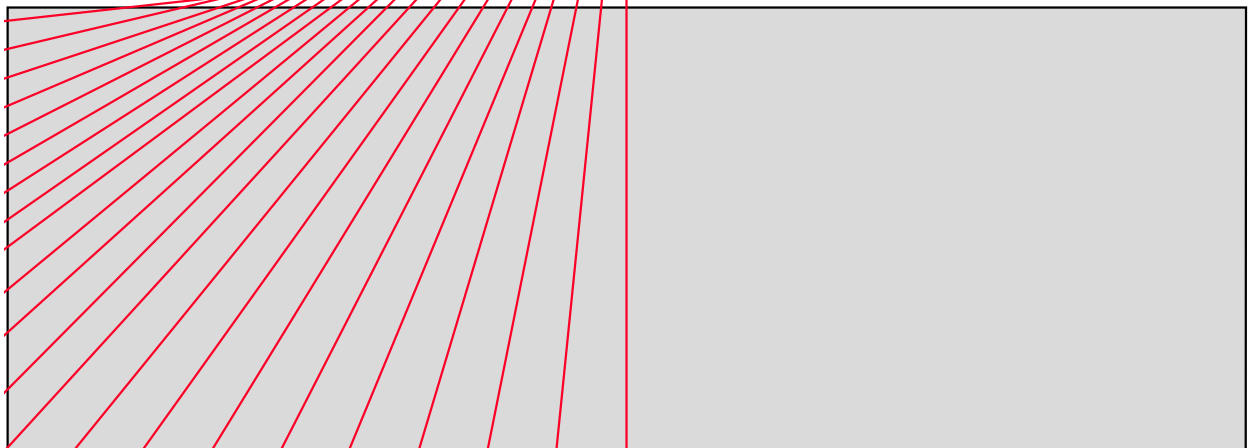


Safety Analysis Team

Report No. SAT-01.1

24, 1997





Executive Summary

The Safety Analysis Team (SAT) was chartered by the Aircraft Certification Management Team (ACMT) of the Aircraft Certification Service (AIR) to find significant safety threats to aviation. The mandate was to provide information to the ACMT to formulate industry and business initiatives to reach the “zero-accidents” goal. The SAT was composed of team members from each Directorate and Division of AIR with all disciplines represented.

Each Directorate and Division of AIR has presented in this report a closer look at its cognizant FAR Part. The individual FAR Part sections in this report include specific intervention strategies.

The SAT noted a surprising number of fuel related accidents in the data; specifically, accidents caused by running out of fuel, mismanagement of fuel, and fuel contamination.

The SAT noted the lack of a single source for data. The FAA-resident data bases, quite appropriately, possesses only domestic data. NASDAC data is very useful, but for Transport Aircraft, a UK insurance data base (Air Claims) had the most appropriate data. Additionally, ASAP was better suited for a search of Airworthiness Directives part numbers than NASDAC. The research capability of NASDAC/ASAP, coupled with the Global Analysis and Information Network (GAIN), will help continue the work identified in this report.

The SAT recommends that AIR begin to disposition the existing studies. Some recommended intervention strategies will require a research and development program at Hughes Technical Center. Individual programs could be managed by the appropriate Directorate to satisfy an intervention strategy. The SAT further recommends that the Airworthiness Directives (AD) system, with some modifications, could be a very useful tool for Part 21 intervention strategies.



Process

Introduction

The Team

The Safety Analysis Team (SAT) is composed of ten Aircraft Certification Service (AIR) employees who possess a wide range of experience, education, and expertise, comprising a cross section of the AIR workforce. Each SAT member was selected by Directorate and Division Managers, representing each Directorate and Division of AIR. The SAT is composed of engineers, inspectors, a pilot, and a National Resource Specialist (NRS). The linking Aircraft Certification Management Team (ACMT) member was the Manager of the Engine and Propeller Directorate (ANE-100). The SAT also was given facilitator and automation support from the Planning and Program Management Division (AIR-500), technical writing and graphic arts support from the Technical and Administrative Support Staff (ANE-103), and additional technical support from the Engine Certification Office (ANE-140).

The Safety Analysis Team would like to express its thanks to many individuals and organizations who provided information, assistance and support to this effort. We sincerely appreciate the NASDAC and the tireless analysts who always found what we wanted and willingly made it presentable for us.

The team also wants to express its thanks to the technical staff that never said can't and always "found a way." Our very capable team: Technical writer/editor, Matt Epstein; graphic presentations, Donna Syme; our publisher, Mary Culver.

The Safety Analysis Team:

Jay Pardee, ACMT Linking member	ANE-100
Lee Nguyen	AIR-100
Ben Pourbabai	AIR-200
Julia Meck, Facilitator	AIR-500
Joe Mahoney	AIR-500
Jeff Duven	ANM-140S
Sharon Miles	ASW-111
Ben Beets	ASW-103
Lowell Foster	ACE-111
Ann Azevedo	ANE-110
Dave Downey, Team Leader	ANE-150

The Charter

Charter for the Aircraft Certification Service Aviation Safety Management Program Team

I. Background:

The Service is committed to a proactive safety program that will result in a significant reduction in aircraft accidents. Achieving this goal requires a strategy that identifies critical safety threats and focuses resources on effective intervention action for these threats. The purpose of this document is to charter a Service team to identify the most critical safety threats and recommend potential intervention actions to support this strategy.

II. Task:

A. The team shall acquire historical data, from existing sources, such as NTSB accident/incident reports, service difficulty reports, etc., that can be used to identify the most significant safety threats, by FAR Part, that could potentially cause accidents. Additionally, the team should identify any safety threats that occur across FAR Parts.

B. The team will analyze this data and present in the form of a Pareto analysis, the ranked safety threats for each FAR Part.

C. Further analyze this data (root causes and life cycle to failure, considering design, manufacturing and maintenance, if applicable) and recommend intervention strategies for the top ranked safety threats, by FAR Part, or across FAR parts. The recommended intervention strategies, and supporting data shall be provided to the responsible Directorates for development of appropriate implementation action.

D. As part of this process, the team should develop a listing of additional types of service information or data sources, which would be helpful for future efforts as well as documenting the methods and techniques used by the team in completing their tasks.

III. Membership:

Representation from each Product and Policy Directorate is required and each discipline (ASI, FTP, ASE) should be included. Consultation with various NRSs and technical specialists will be required during the process.

IV. Product:

The deliverables include a full report, documenting the team's findings, recommendations and an executive presentation to the ACMT.

V. Timeframe:

The team will have 60 days to complete the assigned task. Interim briefings to the ACMT shall be provided while the team is in process.

VI. Follow-on Activities:

Following completion of this initial activity to determine the longer-term Service safety targets and intervention strategies for accident-rate reduction, Service Management shall define additional tasks for this or follow-on team activities. These future activities may focus on the development of a daily operational risk management strategy and the tools, methodologies and best business practices to support this concept. These future activities are beyond the scope of the present charter.



Thomas E. McSweeney
Director, Aircraft Certification Service

SAT's Charge

The SAT's charge was to formulate a set of recommendations that could be implemented into Fiscal Year 1998's business plan. These recommendations comprise the significant threats that AIR, the aerospace industry, and other FAA offices agree will help reduce accidents. The recommendations have multiple facets for proper implementation. Some recommendations will require regulatory actions, while others will not. As a whole, the non-regulatory recommendations are more operationally oriented than design related.

The SAT was asked to examine all engineering FAR Parts within a short timespan and without any prejudicial assumptions.

At the initial meeting, the SAT examined the charter in detail to identify the specified tasks. The team soon realized the difficulty of procuring the required information, as safety-related information is not uniformly available across all aircraft types and operations. There is no one good single database that offers comprehensive information that lends itself to analysis. Many sources of data were utilized to produce the team's recommendations.

Report Methodology

Each FAR Part has an individual report section, structured as follows:

- Data
- Analysis
- Pareto
- Spreadsheet
- Intervention Strategies
- Recommendations

Gathering Data

General

The SAT used the National Aviation Safety Data Analysis Center (NASDAC) as the initial source for data. NASDAC is located in the FAA Headquarters and at some selected field locations. Additionally, the Aviation Safety Analysis Program (ASAP) was the primary data source for FAR Parts 27 and 29, since the Rotorcraft Directorate is the ASAP cognizant organization. Further data on both NASDAC and ASAP are contained in the Appendix.

Transports (FAR Part 25)--There is a great deal of safety-related information on transport category airplanes, as they have been extensively researched. The safety-related data can be found in a variety of sources, from NTSB reports to trade association studies. However, all this information tends to be in forms that reflect the assumptions underlying the data gathering methodology and the purposes and needs of the particular agency or association that created the studies. In addition, transport aircraft have an operational FAR Part (121) that has many equipment requirements that fall under the aegis of the SAT's study, such as the requirement to install Ground Proximity Warning Systems (GPWS).

Small Airplanes (FAR Part 23)--General aviation has the greatest variety of aircraft, with types varying from antique biplanes to modern corporate jets. As such, the safety-related data is disparate and vast, and does not lend itself to easy categorization. Early on, the team decided to limit the scope of its study of general aviation to fatal accidents in order to make the data gathering task more manageable.

Rotorcraft (FAR Parts 27 and 29)--Helicopters have unique operational characteristics and unique missions regulated in additional FAR Parts (133 Rotorcraft External-Load Operations and 137 Agricultural Operations) that influenced the team's analysis of accident data.

Engines and Propellers (FAR Parts 33 and 35)--All the data analyzed by the SAT had the common element of having the aircraft involved in the accident having a powerplant of one form or another, and so the analysis of the engine data cuts across the other three sections.

Engine and Propeller Matrix

FAR Parts	33- Reciprocating Engines	33- Turboshaft Engines	33- Turbojet Engines	33- Turbofan Engines	35 Propellers
23- Small Airplanes	x	x	x	x	x
25- Transport Airplanes	x	x	x	x	x
27- Small Helicopters	x	x			
29- Transport Helicopters	x	x			

Manufacturing (FAR 21)-- This Part deals with everything from restricted category aircraft airworthiness issues to manufacturing inspection. There is very little in-depth information to support accident study in this area. Additionally, since the AIR initiatives were in the Product Directorates, and vice Policy Directorates, the Part 21 area was abridged.

Analysis Model

The FAA has used the 5-Step Safety Management Plan as a guide for implementing an internal flight safety program. This analysis model was modified slightly to fit the team's requirements. The on-going National Civil Aviation Review Commission has also used this model for its analysis.

Analysis Presentation

Each FAR Part section will have accident data displayed in Pareto and spreadsheet formats.

Intervention Strategies and Recommendations

AIR initiated this study to proactively pursue reducing accidents. Though it is widely known that air travel is by far the safest mode of transportation, aircraft accidents receive extensive coverage and scrutiny. The transport category accident rates have for the most part declined. But FAR Part 25 aircraft accidents are particularly visible to the public since they carry the highest number of passengers and flight aboard scheduled airlines is by far the most common experience of flight to the public. Though the transport accident rate has declined over the past decade, the volume of flights by FAR Part 25 aircraft is rising at a rate that will increase the total number of accidents. Even though, on a percentage basis, the accident rate is low and getting lower, the public's **perception** of the increasing absolute number of fatal accidents and hull losses will soon be unacceptable. The SAT, therefore, had to examine the less likely causes of accidents in the data and present intervention strategies in order to reduce the total number of accidents. For example, some accidents have unknown causes. In some cases, aircraft disappear, or the accidents are not adequately investigated due to resources available in other countries, or the aircraft themselves are difficult to recover, such as those lost over water. The team concluded that some accidents will never be fully stoppable, such as hostile actions or hijackings. However, the SAT did recommend increased vigilance in the areas of security. As such, the team has not confined its recommendations to design-related issues.

Intervention Strategy "Big Picture"

The SAT did not set out with a particular focus for any intervention strategy. We adopted the FAA methodology for accident intervention. This methodology is based on the Domino Theory first produced by H.W. Heinrich in 1931.

The Accident Sequence Metaphor

The chain of events that leads to an accident can be pictured as a series of five solid disks mounted on a shaft. Each disk has one hole drilled in it at the same radius. Each disk is rotating at a different RPM than the adjacent disk. An accident is only going to occur if that unique set of events aligns all the holes at the exact instant. A proactive safety effort aims to keep that from happening.

1. The first disk in the model is *Underlying Cause*. Individual expectations are framed by the actions or inactions of management. Management may introduce latent errors into the organizational system. In this area, management has inadvertently introduced problems in the areas of planning, organizing, directing, controlling, and staffing. Basically, the environment is what is wrong.
2. The second disk is *Basic Cause*. These latent System errors are reacted to both inappropriately and appropriately. The inappropriate reaction introduces more latent errors. This disk, combined with the first disk, become the preconditions for an accident. An example would be a lack of enforcement for breaches of policy and regulation.
3. The third disk is the *Immediate Cause* of an accident. Individuals commit active errors by just doing their jobs or mechanical systems can break. An example would be lifting something that is too heavy.
4. The fourth disk is *Safety Defenses*. The organizational oversight and safety programs are the countermeasures or Filters that defend against errors. Examples are crew rest policies, stabilized approach criteria, “sterile” cockpits below 10,000 feet, and ramp checks.
5. The final disk is the *Consequences*. If all the defenses work, the Result is no accident. When there is a catastrophic failure, we have an accident. If there are minor failures we have an incident or close call.

With this metaphor to frame thinking about aircraft accidents, the SAT was able to ask the questions: What is safety? How do I get my hands around it? And, what does it look like when I have some?

There are three areas where the SAT can make recommendations:

- *Underlying Cause* - This is the environment that the FAA operates within. This area includes, but is not limited to: FAR, Orders, Notices, NPRM, etc. As a result of the SAT’s studies, there are areas that may require either regulatory or non-regulatory changes.

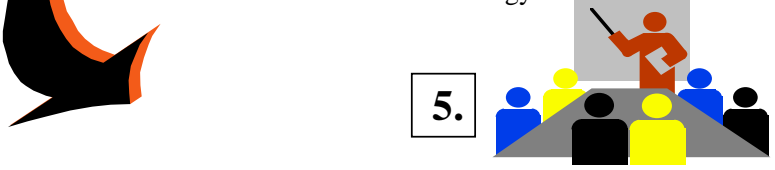
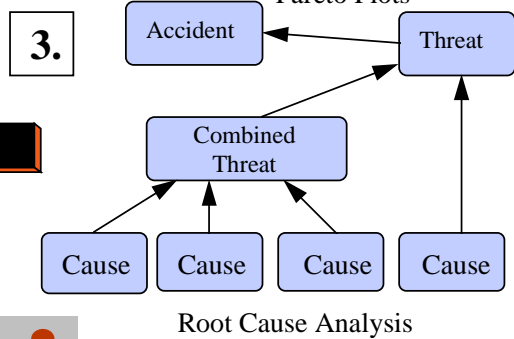
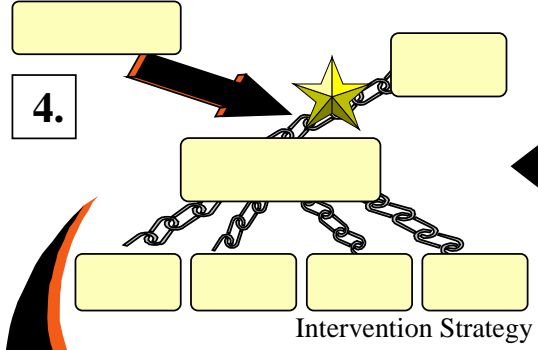
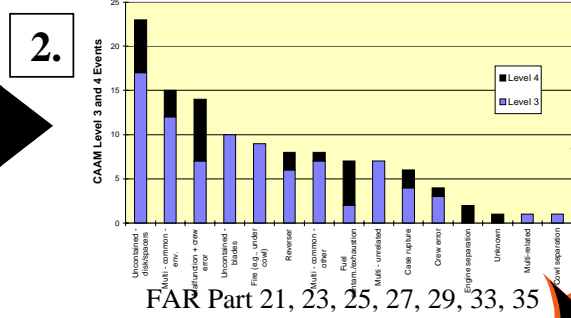
- *Basic Cause* - The FAA can react to problems in an appropriate or inappropriate manner. Several accidents were breaches of FAR Operating Rules. Swift, aggressive enforcement sends a very clear picture of the FAA’s willingness to be decisive and show little tolerance to violations. Additionally, there are several studies and reports with recommendations that have not had any disposition. Another area is Research and Development Programs. There should be a clear structure to program management targeted R & D programs at the Hughes Technical Center. The oversight and funding of these programs should be managed by the cognizant AIR Directorates.
- *Safety Defenses* - In this area, the ACSEP program is a valuable “filter” for working safety issues. Redundant/reliable systems also provide the “belt and braces” effect for intervention ideas. The filters need not be sophisticated; it could be as simple as an Angle-of-Attack indicator for pilot situational awareness.

