whitney Aircraft
Airworthiness Engineering Division
400 Main Street
East Hartford, CT 06108

Mr. Steve Clark
Rolls-Royce Inc.
1895 Phoenix Boulevard
Atlanta, GA 30349

Mr. William Burcham
Propulsion Branch, Code OFV
NASA Ames - Dryden
P.O. Box 273
Edwards, CA 93523

Mr. Ralph E. Kesler
Delta Air Lines, Inc.
Hartsfield Atlanta International Airport
Atlanta, GA 30320

Mr. P. B. Gardner
Commander
Naval Air Systems Command
AIR-330
Department of the Navy
Washington, DC 20361

Commander
Naval Air Systems Command
AIR-330A
Department of the Navy
Washington, DC 20361

Commander
Naval Air Systems Command
AIR-5017A
Department of the Navy
Washington, DC 20361

Commander
Naval Air Systems Command
AIR-536
Department of the Navy
Washington, DC 20361

Commander
Naval Air Systems Command
AIR-5360
Department of the Navy
Washington, DC 20361
United Airlines, Inc.  
ATTN: J. D. Smith  
VP, Flight Safety and Industry Affairs  
P.O. Box 66100  
Chicago, IL 60666

Pratt and Whitney Aircraft  
Division of United Technologies Corp.  
ATTN: Technical Library  
400 Main Street  
East Hartford, CT 06108

Piper Aircraft Corporation  
ATTN: Mr. Walter C. Jamouneau  
Chief Engineer  
Lock Haven, PA 17745

Rolls-Royce Limited  
ATTN: D. McLean, Chief Design Engineer  
Aero-Engine Division  
Derby  
ENGLAND

Canadian Air Transportation Admin.  
ATTN: D. R. Hemming  
No. 3 Temp. Building  
Wellington Street, Ottawa, Ontario  
CANADA

Rolls-Royce Limited  
ATTN: S. Cox, Bristol Engine Division  
P.O. Box 3 Filton House  
Bristol BS12 7QX  
ENGLAND

Northrop Corporation  
Aircraft Division  
3901 West Broadway  
Hawthorne, CA 90250

Pan American World Airways  
Pan American Building  
ATTN: Mr. John G. Borger  
Chief Engineer  
New York, NY 10017

National Research Council  
Assembly of Engineering  
ATTN: Mr. John P. Taylor  
2101 Constitution Avenue  
Washington, DC 20418

North American Rockwell Corporation  
Aerospace and Systems Group  
ATTN: Technical Library  
6633 Canoga Avenue  
Canoga Park, CA 91304

British Aircraft Corporation, Ltd.  
GPO Box 77, Filton House  
ATTN: J. Wallin, Chief Prop. Engineer  
Bristol BS99 7AR  
ENGLAND

DOT/Federal Aviation Administration  
Mike Monroney Aeronautical Center  
AFS-581  
P.O. Box 25082  
Oklahoma City, OK 73125

DOT/Federal Aviation Administration  
Mike Monroney Aeronautical Center  
AFS-580  
P.O. Box 25082  
Oklahoma City, OK 73125

National Transportation Safety Board  
Bureau of Aviation Safety  
Engineering Division  
ATTN: Mr. Martyn V. Clarke, Asst Chief  
Washington, DC 20591

British Aircraft Corporation. Ltd.  
ATTN: B. Fletcher  
GPO Box 77, Filton House  
Bristol BS99 7AR  
ENGLAND

Civil Aviation Authority  
ATTN: L. R. Wilson  
Brabazon House  
Redhill, Surrey  
ENGLAND

Hawker Siddley Aircraft  
ATTN: Technical Library  
Hawskidair, Hatfield  
ENGLAND

Ministry of Defense  
W. J. Moschini, Engines T1, Room 151  
St. Giles Court 1-13  
St. Giles High St., London WC2H 8LD  
ENGLAND
END
8-87
DTIC