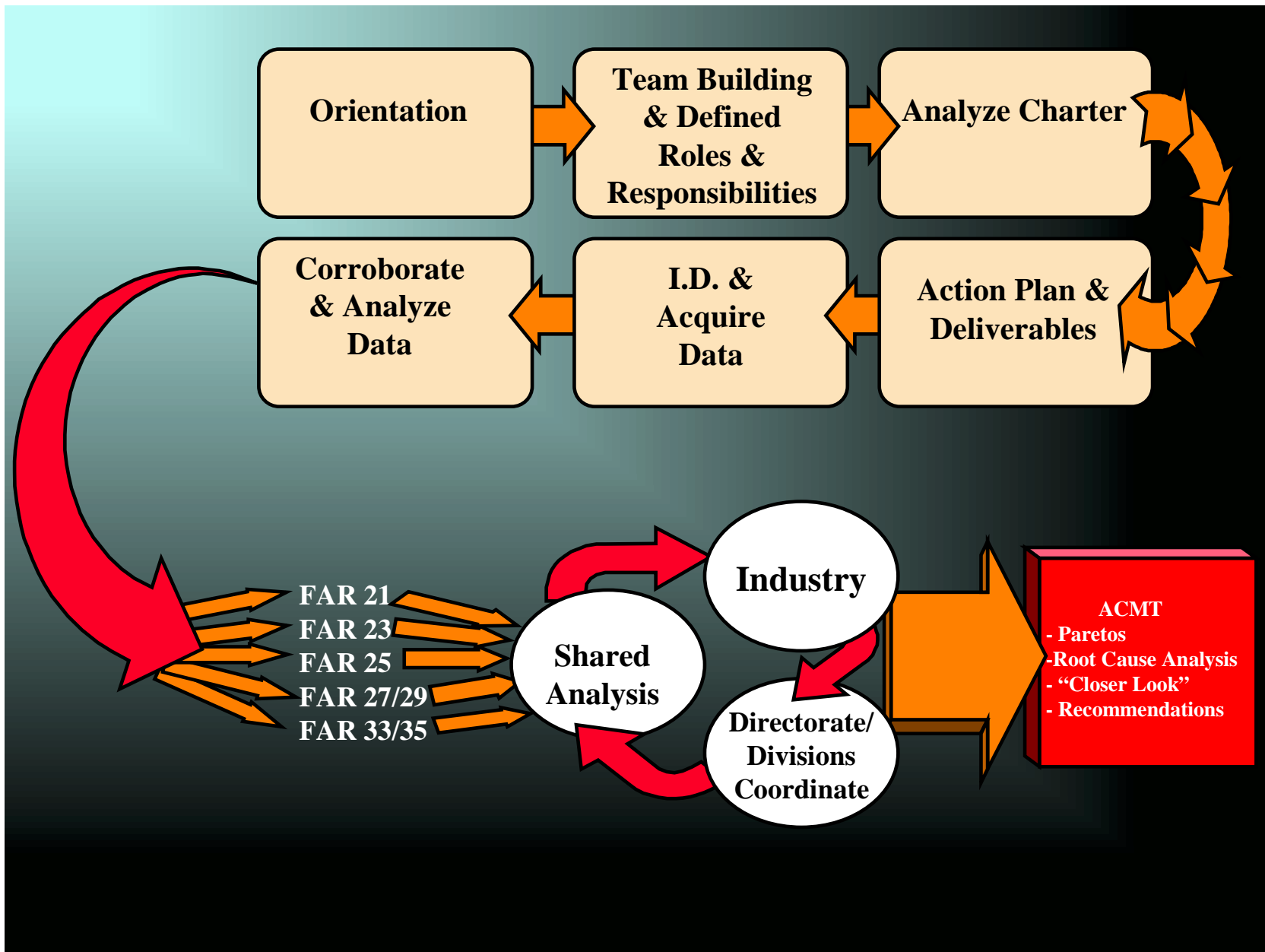
Safety has five elements within the Organizational System, of which four apply to the AIR application:

Effective Management	This is the single most important part of any safety effort. Safety must be a part of all operations-- not just a separate program. It must pervade the workplace and be viewed as: <i>the way we do business.</i>
Trained Personnel	This means everyone “buys-in” and is focused on the FAA’s commitment to the public safety.
Clearly Specified or Implied Mission	We have a business plan that clearly defines this. However, this plan is little known below the management levels for the most part. Bottom line people do not see their role in this effort or what safety might have to do with them or the business plan.
Organizational Structure	Proactive risk-management an excellent tool. This must be further refined into an organizational process (probably the AIR/AVR/FAA business plan), instead of a business as usual posture.

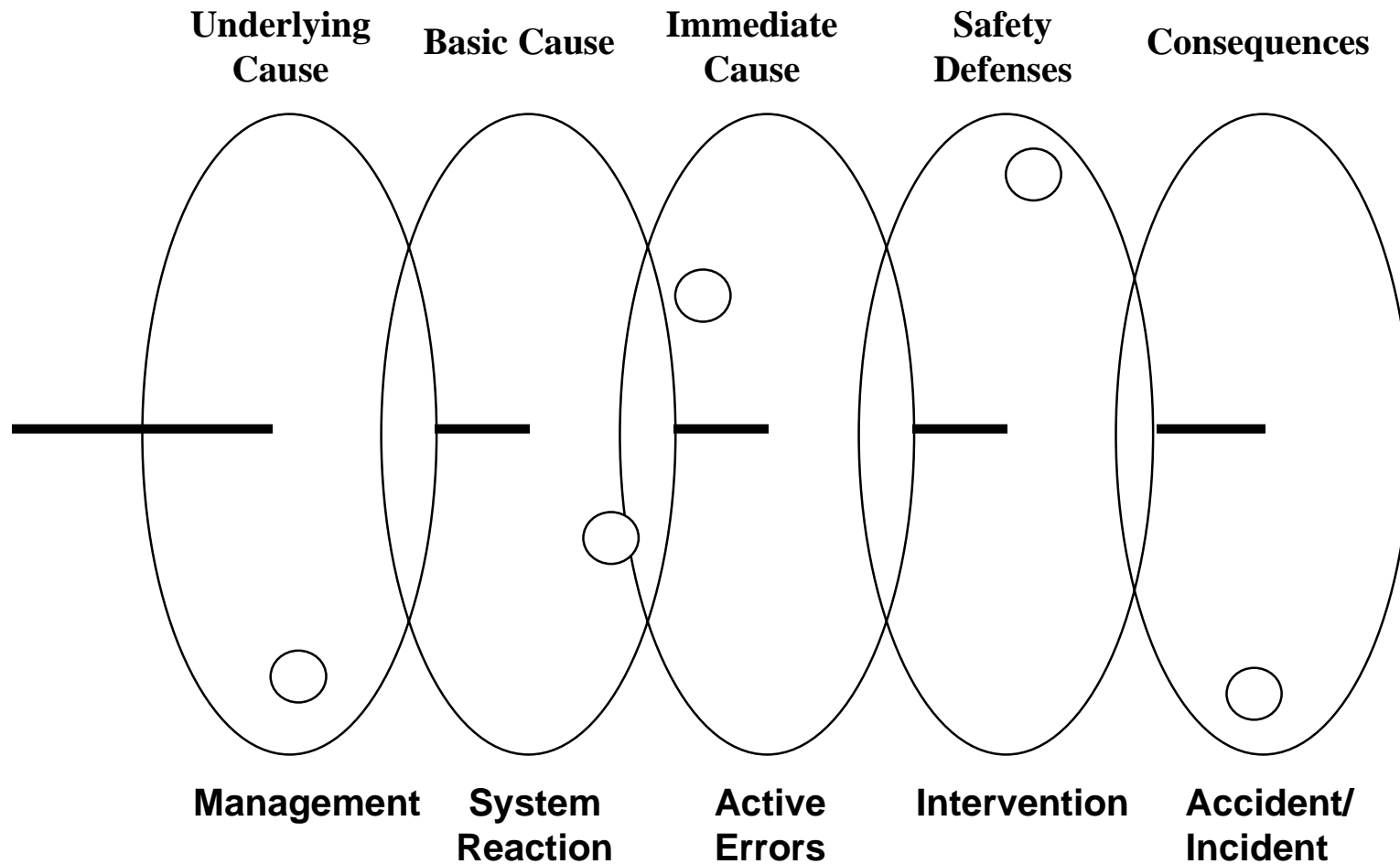
Safety Analysis Process

- NTSB Accident Incident Reports
 - 21.3 Reports
 - NASDAC data
 - Airclaims data
 - Industry





FAA SYSTEM SAFETY METHODOLOGY





Transport Category Aircraft

Data

Sources

The SAT obtained data pertaining to accidents and incidents involving Transport Category airplanes (type certificated under Part 25 or preceding standards) from NASDAC. The primary data source was the Airclaims database, covering the period of 1987 through 1996. In some instances, the SAT obtained clarifying information from NTSB accident/incident reports, accident reports issued by foreign governments, and manufacturers' reports.

International Data

NTSB and FAA databases were also available through NASDAC; however, because these databases typically include only reports for events involving domestic operators or events occurring within the United States, they were considered to be too limited to provide a representation of the transport airplane fleet. The time period of 1987-1996 was considered to represent a reasonable amount of data for beginning this analysis and also coincided with the time period used in a recent Air Transport Association (ATA) Industry Safety Strategy Team (ISST) analysis of transport airplane accidents and incidents.

Using Airclaims as the primary database provided the largest single source of worldwide data for both accidents and incidents. In general, the events included in the Airclaims data base involved damage to the airplane which exceeded 10% of the airplane's value. While the Airclaims data base is extensive, there are numerous events where a significant incident occurred but didn't result in a level of damage extensive enough to be included in the Airclaims data base. Examples of significant events involving the propulsion system that were not found in Airclaims are noted below.

Significant Propulsion System Events Not in Airclaims

- 767 Multi-engine shutdown event during initial climb- June 1987
- 737-300/CFM56-3 Multi-engine powerloss events - August 1987, May 1988
- 747-400, 757, 767 Significant fuel loss events - 1987 through 1994

- 737, 747, 757, 767 Fire detection and extinguishing cross wiring/plumbing events - January 1989
- 747-400/RB211-524 Wide chord fan blade failure event - November 1993
- BAE 146 All engine roll-back events - March 1992 through May 1996
- 727/Rolls-Royce Tay All engine powerloss event - June 1996

FAA Response

All of the propulsion system incidents noted above have resulted in FAA action in the form of either an Airworthiness Directive (AD), revised policies, or rulemaking. Efforts should be made to identify and include these “non-damage” events into any records (reports, documents, data bases, etc.) that AIR will use in the future to capture historical data on accidents and incidents.

Data Sources Not Consulted

There are several additional data sources that undoubtedly contain relevant information; however, due to the time constraints of this project they were not examined. These data sources include NTSB incident reports, FAA Accident/Incident System (AIDS) event records, FAA Aviation Safety Reports (ASRS), and data sources maintained by the various manufacturers.

Analysis

Affected Aircraft

Appendix A contains a list of the airplane models considered for this analysis. The Airclaims data base for the period of 1987 thorough 1996 included events for all of the airplane models noted in Appendix A with the exception of the DeHavilland Comet and the Boeing 777.

The database consists of 873 events, with 594 involving turbofan/turbojet powered airplanes and 279 events involving turboprop powered airplanes. The SAT made a special effort to include and analyze events for the turboprop powered airplanes because this group of airplanes has not been included in studies previously conducted by the ATA or the major airplane manufacturers. By including the turboprop events, a comparison can be made between the jet and prop fleets with respect to historical threats and the intervention strategies.

To make the database as inclusive as possible, relevant events from non-transport category operations (ex. military, training, cargo) were included in the analysis. Events which were considered unrepresentative of transport category operations (ex. restricted category (fire fighting)) were excluded.

Accident Categories

Appendix B contains a list of the definitions used for categorizing the accident and incident events for the Pareto charts. A total 51 Pareto category definitions are provided in Appendix B. The SAT made efforts to use relatively narrow definitions to preclude situations where a large number of events could be arbitrarily lumped together under a very general category that didn't represent the wide variety of factors associated with the accidents and incidents. Additionally, the definitions were selected to allow a more detailed look at existing intervention strategies for each accident category.

Each of the 873 events was assigned a single Pareto category considered most representative of the initiating event for the accident/incident or most representative of the effect the event had on the airplane. This approach admittedly results in an over simplification of an accident or incident (by identifying only one primary factor) but is considered a meaningful first effort to identify accident and incident categories with the objective of differentiating those of greatest risk to those of lesser risk.

As with all analysis of this type, there is a degree of subjectivity in selecting and applying the definitions. The definitions by themselves do not identify causes but rather serve as a way of grouping accidents and incidents with common characteristics.

Ranked Safety Threats - Pareto Charts

The following table provides an overview of how the 873 events retrieved from the Airclaims database were segregated into different groups for the purpose of constructing the Pareto charts. Three groupings were selected to provide looks at the data from different perspectives. Again this data represents the period from 1987-1996.

	“All Events”	“Fatal Accidents, Hull Loss & Significant Incidents”	“Fatal Accidents”
Turbofan/turbojet powered airplanes	594 events (Charts 1&2 - Appendix C)	288 events (Charts 3&4 - Appendix C)	131 events (Chart 5 - Appendix C)
Turboprop powered airplanes	279 events (Charts 6&7 - Appendix C)	100 events (Charts 8&9- Appendix C)	100 events (Chart 10 - Appendix C)

For the purpose of this analysis, significant incidents were arbitrarily defined as events where the damage to the airplane exceed 50% of the airplanes value.

Accident Category Definitions

As discussed previously, the SAT used a total of 51 definitions to segregate the events into various categories. By using rather narrow definitions, the Pareto plots did not fit neatly onto single charts, but rather required two charts to represent most of the event groups noted in the preceding table. This approach, although cumbersome, does present the data in a meaningful way with respect to evaluating specific intervention strategies.

The chevron (>) symbol used in the category titles for all of the Pareto charts denotes events involving failure conditions that would be reportable to the FAA under the requirements of FAR 21.3 or 121.703.

The SAT estimates that of the 210 fatal accidents reviewed, approximately 17% involved malfunctions that would be reportable under the requirements of FAR 21.3 or 121.703. Considering all of the 873 events reviewed, approximately 22% involved malfunctions that would be reportable under the requirements of FAR 21.3 or 121.703. These figures highlight the limitations in relying on the existing reporting processes for providing early warning signs for conditions that may later result in incidents or accidents.

Mechanical Failures vs. Human Performance

Review of all of the data contained in the Pareto charts will continue for some time. Though it is observed that FAA and industry efforts to address mechanical failures have worked well, as demonstrated by the smaller number of events contained in these categories (see Appendix C - Charts 3&4, 8&9), the SAT has determined that to make a meaningful reduction in the accident rate will require strengthened efforts within the FAA and industry to address all areas involving “human performance.”

Highest Frequency Fatal Accidents

Focusing on the highest frequency fatal accident categories shows similarity between the turbofan/turbojet and turboprop fleets. The first five categories from the turbofan/turbojet fatal accident chart (Appendix C - Chart 5), listed in decreasing order of frequency, are:

- Controlled flight into terrain (CFIT).
- Loss of control inflight.
- Acts of aggression.
- Takeoff procedures.
- Unknown.

Four of the five highest frequency categories noted for the turbofan/turbojet fleet are in common with the turboprop fleet. In total, these five categories represent approximately 65% of the fatalities experienced between 1987 and 1996 for Transport Category airplanes.

CFIT

CFIT events involve 72 of the 873 events studied. Fatalities occurred in 63 of the 72 CFIT events and these fatalities represent just over 30% of the total for the period 1987-1996. A substantial number of the turboprop fatal accidents (Appendix C - Chart 10) that were categorized as unknown have characteristics similar to accidents categorized as CFIT, but without additional information the CFIT categorization could not be made with confidence.

A closer examination of the information available for the CFIT events is provided in Appendix C - Chart 11. This chart presents all of the information that was retrievable from Airclaims for the 72 CFIT events (turbofan/turbojet and turboprop fleets combined).

The limited information presented on this chart signifies the need for the FAA to work with industry in conducting a root cause analysis of these events.

The SAT has recently learned of several industry activities that correspond to the greatest risk areas, including CFIT. These industry activities are identified in the Prevention/Intervention section which follows. Near term efforts should concentrate on reviewing these activities with consideration given to how the FAA can support these initiatives either through voluntary or required actions.

Intervention Strategies

Table 1, Intervention Strategies, is contained in Appendix D. Each row in the table corresponds to one of the Pareto categories noted in the fatal accident Pareto plots (Appendix C - Charts 5 & 10). The purpose for this table is to allow identification of existing activities (completed or on-going) or needed future activities that correspond to the specific categories identified in the fatal accident charts.

The Pareto categories shown in Table 1 are listed, in decreasing order, based on the number of fatalities associated with each category. Organizing the table based on decreasing fatality count is not a perfect way to convey the relative risks between the various categories, but it will allow users to focus on the larger risks before examining the smaller risks.

Table 1 is not an all-inclusive document, but rather a working document that will need to be refined as the information is shared with additional organizations (both internal and external to the FAA).

Table 1 illustrates that a considerable number of activities are already underway within the FAA and industry that align directly with the Pareto categories. The SAT notes special recognition of

the FAA Human Factors Team Report, issued in June 1996, and the FAA Inflight Aircraft Icing Plan, issued in April 1997. These two documents provide detailed recommendations and/or plans, that when implemented, have the potential to significantly improve safety in many of the greatest risk categories. Continued FAA and industry support of these important activities cannot be over-emphasized.

The statement “Further emphasis” in the Table 1 column, Industry Activities/Comments, notes that despite ongoing activities the SAT recommends that additional steps be taken to address accidents in these specific categories. Discussion of these recommendations follows.

Recommendations

Education and Training

The SAT reviewed FAA and industry safety initiatives and was surprised to see that greater emphasis has not been placed on educating the working level personnel (within the FAA and industry) on the cause of accidents and incidents and how these events have led to changes in design, certification and operating standards. The benefits from providing this training may not be evident for many years, but in the absence of this effort it is unlikely that AIR will be able to make serious strides to improve safety until the workforce understands the events which have caused, and continue to cause, fatal accidents and serious incidents.

The SAT recommends that the training proposal provided in Attachment E be considered as a long term effort to educate AIR personnel on the causes of accidents and incidents. Consideration should be given to making the training available to industry personnel.

Analysis of Historical Data

The SAT recommends that further efforts should be made to identify the significant non-damage events which are excluded from the Airclaims database. These events should be included into any records (reports, documents, data bases, etc.) that AIR will use in the future to capture historical data on accidents and incidents.

The SAT recommends continuing ongoing refinements to the Intervention Strategy table presented in Appendix D. Any additional accident/incident categories that are considered relevant should be added to the table.

The SAT recommends initiating root cause analysis for the major accident categories. The CFIT root cause analysis should receive the highest priority.

The SAT recommends making efforts to review and validate work being conducted by a number of industry task teams. Consideration should be given to how the FAA can best support these activities.

Data Sources

In coordination with Flight Standards (AFS), the SAT recommends reconsidering the type of events that should be formally reported under FAR 21.3 and 121.703 and the quality standards for making these reports. Looking beyond the current reporting requirements contained within FAR 21.3 and 121.703, emphasis should be placed on developing processes to communicate “precursor data” for event categories that are predominantly associated with human factors.

Safety Initiatives

Events included in the categories of CFIT, loss of control (flight), preflight, takeoff, approach, and landing represent over 50% of the fatalities experienced between 1987 and 1996. In recognition of this, as a near term initiative, AIR should review the results of this study with AFS. The objective of this review should be a determination if training improvements can be made in these areas. Consideration should be given to recently developed training aids. Conclusions from this review should be shared with industry and civil aviation authorities worldwide.

The SAT recommends that conclusions from the CFIT root cause analysis should be used as a guide for identifying future actions to further reduce these accidents.

The SAT recommends proceeding with efforts to raise the certification standards through implementation of the “RTO” and “Low Fuel Quantity” rules.

The SAT recommends that minimum power standards should be developed to ensure that flight data recorders continue to function during emergency situations.

The SAT recommends that continuing efforts should be made to implement the recommendations from the FAA Human Factors Team Report and complete implementation of the FAA Inflight Aircraft Icing Plan.

Appendix A

Turbofan/turbojet airplane models considered:

Aerospatiale	Caravelle
Airbus	A300, A310, A320, A321, A330, A340
Boeing	707, 720, 727, 737, 747, 757, 767, 777
British Aerospace	Concorde, 146, 111, Trident
DeHavilland	Comet
Fokker	F28, 100
Lockheed	L1011
McDonnell Douglas	DC-8, DC-9, DC-10, MD-80, MD-11

Turboprop models considered:

Aerospatiale	N262/Fregate
Avions De Transport Regional	ATR-42, ATR-72
British Aerospace	ATP, HS748, Jetstream 41
Construcciones Aeronauticas SA	CASA 212, CASA 235
DeHavilland	Dash 7, Dash 8
Deutsche Aerospace AG	Dornier 328
Embraer	EMB-120
Fokker	F27, F50
General Dynamics	Convair 540/580/600/640
Gulfstream	Gulfstream 1
Lockheed	L-188 Electra
SAAB	340
Shorts	330, 360

Appendix B

Definitions

The philosophy behind using the following definitions was to identify the event highest in a chain of events that was considered a primary contributor to the accident or incident. Additionally, the SAT made efforts to use or develop definitions that were associated with accepted intervention strategies.

These definitions, although general, were selected to minimize situations where one event could be categorized several different ways. This approach admittedly results in an over simplification of an accident or incident (by identifying only one primary factor) but is considered to be a meaningful best first effort to present an analysis of the various accident and incident categories with the objective of differentiating those of greatest risk to those of lesser risk.

Act of aggression

Events where a deliberate act resulted in damage or destruction of the airplane. Events included in this category include:

- Sabotage
- Hijacking
- War acts
- Military acts

Airframe fire/explosion

Events which resulted from either an airframe fire or explosion. Events excluded from this category include APU fires and engine fires. Fires that were the result of maintenance procedures that were not properly performed were included in the maintenance category.

Approach procedures

Events where the approach procedures were not properly performed. When discussing events in this category, events in the categories “Go-around procedures”, “Landed long/fast/overran runway”, “Undershot landing”, and “Unstable landing” should also be recognized because many of the events in these categories likely involved approach procedure deviations or errors.

APU failure/fire

Self explanatory.

Bird ingestion/impact

Events which involved birds being ingested into one (or more) engine or birds which impacted other parts of the airplane.

Cabin/cargo doors

Events which involved an in-flight failure of a cabin or cargo door.

CFIT (Controlled flight into terrain)

Events where an airworthy airplane struck something in its flight path. In the majority of cases the impact was with terrain, although there are a limited number of events included in this category where the airplane impacted something other than terrain (e.g., water, building, radio tower, etc.). The CFIT definition used for this analysis differs slightly from other analyses in that events following certain equipment malfunctions (engine failure, gear problems, cargo fire warning) are included because the airplane was considered to still be capable of continued safe flight and landing. In these events, the crew may have become distracted with the equipment malfunction and allowed the airplane to deviate from the required flight path.

Cowling/fairing separation

Events involving the separation of engine cowling or various airframe fairings.

Engine attachment

Events associated with the separation, or partial separation, of an engine or engine and strut from the airplane.

Engine failure

Events involving miscellaneous engine failures that did not fit into any of the other categories involving engine failures (uncontained engine failure, engine fire, engine failure plus inappropriate crew response) This information is presented more in depth in the Part 33 section of this report.

Engine failure plus inappropriate crew response (ICR)

Events where the combination of an engine failure along with an inappropriate crew response was a significant factor in the accident. This information is presented more in depth in the Part 33 section of this report.

Engine fire

Self explanatory.

Flight controls

Events which resulted from the failure of a flight control system or the failure or separation of a flight control surface. This category does not include events where a maintenance error or oversight affected a flight control system or component.

Forced landing (airport closed)

Self explanatory.

Fuel contamination

Self explanatory.

Fuel exhaustion

Events that resulted in fuel exhaustion for a variety of reasons, which include continued approaches to airports where the weather was not suitable for landing and other unknown reasons. Events which resulted in fuel exhaustion following navigational errors were categorized as “navigational errors.”

Fuel management

Events where the airplane had usable fuel remaining but for some reason the fuel system was not configured properly to access the fuel.

Fueling

Airplane damage events which were associated with airplane fueling operations.

Fuselage structure

Events which resulted from the failure of fuselage structure. Events which involved engine attachment, cabin/cargo doors, or gear failure (or failure to extend) are categorized separately.

Gear failure (or failure to extend)

Events where the landing gear failed and there was no other information available to explain why the gear failed. Events where the gear failed following a runway overrun or a hard or bounced landing are categorized separately. Additionally, events where the crew failed to extend the gear are categorized separately.

Gear up landing

Events where the flight crew failed to extend the landing gear.

Go-around procedures

Events which involved delayed or improperly executed go-around procedures.

Ice/Snow

Events which resulted from snow or ice contamination on the airframe or engine. Loss of directional control events during ground operations on snow or ice covered runways and taxiways are categorized under “loss of control (ground).”

Inability to climb

Events where the airplane was able to get airborne, but shortly after becoming airborne the airplane settled back to the ground. Information on these events is very limited. It is possible that these events involve overloading the aircraft or not having the flaps/slats in the correct position for takeoff, but without additional information a more definitive categorization could not be made.

Landed long/fast/overran runway

Events where the airplane was observed to have landed long or fast with insufficient runway available to come to a stop before departing (overrunning) the runway. Additionally, this

category includes events where the airplane overran the runway for reasons other than landing long or fast. Examples of such events include poor braking conditions (aquaplaning, snow or ice contamination) or failure to arm the ground spoilers.

Loss of control (flight)

Events where a loss of control occurred in flight for a variety of reasons that did not fit into other well defined categories.

Loss of control (ground)

Events where the airplane lost directional control during ground operations for unspecified reasons or for reasons that did not fit into other well defined categories.

Maintenance

Events where maintenance was not properly performed or completed, and this failure then directly contributed to the accident or incident. To help better describe this category, an event where there was a loss of control in flight which was caused by improper maintenance would be included in the “maintenance” category as opposed to the “loss of control (flight)” category, which would be considered to be representative of the effect rather than the primary originating event.

Midair collision

Self explanatory.

Miscellaneous mechanical failure

A variety of single events involving airframe system mechanical failures (brakes, hydraulics, wheels, etc.).

Multi-engine powerloss

Events where there was a multi engine powerloss where the cause could not be more specifically defined. Some of the events in this category could have involved fuel starvation/mismanagement, but sufficient information was not available to make such a determination with confidence.

Navigational error

Events involving navigational error. Events involving fuel exhaustion following navigational errors are included in this category.

Other

Miscellaneous single events that did not fit into other defined categories.

Personnel movement

Events where people were killed after being struck by a rotating propeller.

Preflight

Events where a failure to accomplish preflight activities was considered a primary contributor to an accident or incident. Events involving improperly secured cargo or loading the airplane outside of the center of gravity envelope are included in this category.

Propeller beta

Events where the crew selected in-flight propeller beta and this resulted either in engine damage (engine overspeed) or a loss of control due to asymmetric thrust where at least one propeller did not come out of the beta position.

Propeller system failure

Events which involved failure of a propeller blade, the propeller hub, the propeller control system, or the propeller gearbox.

Rejected Takeoff (RTO)

Events where the accident or incident was identified as being primarily the result of an RTO being conducted with insufficient runway remaining.

Runway incursion

Events where a collision occurred between two airplanes on a runway. The USAir accident at Los Angeles where two airplanes had been cleared onto the same runway (one landing, one preparing for takeoff) was included in this category. Events where two airplanes collided on a taxiway or on the ramp are included in the “struck object (ground)” category.

Storm damage (flight)

Self explanatory.

Storm damage (ground)

Self explanatory.

Struck object (ground)

Events where the airplane was damaged or destroyed during ground operations other than on a runway. Typical events included in this category are noted below. Events where an airplane was damaged because it struck an object during maintenance ground running of an engine are included in the “maintenance” category.

- A vehicle (tug, truck, etc.) struck the airplane.
- The airplane struck another airplane or vehicle.
- The airplane struck a building or extension of a building.

Takeoff procedures

Events where the takeoff procedures were not properly completed or followed and this was a primary contributor to an accident or incident.

Thrust reverser

Events where a thrust reverser deployed inflight or did not deploy during ground operations.

Tire failure

Self explanatory.

Turbulence

Self explanatory.

Uncontained engine failure

Self explanatory. This information is presented more in depth in the Part 33 section of this report.

Undershot runway

Events where the airplane touched down short of the runway threshold.

Unknown

Self explanatory.

Unstable landing

Events where an unstable (hard or bounced) landing was made. Typically an unstable landing resulted in a landing gear failure or an airplane departing the runway, which then lead to a gear failure.

Windshear

Self explanatory.

Appendix C - Pareto Charts

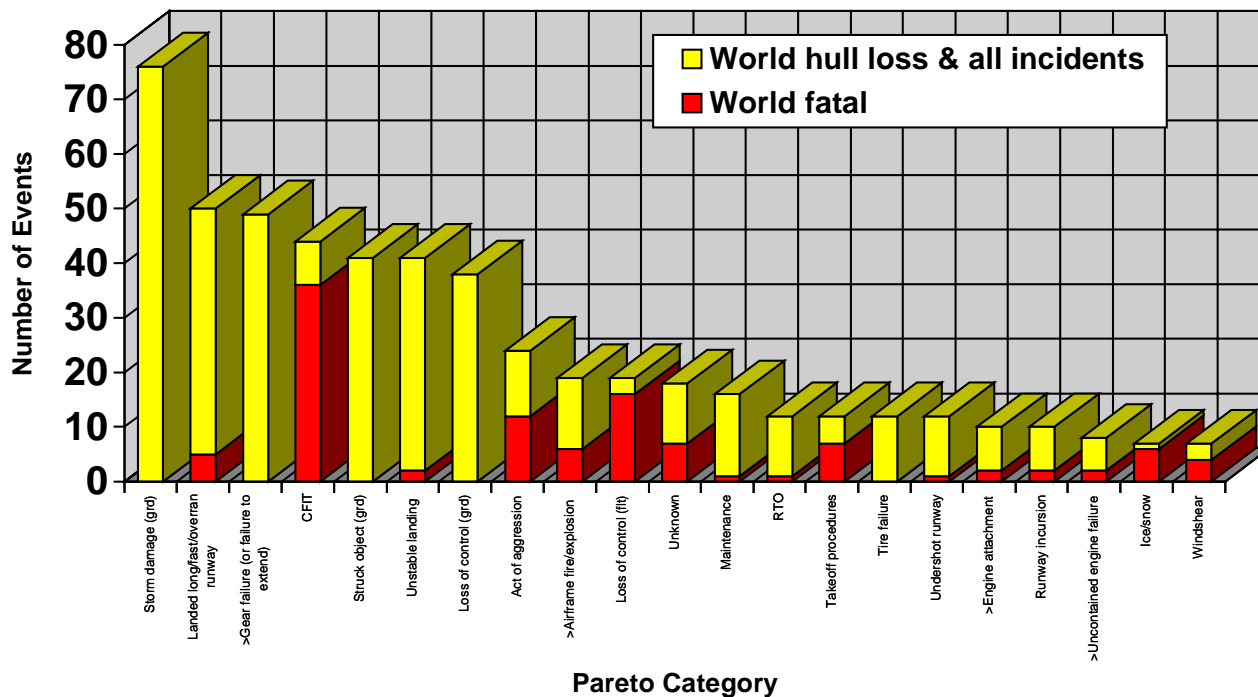
Insert Pareto Charts that Donna Syme has prepared for the presentation. The charts should be identified as noted below.

- “All Events” (turbofans/turbojets) charts - Chart 1&2
 - “Fatal Accidents, Hull Loss and Significant Incidents” (turbofan/turbojet) - Charts 3&4
 - “Fatal Accidents” (turbofan/turbojet) - Chart 5

 - “All Events” (turboprops) charts - Chart 6&7
 - “Fatal Accidents, Hull Loss and Significant Incidents” (turboprops) - Charts 8&9
 - “Fatal Accidents” (turboprops) - Chart 10
- “CFIT Events” (turbofan/turbojets & turboprops) - Chart 11

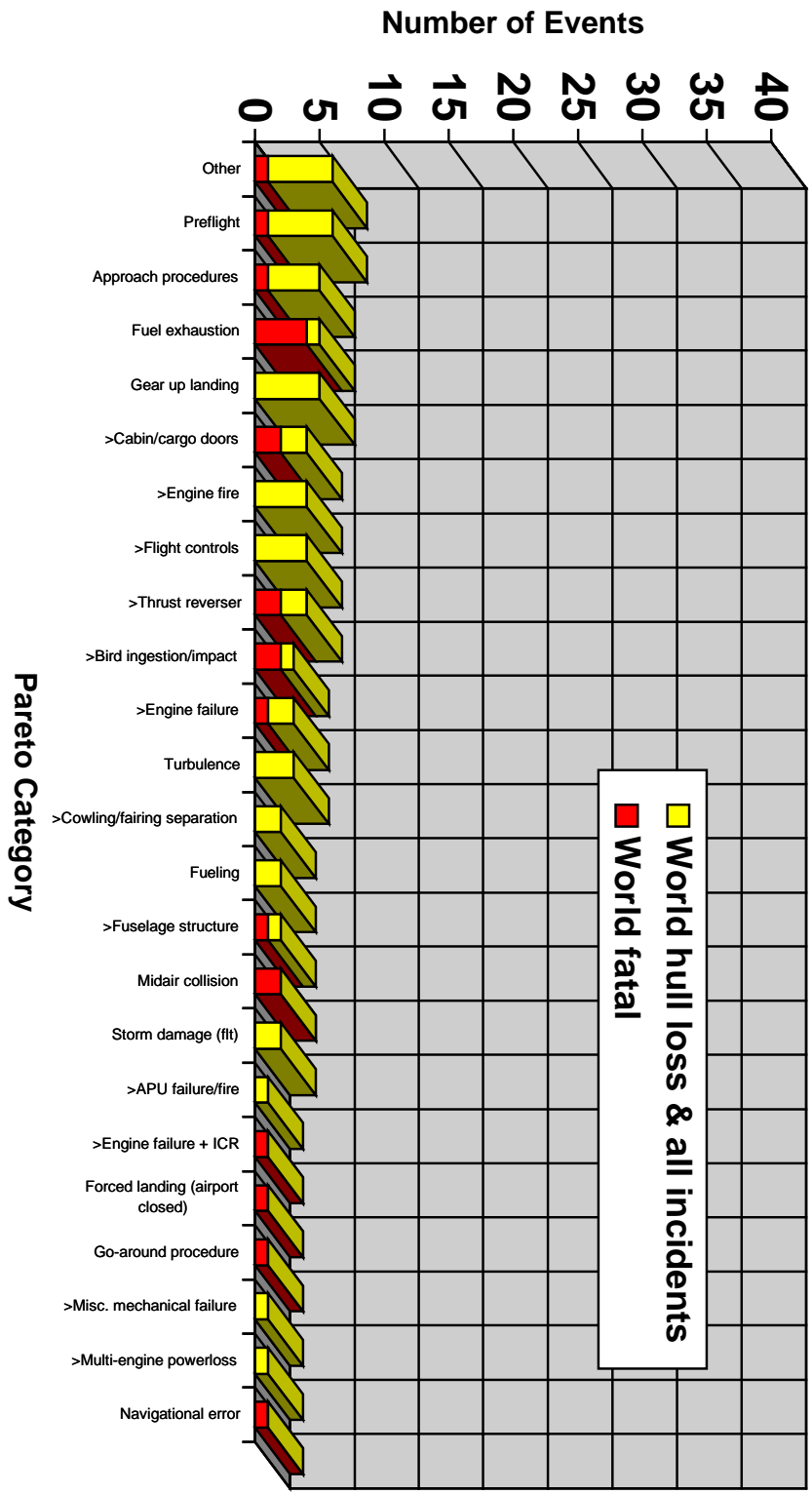
All Events

FAR 25 Turbofan/Turbojet Powered Airplanes, 1987 - 1996

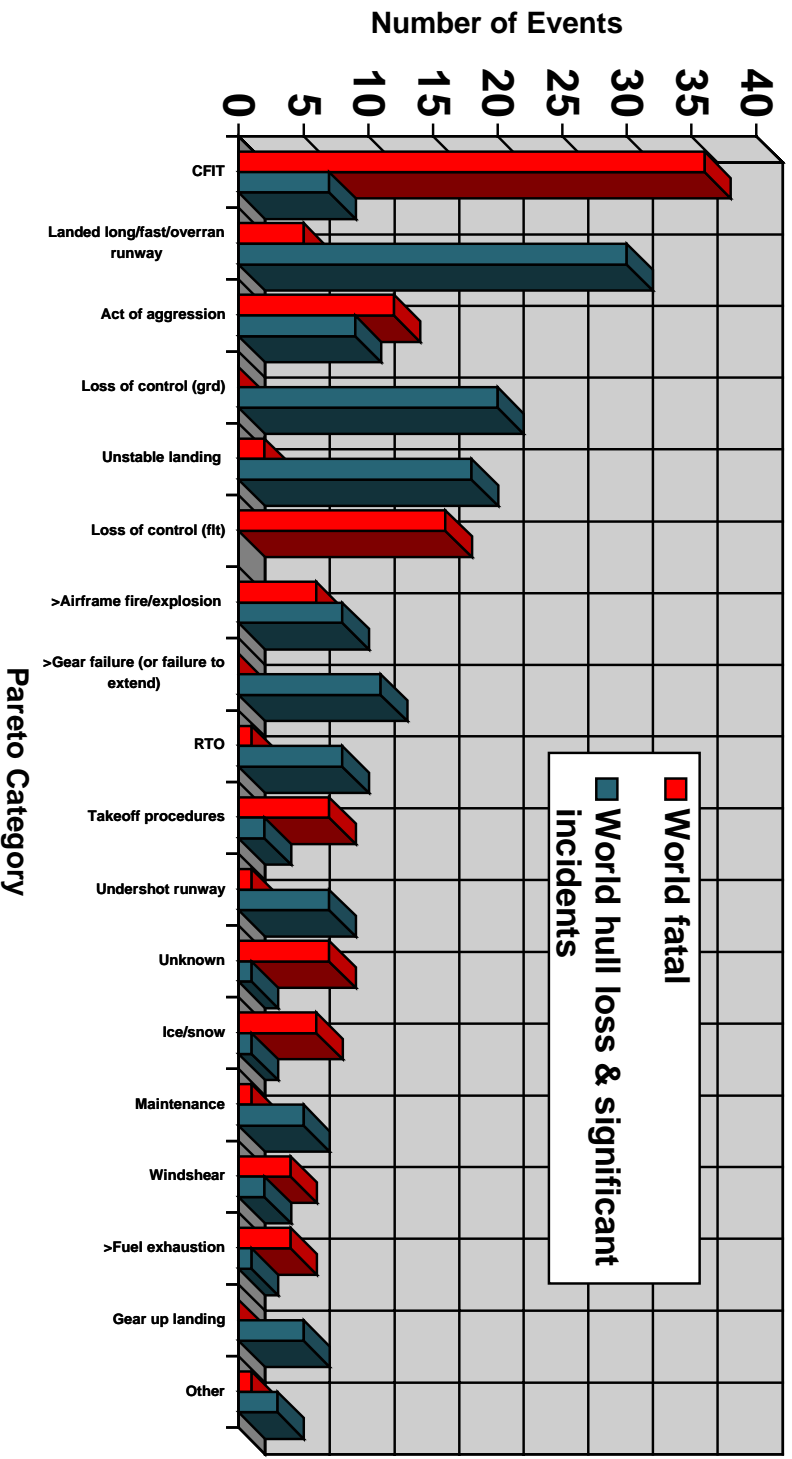


All Events (Cont.)

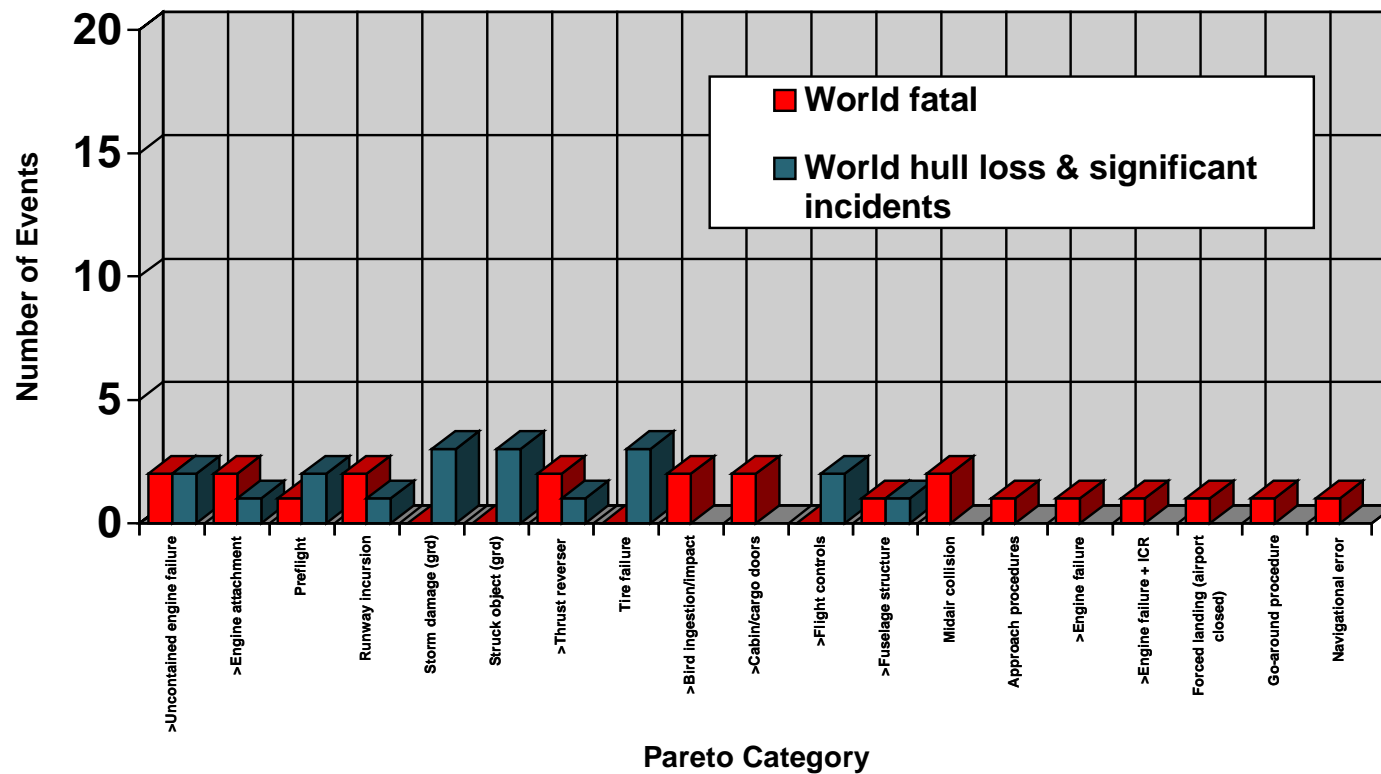
FAR 25 Turbofan/Turbojet Powered Airplanes, 1987 - 1996



Fatal Accidents, Hull Loss & Significant Incidents Turbofan/Turbojet Airplanes, Airclaims, 1987 - 1996



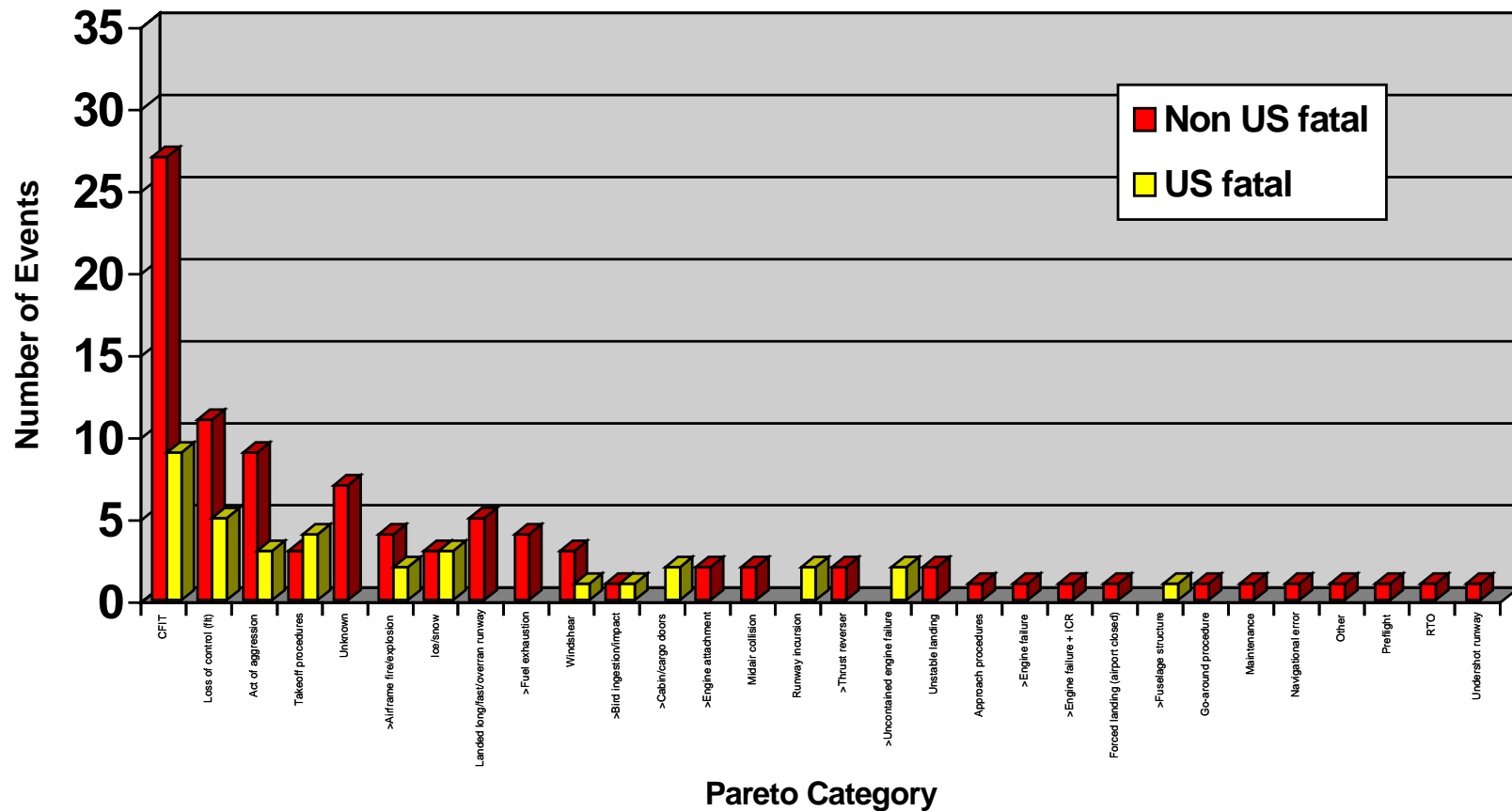
Fatal Accidents, Hull Loss & Significant Incidents Turbofan/Turbojet Airplanes, Airclaims, 1987 - 1996 - (Cont.)



Fatal Accidents

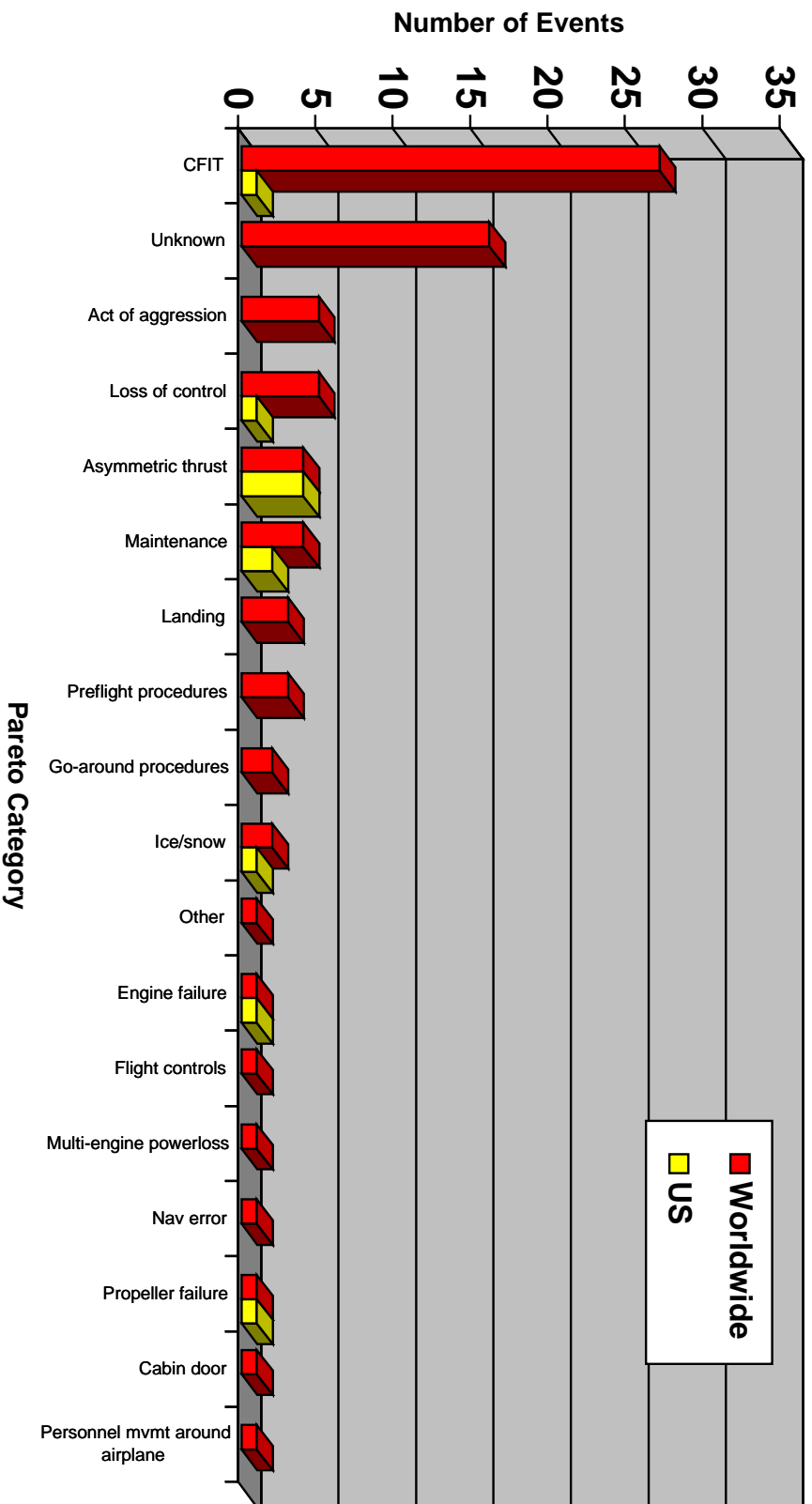
Turbofan/Turbojet Powered Airplanes

Airclaims, 1987 - 1996



Fatal Accidents

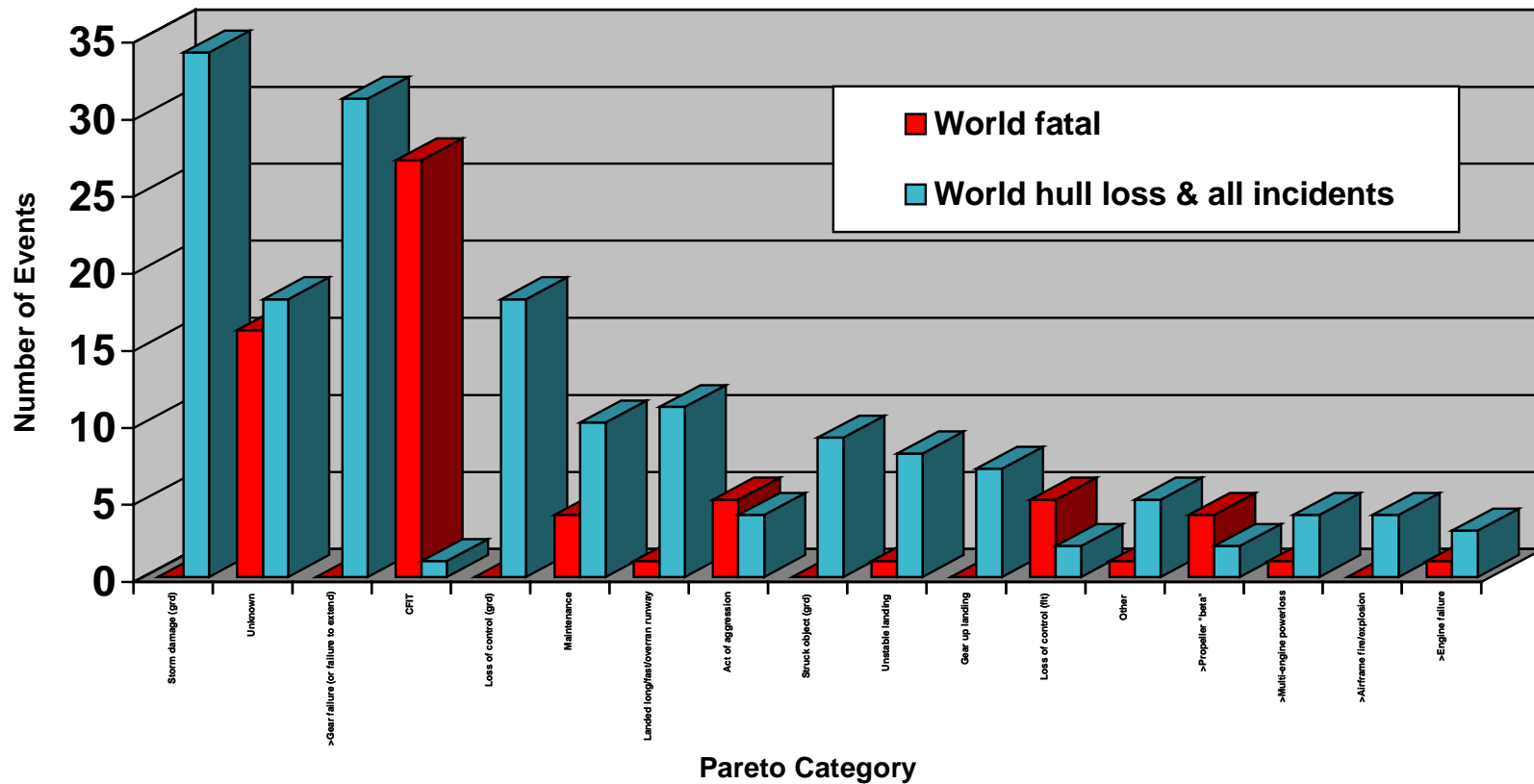
FAR 25 Turboprop Powered Airplanes, 1987 - 1996



All Events

Turboprop Powered Airplanes

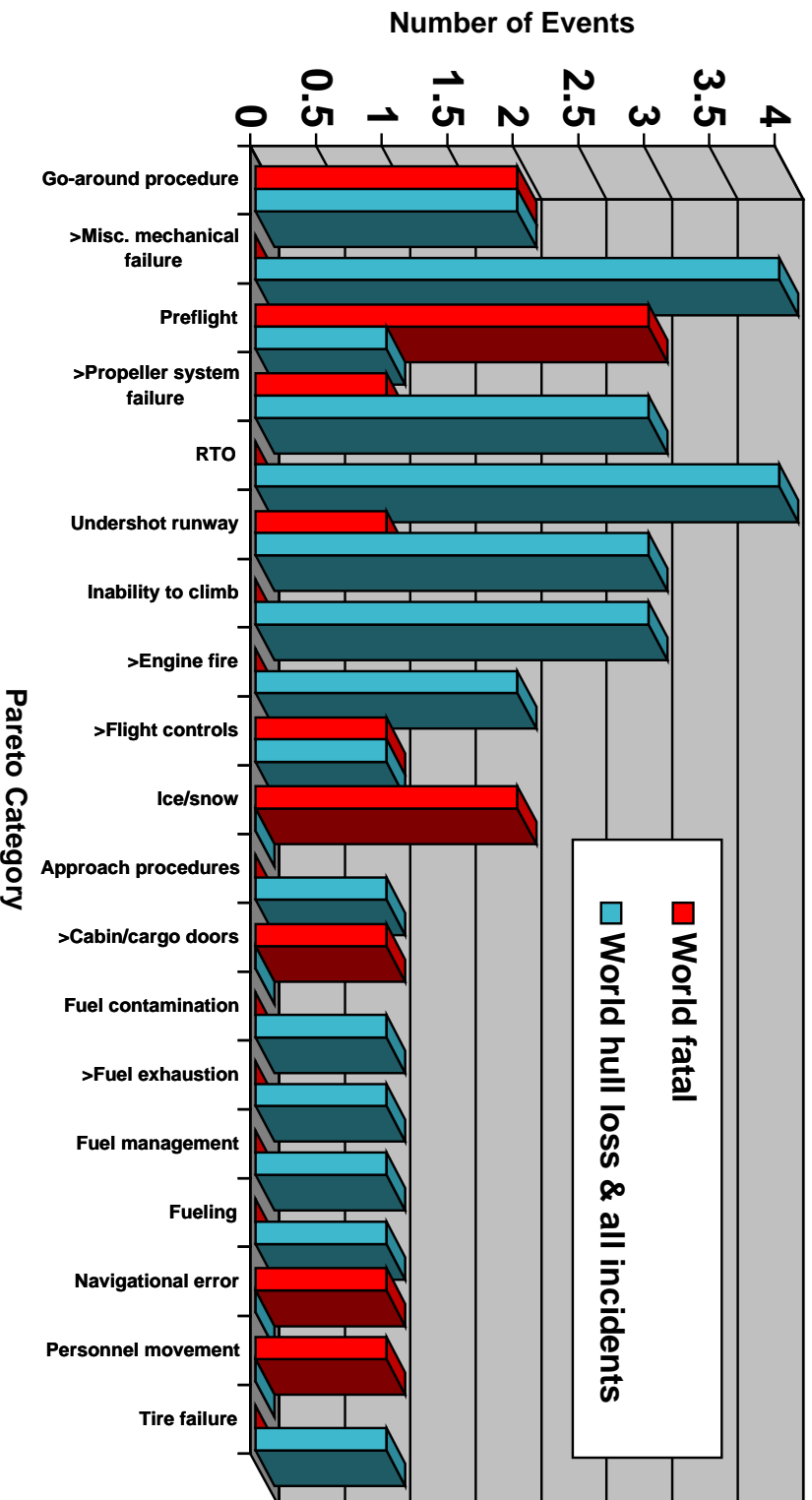
Airclaims, 1987 - 1996



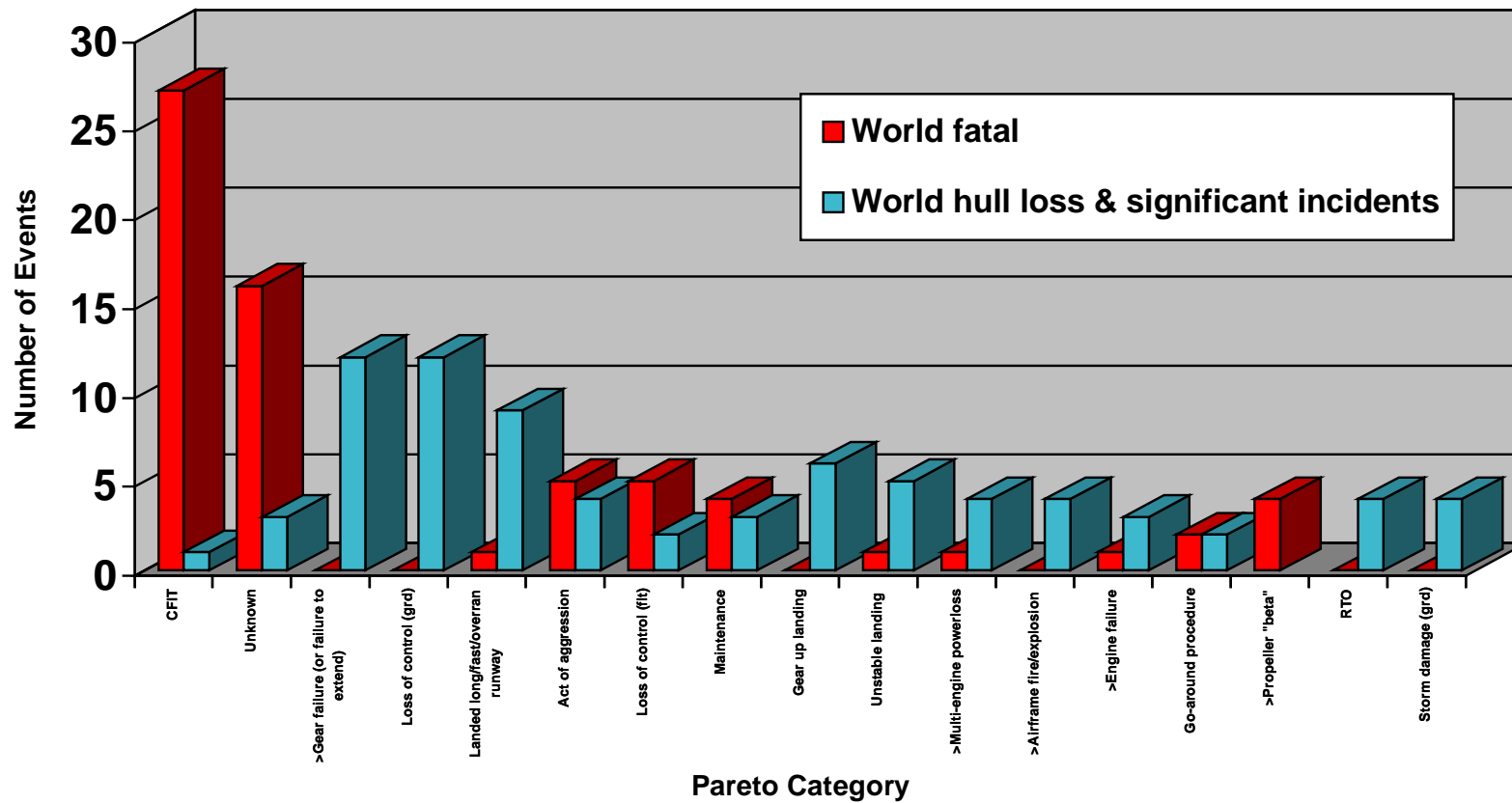
All Events - (Cont.)

Turboprop Powered Airplanes

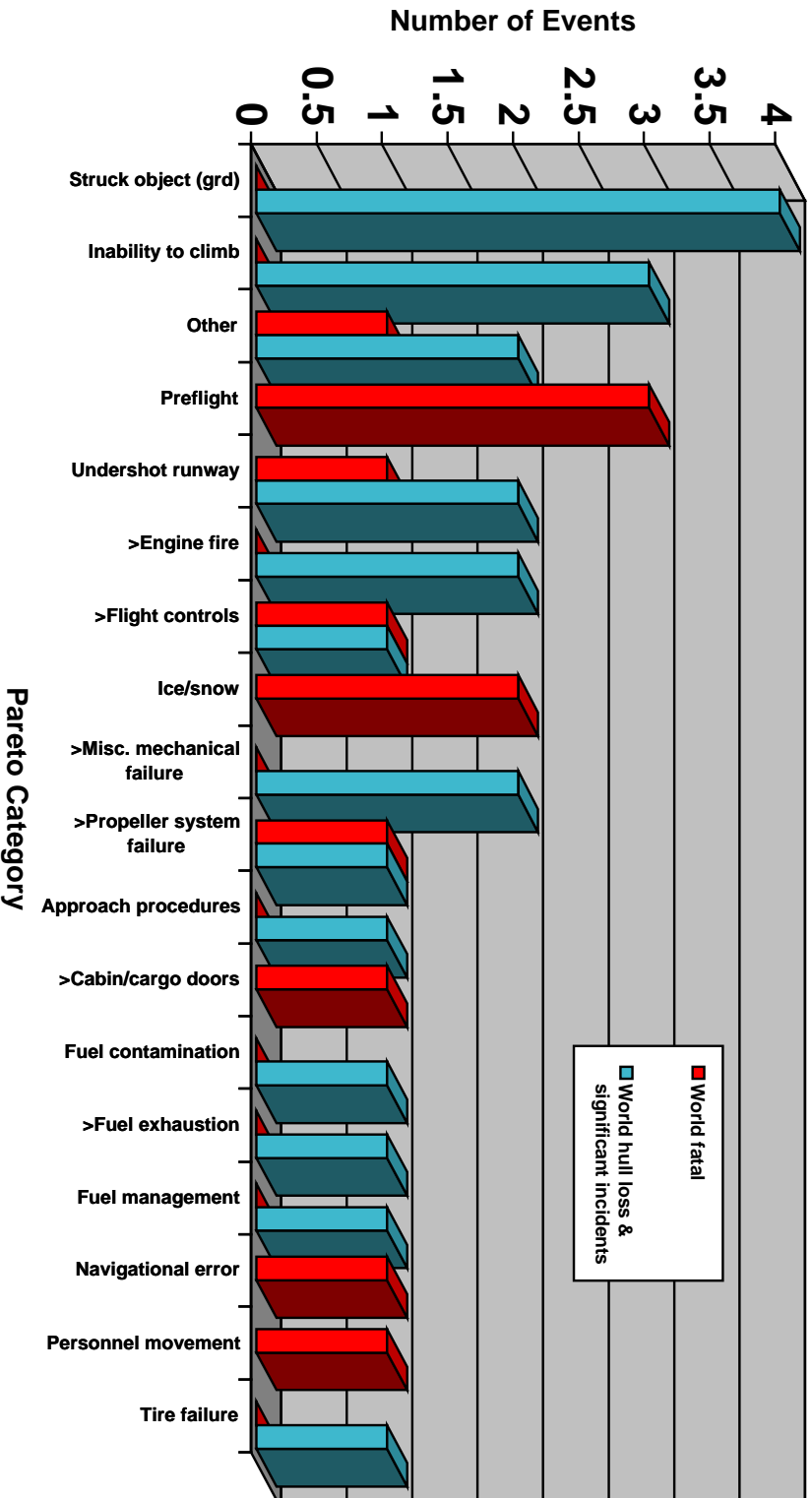
Airclaims, 1987 - 1996



Fatal Accidents, Hull Loss & Significant Incidents Turboprop Powered Airplanes Airclaims, 1987 - 1996



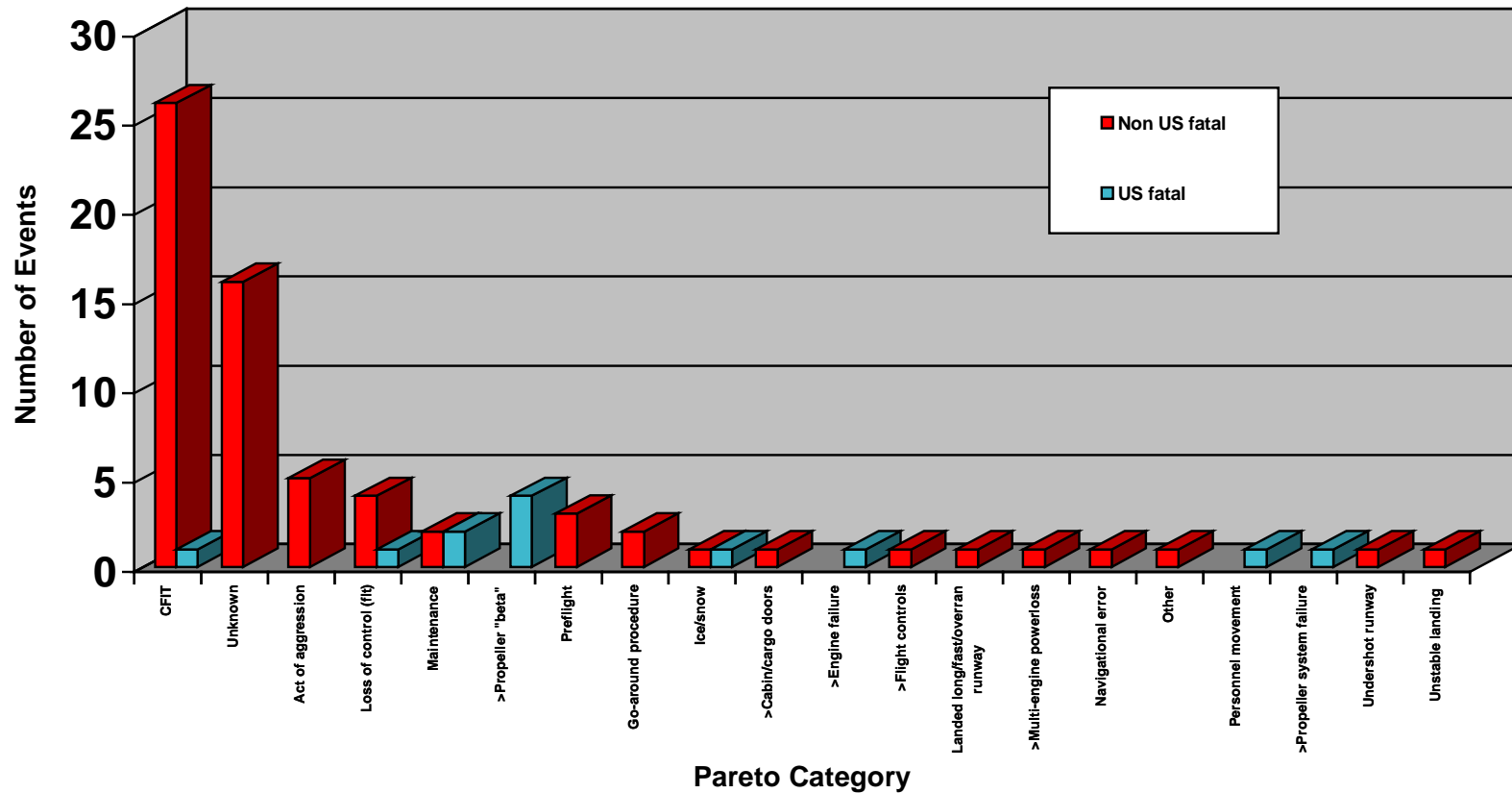
Fatal Accidents, Hull Loss & Significant Incidents Turboprop Powered Airplanes Airclaims, 1987 - 1996 - (Cont.)



Fatal Accidents

Turboprop Powered Airplanes

Airclaims, 1987 - 1996

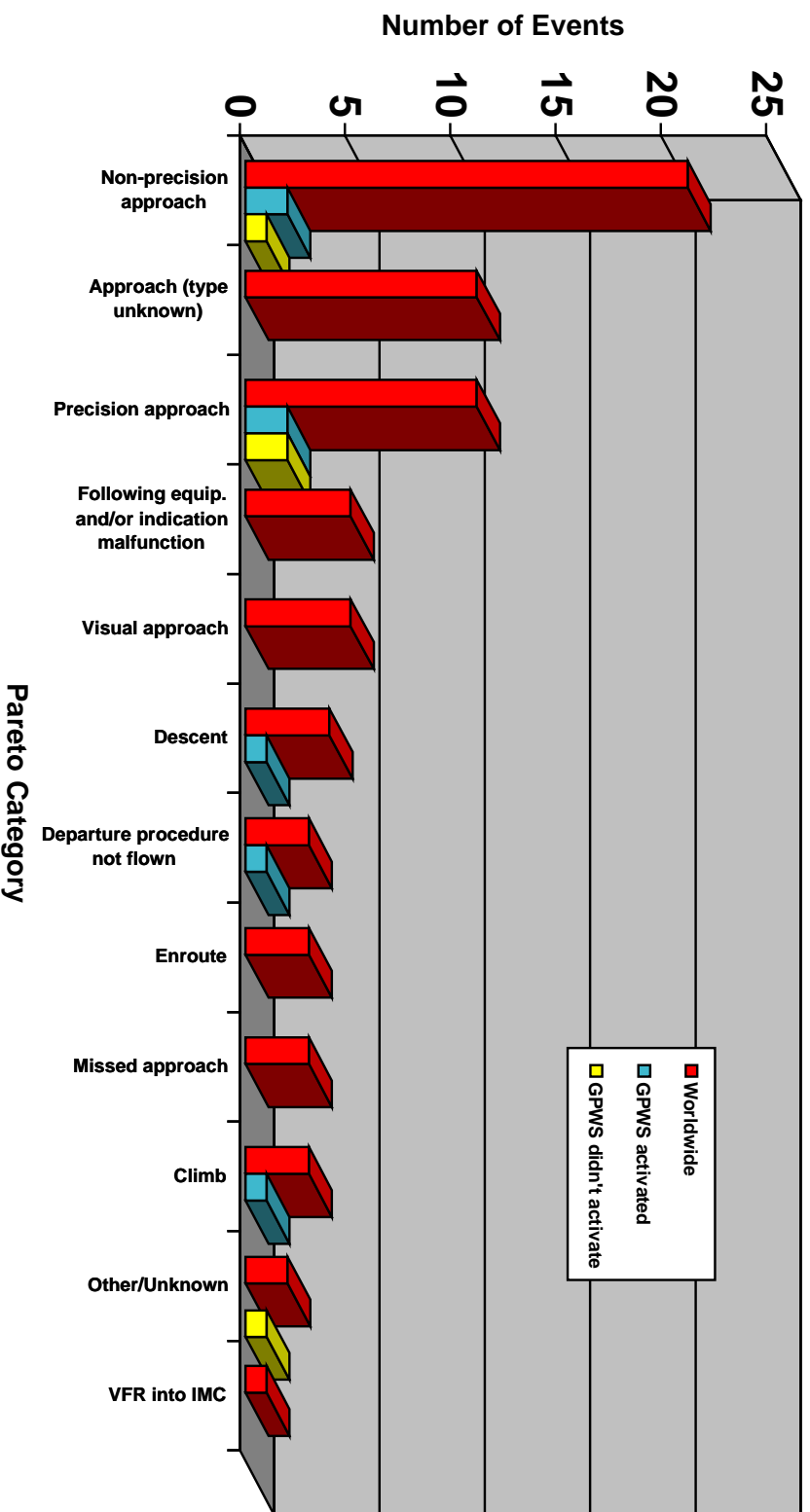


CFIT Events

Turboprop/Turbojet & Turboprop Powered Airplanes

Airclaims, 1987 - 1996

(63 of 72 Fatal)



Appendix D

**Table 1 - FAR 25 Accident Prevention/Intervention Activities
(Pareto fatal accident categories)**

	Operations rule changes	FAR 25/33/35 Rule changes	Policy/ proposed policy changes	R & D activity	Other FAA activities	Industry activities/ Comments
Controlled Flight Into Terrain	Notice of Proposed Rulemaking (NPRM) for enhanced ground prox. system			Yes	- Human Factors Team Report (6/96)	- International task team (FSF, ICAO, IFALPA) - Further emphasis
Acts Of Aggression				Yes	- FAA to adopt ICAO annex 8 changes within 2 years	
Loss of Control (Flight)				Proposed, not funded	- Human Factors Team Report (6/96) - 737 flight control CDR team	- International task team - upset recovery (FSF) - Further emphasis
Airframe Fire/Explosion	Class D/C cargo (NPRM)	Class B cargo (ARAC)		Yes		- DoT has banned shipment of O ₂ canisters
Unknown	Digital Flight Data Recorder final rule (7/97)					- Specify power requirements for DFDR
Midair Collision	Require TCAS for cargo airplanes					- TCAS III under development
Thrust Reverser & Propeller “Beta”			FAA/AIA thrust reverser safety assessment criteria		- Human Factors Team Report (6/96) - Propulsion system malfunction plus inappropriate crew response working group	- International Task Team - upset recovery (FSF)

	Operations rule changes	FAR 25/33/35 Rule changes	Policy/ Proposed policy changes	R & D activity	Other FAA activities	Industry activities/ Comments
Takeoff Procedures					- Human Factors Team Report (6/96)	- Further emphasis
Ice/Snow		Terms of Reference for FAR 25 App C	AC 25.1419 (future activity)	Yes	- FAA Inflight Aircraft Icing Plan (4/97)	
Preflight Procedures					- Human Factors Team Report (6/96)	- Further emphasis
Windshear			Draft AC	Yes	- Human Factors Team Report (6/96)	
Uncontained Engine Failure				Yes	- Titanium Consortium - Enhanced inspections - Damage tolerant designs	- Refer to ANE specific plan
Fuel Exhaustion		Potential (priority problem)			- Human Factors Team Report (6/96)	- Proceed with rulemaking
Approach Procedures					- Human Factors Team Report (6/96)	-International Task Team - approach & landing (Boeing, NASA, NTSB, FAA-AFS) - Further emphasis
Maintenance						

	Operations rule changes	FAR 25/33/35 Rule changes	Policy/ Proposed policy changes	R & D activity	Other FAA activities	Industry activities/ Comments
Unstable Landing					- Human Factors Team Report (6/96)	-International Task Team - approach & landing (Boeing, NASA, NTSB, FAA-AFS) - Further emphasis
Bird Ingestion/ Impact		FAR 33.76			-Engine Harmonization Working Group	- Refer to ANE specific plan for engine issues
Flight Controls		Terms of Reference for jammed flight controls				
Engine Failure “Plus” Inappropriate Crew Response					- Human Factors Team Report (6/96) - Propulsion system malfunction plus inappropriate crew response working group	- Further emphasis
Landed Long/Fast/ Overran Runway					- Human Factors Team Report (6/96)	-International Task Team - approach & landing (Boeing, NASA, NTSB, FAA-AFS) - Further Emphasis
Go-Around Procedures					- Human Factors Team Report (6/96)	-International Task Team - Further emphasis

	Operations rule changes	FAR 25/33/35 Rule changes	Policy/ Proposed policy changes	R & D activity	Other FAA activities	Industry activities/ Comments
Runway Incursion					- Human Factors Team Report (6/96)	-International Task Team
Other						
Navigation Error					- Human Factors Team Report (6/96)	
Engine Attachment						
Cabin/Cargo Door						
Propeller System Failure		Part 35 (JAA Harmonization)			- Aging Propeller Program	- Refer to ANE specific plan
Undershoot Runway					-Human Factors Team Report (6/96)	-International Task Team - approach & landing (Boeing, NASA, NTSB, FAA-AFS) - Further emphasis
Multi-Engine Powerloss		FAR 33.78	Improved Guidance	Yes	- Rain/Hail Team	- Refer to ANE specific plan
Fuselage Structure				Yes	- Aging Aircraft Program	
Rejected Takeoff		V _r rule 93-8			- Human Factors Team Report (6/96)	- Complete Rulemaking
Personnel Movement Around Airplane						



U.S. Department
of Transportation
**Federal Aviation
Administration**

Memorandum

Subject: INFORMATION: Transport Airplane Accident Course Development Proposal Date:

From: Manager, Seattle Aircraft Certification Office
Propulsion Branch, ANM-140S Reply to 97-140S-126
Attn. of:

To: Manager, Transport Airplane Directorate, ANM-100
THRU: Manager, Seattle Aircraft Certification Office,
ANM-100S

The purpose of this memorandum is to provide a proposal for the development of a course intended to train Aircraft Certification Service (AIR) personnel on the causes of major aircraft accidents and the resulting changes to regulations and policies. In response to item No. 8 of the Aircraft Certification Management Team (ACMT) meeting notes, dated February 11-14, Mr. McSweeney (AIR-1) challenged each ACMT member to report back to headquarters, within three to four months, with two items intended to increase the level of safety (presumably of the current transport airplane fleet) by ten-fold. He further allowed the plans could be five year efforts, and that the Transport Airplane Directorate would take the lead in the area of human factors. I recommend that this course development be considered as one of these safety improvement proposals.

During the last ten years or so, the Seattle Aircraft Certification Office (SACO) has observed a significant reduction in the experience level of our workforce. While there does not seem to be a single reason for this transformation, based upon discussions with our counterparts at other AIR offices, it seems to be occurring to a similar degree within those offices as well. When a 20 to 30 year experienced person leaves our office, we often find ourselves replacing this individual with an employee with no Federal Aviation Administration (FAA) experience and five to seven years industry experience. We also find that these new employees frequently do not have the "corporate knowledge" relative to transport airplane history, particularly with regard to accident causes. This seems to be true regardless of the company the new employee comes from. We find that much of our training and mentoring involves reviewing past accidents and their relevance to the Federal Aviation Regulations and related policy. This also seems to be a subject in which the new employee expresses keen interest.

An in-depth "accident causes" course for major aircraft accidents would provide the Aircraft Certification Service personnel with needed insight as to the elements of unsafe conditions. In addition, by becoming more knowledgeable of the origins of our regulations, these personnel would be in a better position to apply the regulations and policies correctly, interpret the significance of service data, and be more proactive in initiating corrective actions.

In viewing where we are as an organization and the challenges we have with respect to a projected three-fold increase in world wide air travel in the next two decades, it appears that some significant steps will need to be taken in order to prevent a rise in the number of accidents. An overall awareness as to the causes of yesterday's major accidents could be considered as one step in a series of steps towards meeting this challenge. I would envision that this course would differ from our existing accident investigation course in that it would concentrate on the causes of accidents, corrective actions taken, and changes to our regulations or policies, rather than focus on the investigation process. This course could initially concentrate on

transport airplanes, and later be expanded to include other types of aircraft. I would recommend that the course not be broken into particular disciplines since I believe it is important for all of us to have a broad understanding of the elements of safety and what factors exist when things go wrong.

I have discussed this course with others within our office as well as some of our customers in industry. As far as I have been able to determine, no such course currently exists. I would also expect that, based upon these discussions, this type of instruction would be very well received by the AIR workforce. It could also benefit other elements within the FAA since many important accidents have been shown to cut across multiple lines of business such as Air Traffic Control, Airports, and Flight Standards. With the expanding complexity of aircraft and the integration of their systems, it is becoming increasingly important for all of us in the field of safety to understand the interrelationship of safety issues.

In summary, if the ACMT would consider such a course to be of value, I would welcome the opportunity to work with the technical training steering committee or other appropriate groups in its development. For reference, attached is a partial listing of certain transport airplane accidents which have resulted in significant changes to our regulations, policies, or both. Although extensive research would be required in order to identify the major issues related to these accidents, I believe that the effort would be worth the investment.

Daniel I. Cheney

Attachment

Appendix E

EXAMPLES OF MAJOR TRANSPORT AIRPLANE ACCIDENTS WHICH HAVE HELPED SHAPE CIVIL AVIATION REGULATIONS AND POLICIES

Ford Tri Motor in U.S.-1930 (engine failure on takeoff)
TWA L1049/UAL DC-7 near Grand Canyon-1956 (enroute ATC)
Braniff L-188 near Buffalo, Texas-1959 (propeller whirl mode)
U.S. operator/Viscount in Maryland-1962 (bird strike to tail)
Northwest L-188 near Cannelton, Indiana-1960 (propeller whirl mode)
Eastern L188 at Boston-1960 (bird ingestion to engines)
Pan Am B707 near Elkton, Maryland-1963 (lightning strike to fuel tanks)
United B727 at Salt Lake City-1965 (stretchable fuel lines)
Pan Am B707 at San Francisco-1965 (rotor burst)
Mohawk BAC1-11 in United States-1967 (APU inlet fire)
U.S. carrier B727 at Los Angeles Int. Airport-1969 (human factors, cockpit switches)
Air Canada DC8 near Malton, Ontario-1970 (human factors, spoilers)
Eastern L-1011 near Miami-1972 (human factors, ATC)
VARIG B707 near Paris-1973 (smoking/waste bin fire in lavatory)
Turk Hava Yollari DC-10 near Paris-1974 (pressure relief, human factors)
Lufthansa B747 near Nairobi-1974 (takeoff warning, human factors)
TWA B727 near Berryville, Virginia-1974 (human factors, ground prox.)
Eastern B727 near New York City-1975 (wind shear)
KLM B747/Pan Am B747 at Tenerife-1977 (human factors, ATC)
Southern Airways DC-9 near Atlanta, Georgia-1977 (rain ingestion to engines)
Pacific Southwest Airlines B727 at San Diego, California-1978 (human factors, TCAS)
United Airlines DC-8 near Portland, Oregon-1978 (human factors, low fuel warning)
American Airlines DC-10 at Chicago, Illinois-1979 (system isolation, human factors)
Saudia L-1011 near Riyadh, Saudi Arabia-1980 (interior fire, human factors)
Air Florida B737 at Washington DC-1982 (human factors, airframe/engine icing)
British Airtours 737 at Manchester, England-1985 (fuel tank access covers)
Delta L-1011 at Dallas, Texas-1985 (wind shear)
Japan Air Lines B747 near Tokyo-1985 (system isolation, pressure venting)
Mexicana B727 near Maravatio, Mexico-1986 (wheelwell fire)
Northwest DC-9 at Detroit-1987 (human factors, takeoff warning)
South African Airways B747 in Indian Ocean-1987 (cargo compartment fire)
Aloha Airlines B737 in Hawaii-1988 (structural corrosion)
American Airlines DC-10 at Dallas Ft. Worth-1988 (brake wear)
TACA B737 near New Orleans, Louisiana-1988 (hail ingestion to engines)
United Airlines 747 in Hawaii-1989 (structural inspection)
United Airlines DC-10 near Sioux City, Iowa-1989 (system isolation, engine inspections)
USAir Jetstream 3100 at Beckley, W. Virginia-1991 (tail plane icing)
Lauda B767 near Bangkok, Thailand-1991 (thrust reverser in-flight deployment)
American Eagle SF340 near New Roads, Louisiana-1994 (propeller beta in flight)
Simmons Airlines ATR-72 near Roselawn, Indiana-1994 (freezing rain)
ValueJet DC-9 near Miami-1996 (haz. mat., cargo fire protection)



ROTORCRAFT

Data

The SAT considered all rotorcraft accidents/incidents for the period of 1983 through the most current available for 1997. Consequently, there are ongoing investigations and no cause assigned in some cases.

All Pareto Charts are derived from data retrieved from the FAA's Accident/Incident Information database, which is derived from the NTSB reports. The data was not broken into specific operating environments, but only subdivided as to Part 27 (normal category) or Part 29 (transport category). The SAT obtained additional data from NASDAQ information and the Helicopter Association International (HAI).

Analysis

Rotorcraft Missions

Rotorcraft operate in environments that are unique and are normally more hazardous because of the specific mission. In particular, external load operations, agricultural operations, fire fighting operations, power line patrol/repair, search and rescue operations, cattle herding, predator/nuisance animal eradication, and public use by law enforcement agencies, Forestry Service, Drug Enforcement Agency, and others. It seems the helicopter use is only limited by an operator's imagination. There are other operating environments which on the surface would not appear to be an hazardous environment such as emergency medical service (EMS) operations, transporting workers to and from off shore oil rigs, sightseeing, and others. But in fact, they can and are more hazardous than the typical air taxi environment.

Risk Factors

In order to develop Pareto charts that would reflect the broad spectrum of primary causes and develop Paretos that would show areas for proactive solutions, the SAT determined a "risk" factor. The SAT considered the fatal accidents and the injury accidents by calculation of "K" factors. For instance, K_{fatal} was determined by the total number of accidents divided by the total number of fatal accidents. Likewise, K_{inj} is the total number of accidents divided by the total number of injury accidents. The "Risk" number is then derived based on the summation of fatal accidents and injury accidents, each multiplied by the appropriate K factor. The "Risk %" is calculated based on the "Risk" number divided by the total "Risk". The SAT assumes that based on the available data,

these are the top causes for accidents that have or could have a probability of fatalities or serious injuries.

The Pareto Charts are developed for all rotorcraft and further expanded for Part 27 and Part 29 rotorcraft. While there are some differences between the two category of rotorcraft, they are very similar in accident causes.

Accident Primary Causes

The SAT determined the following primary causes for accidents in all rotorcraft, with references to applicable FAR Parts 27 and 29:

- Object Avoidance- failure to avoid objects, external load contact with objects such as trees, powerlines, etc., and rotorcraft contact with power lines, oil rigs, fences, trees, boats, buildings. (27 and 29)
- Improper Flight Control - improper operation of flight controls in the air, such as failure to maintain altitude and buzzing. (27 and 29)
- Collision with Ground or Water- failure to avoid collision with ground or water, caused by failure to maintain altitude, spatial disorientation due to flying over glassy water. (27 and 29)
- Low Rotor RPM- failure to maintain rotor RPM, caused by lack of pilot training, improper autorotation, overstress due to external loads, pilot failing to check warning lights, loss of rotor RPM for undetermined reasons. (27 and 29)
- Turboshaft Engine Failures. (27 and 29. This subject is addressed in depth in the Report section on Part 33)
- Inadequate Preflight Inspection - inadequate inspection of the rotorcraft during preflight, with results such as water, dirt, frog in fuel tanks, water or other fuel contamination, not draining sump prior to flight, leaky fuel caps, fuel filter by-pass switch inoperable, miscellaneous doors (fuselage, battery, engine cowling) departing during flight due to not being properly secured, failure to remove all skid tiedowns, snow/ice accumulation. (27 and 29)
- Poor Pilot Judgment -VFR landing in IFR conditions, autorotated into trees, encountering turbulence while carrying an unloaded external hook line, takeoff after tail rotor contact on landing without proper inspection, exceeding recommended velocity, exceeding maximum gross weight, too low altitude for safe auto rotation, unauthorized overhaul, low flight over water. (27 and 29)
- Poor Preflight Planning/Fuel Quantity- fuel exhaustion.(27 and 29)

- Reciprocating Engine Failures. (27. This subject is addressed in depth in the Report section on Part 33)
- Fuel Control System Failures. (27 and 29)
- Tail Rotor Driveshaft Failures- Tail Rotor Driveshaft failures due to fatigue, corrosion, separation, improper maintenance, improper inspection, FOD. (27 and 29)
- Inadequate Preflight Planning Regarding Rotorcraft Performance- inadequate preflight planning affecting rotorcraft performance. (27)
- Enroute Judgment Errors- enroute chip light warning ignored and then airport bypassed, low and slow for autorotation after perceived power loss. (27)
- Loss of Control due to Weather- VFR into IMC. (27 and 29)
- Main Rotor Blade System Failure- Main Rotor Blade System failures due to fatigue, corrosion, dry rot, blade delamination, FOD, overstressed blades by unlicensed pilot, improper maintenance. (27)
- Improper Level-off - improper level-off, such as landing on one skid resulting in ground resonance, lightly landing on skids and beginning oscillations until skid collapse, didn't extend floats in water landing, hard landings with catastrophic consequences such as tail boom severed, main rotor blade contact fuselage, hard landings on boats as boat pitches up, over rotated during autorotation flare. (27)
- Failure to See and Avoid- midair collisions. (29)
- Engine/Transmission Coupling- engine/transmission coupling worn beyond use, torque bolt failure, improperly secured coupling, metal fatigue. (27)

Intervention Strategies

The SAT divided its recommended intervention strategies into two parts, human factors related interventions, and engineering related interventions.

Human Factors Interventions

- Increase level of helicopter training, specifically autorotations.
- Improve preflight procedures, specifically fuel planning and checking for contamination.
- Increased operational oversight
- Improved human/machine interface

Engineering Interventions

The SAT subdivided its engineering interventions into three parts:

Tail Rotor Systems

- Improved inspection criteria
- Re-evaluation of life limits based on operating environment
- Damage tolerant design
- Health Usage & Monitoring System (HUMS)

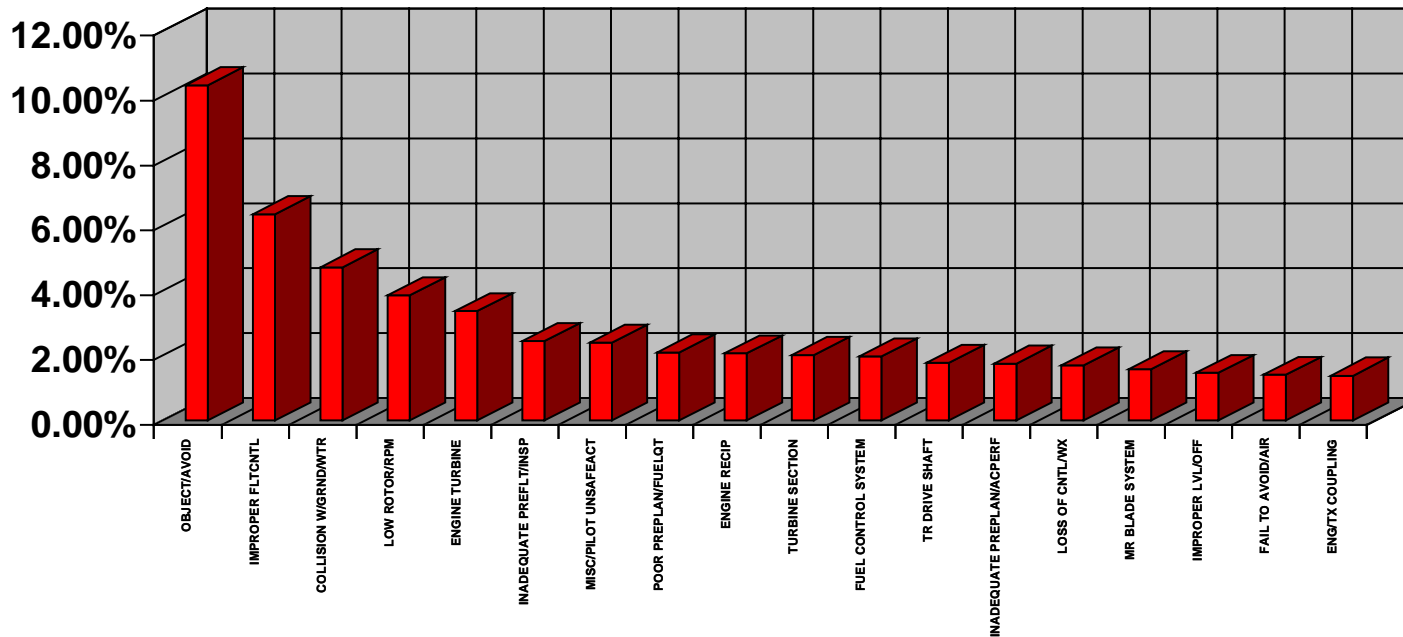
Main Rotor Systems

- Improved inspection criteria
- Re-evaluation of life limits based on operating environment
- Damage tolerant design
- HUMS

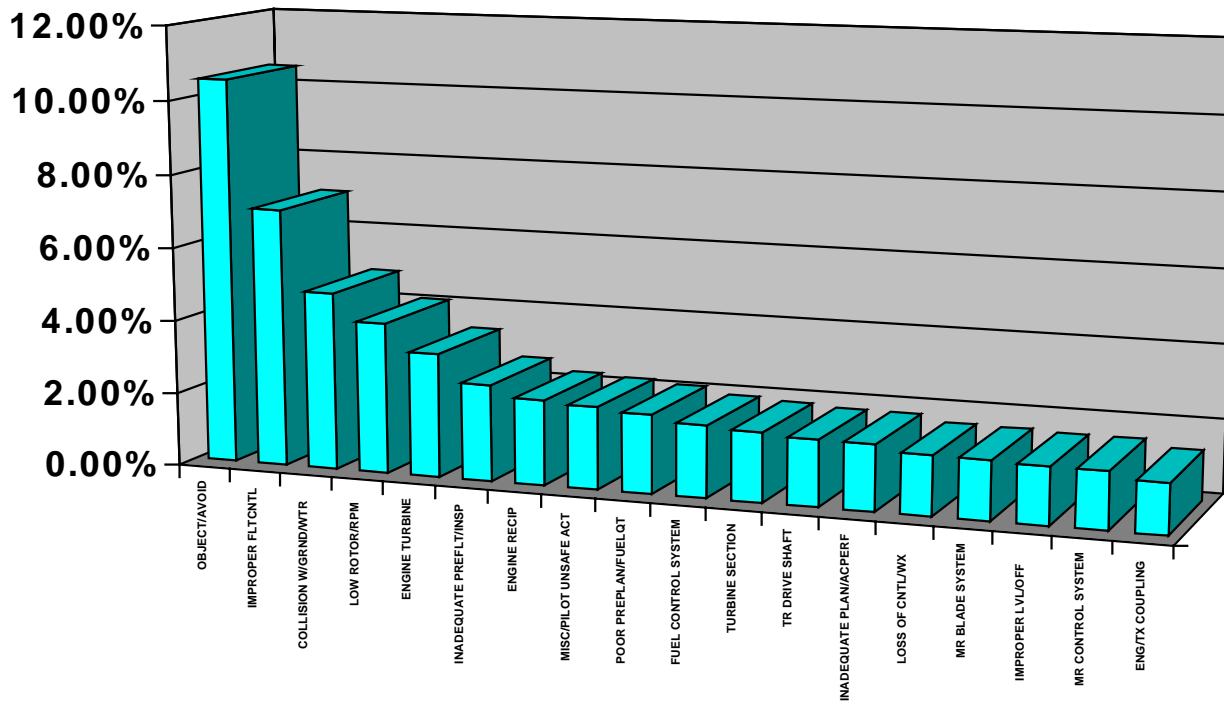
Engine/Transmission Couplings

- Improved inspection criteria
- Simplified installation procedures
- Accounting for multiple torque excursions (external load) in fatigue analysis
- Reducing inspection intervals on older aircraft

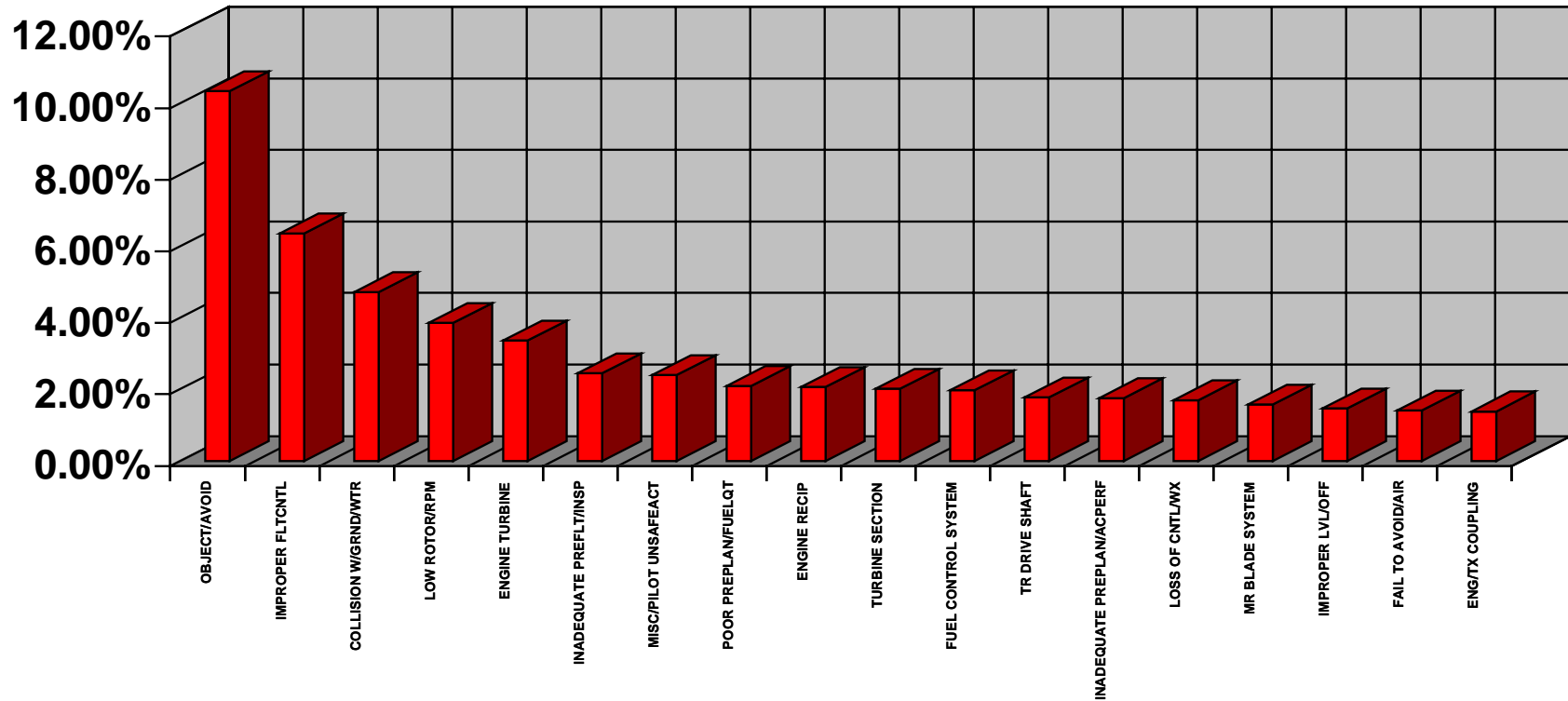
Accidents/Incidents - All Helicopters by Primary Causes (1983-1997)



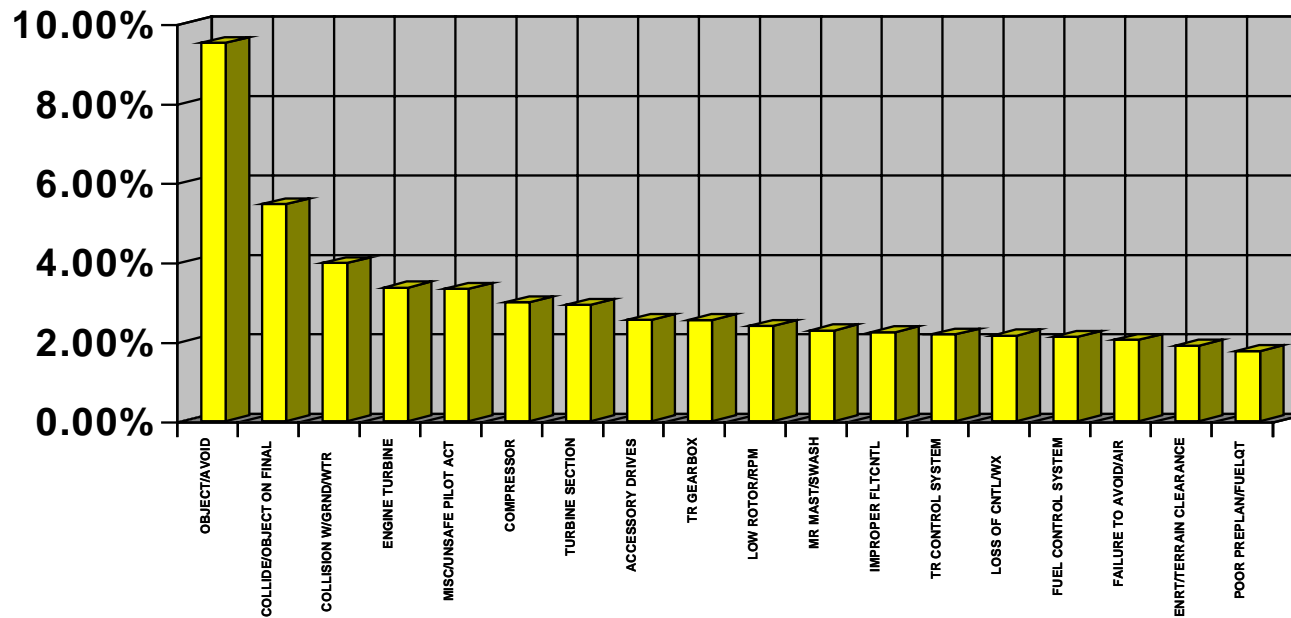
Accidents/Incidents for Part 27 Helicopters by Primary Cause (1983-1997)



Accidents/Incidents - All Helicopters by Primary Causes (1983-1997)



Accidents/Incidents for Part 29 Helicopters (1983-1997)





Small Aircraft

Data

The SAT found only two databases used for accident data gathering for general aviation aircraft: The NTSB database and the FAA Accident/Incident database. The SAT's primary tool for analysis is the *Nall Report* provided annually by the Aircraft Owners and Pilot's Association (AOPA) Air Safety Foundation (ASF). In addition, in 1991, the ASF published a detailed accident analysis, *General Aviation Accident Analysis Book*, that analyzed 16,220 small airplane accidents that occurred between 1982 and 1988. This book is the only comprehensive General Aviation (GA) analysis of its kind and the SAT used it as the core data source for analyzing causal factors.

Analysis

Fatal Accidents

In order to produce a manageable, timely study, the SAT limited its research into GA accidents to only events where there was at least one fatality. In the other sections of this report, less severe events have been tabulated into the data, but due to the higher total number of GA accidents, the SAT decided to review only fatal accidents.

Breakdown of Data

The *Nall Report* concentrates on the phase of flight that initiated the sequence of events that resulted in the accident. This phase of flight is often referred to as "first occurrence." The *Nall Report* is intended to help pilots prevent accidents and therefore the report is biased toward pilot actions and training. The *Nall Report* breaks down the different aircraft classes by single-engine fixed-gear, single-engine retractable gear, and multi-engine.

GA Fleet

- Single-engine fixed-gear airplanes represent the bulk of the training and recreational fleet. The SAT assumed that recreational flying tends to be local flying rather than cross country.
- The single-engine retractable gear airplanes may also be recreational airplanes but they are more typically used for travel and equipped for IFR flight.
- Multi-engine airplanes are used for either training or travel. They are almost always IFR equipped and many have capability for flight into icing conditions.

CAR 3 vs. Part 23

The SAT uses Part 23 and GA interchangeably in this report. The SAT determined that very few airplanes in the GA fleet are certificated to FAR Part 23. Most were certificated to CAR 3 standards or older. Based on the FAA GA Activity Survey, out of approximately 150,000 active GA airplanes, the FAA estimates that only 7,500 are certificated to Part 23.

Types of accidents

- Preflight/taxi - hit objects/people.
- Takeoff/climb - stall/mush, loss of control, collisions in takeoff path.
- Weather - CFIT, loss of control, improper procedures.
- Fuel management - fuel exhaustion, fuel starvation.
- Other cruise flight
- Approach - steep turns/stalls, collision with trees/objects, IFR procedures.
- Go-around - hit object on runway, landed long and hit object past end of runway.
- Maneuvering - low, slow flight or mission related division of attention, such as aerial applications and law enforcement; buzzing and low level acrobatic.
- Landing - loss of control, hard landing, landed long/fast, overshoot, stall/mush.
- Other - alcohol, drugs, poor judgment.

Emphasis in Accident Cause

The SAT determined that the NTSB probable cause and the team's determination of the cause of an accident often differ, due to focus and emphasis on pilot training or aircraft design. Loss of control on takeoff is considered a pilot training issue by the NTSB. But some loss of control accidents result from gusty wind conditions, some result from stalls, and some result from hitting an object. From the NTSB's point of view, these losses of control result from pilot error. The SAT took a different approach underlying its focus on engineering issues. Some pilots may expect to fly in conditions with wind gusts of "X" when the airplane is only designed for gusts up to "Y." The SAT considered whether controllability requirements are high enough, or if stall warning is inadequate, perhaps indicating the need for angle-of-attack (AOA) instrumentation.

Breakdown of Accident Causes

The SAT further analyzed accident causes with the approach of finding underlying design issues. Here is the breakdown:

- Maneuvering-
 - stall/ inadvertent
 - judgment/ hit objects low level operations
 - reckless/ acrobatic
 - stall/ reckless low altitude operations

- Weather-
 - clouds, low visibility, night - VFR conditions
 - IMC/ IFR procedures
 - IMC/ IFR lost control
- Power Loss-
 - unknown cause
 - fuel exhaustion
 - fuel starvation/ system
 - fuel starvation/ pilot
 - engine failure
 - propeller failure
- Mid air collision
- Unknown
- Alcohol/ drugs/ poor judgment
- CFIT
- Hit object
- Controllability-
 - Takeoff/ landing judgment

Categories of Accident Causes

The SAT determined that the causes of GA fatal accidents were not largely class-specific, but reflect aircraft utilization and flight profile (length of trip, IFR/VFR, time of day, purpose of flight, etc.). Multi-engine and retractable-gear single-engine airplanes were involved in a higher proportion of IFR accidents, which correspond to higher usage for cross-country transportation, and fixed-gear, single-engine airplanes were involved in more VFR accidents, such as maneuvering. Fatality rates for the same accident cause are higher for single-engine retractables and still higher for multi-engine airplanes. This higher fatal accident rate is due to the higher speeds involved in accidents in these airplanes.

Clouds, low visibility, night - VFR - Many of these accidents could easily be classified as CFIT. The SAT decided not to address any VFR into IMC type accident as CFIT because the root cause has to do with pilot judgment and not pilot training or airplane control.

Stalls - Inadvertent - The SAT classified any accident that clearly involved stalling and didn't reference aerobatics, buzzing, or low passes as inadvertent.

Low level operations; hit object, terrain, water - The pilot attempted low level flight and either flew into the ground, water, or hit an object on the ground such as power lines, trees, etc.

Reckless, aerobatics - These accidents were obvious pilot judgment issues and included buzzing, low passes, and high speed low passes with pull ups.

Mid-air collisions

Powerloss - unknown cause

Alcohol, drugs, poor judgment

CFIT - Descended into terrain or an object with the aircraft under control and without critical malfunctions.

Hit object

Airplane controllability

IMC/IFR procedures - IFR procedures accidents tended to be approach accidents. The majority of those were descending below approach minimums and improper approach procedures.

Fuel exhaustion - Ran out of fuel. In some cases the pilot took off with low fuel; in others, the pilot flew beyond the range of the airplane.

Stall - reckless, low altitude operations

Stall/low pass, steep turn - Some of these accidents were attributed to inadequate airspeed control during a low pass, while others were low passes with attempted pull up maneuvers.

IMC/IFR lost control - The airplane crashed out of control, but the cause was not attributed to a stall/departure or CFIT.

Fuel starvation/pilot - Fuel starvation is engine stoppage due to an interruption of the fuel supply to the engine, even though fuel remains available in one or more of the aircraft's fuel tanks. The SAT divided the fuel starvation accidents into fuel system design problems and pilot error. Some of the pilot error fuel starvation accidents include switching the fuel selector to an empty tank and failing to drain the tanks and check for water or contamination.

Takeoff/landing judgment - Fatal accidents during takeoff and initial climb in all classes of airplanes were mostly caused by loss of control or stall during or shortly after takeoff. This type of accident is often the result of lack of awareness of the effects of density altitude on aircraft performance or other omissions in takeoff planning. The primary causes for landing accidents fall into three categories: loss of control while in crosswinds or gusts, landing hard, and landing long/fast and overshooting the runway.

Engine failure training - Accidents that result from engine-out training.

Engine failure - These are accidents that result from a confirmed mechanical engine failure, such as connecting rod failure.

Intervention Strategies

General Aviation Costs

The SAT determined that low cost is paramount to any safety improvement installed in small airplanes. The domestic GA fleet is composed primarily of two and four-place airplanes with an average value of \$25,000 and \$50,000. In the last 15 years, the FAA has added equipment requirements that were originally required for transport airplanes; but some of these equipment requirements are required for all aircraft, effectively creating an economic barrier to many possible safety improvements in small airplanes.

Simpler Certification Processes

Since the average age of the fleet is approaching 30 years, even with a revitalized GA industry producing many new airplanes with the recommended safety improvements, modifying older airplanes in the existing fleet is the only way that improvement in the GA accident rate can occur. Modification of existing aircraft designs takes the form of Supplemental Type Certificates (STCs) and amended Type Certificates (TCs). Simpler processes to approve the installation of equipment anticipated to improve safety will also help reduce costs, making the modifications more amenable to the GA community.

Advanced General Aviation Transport Experiment (AGATE)

The SAT determined that the AGATE program currently under development with NASA, Industry, and Academia has developed initiatives for developing airworthiness standards that address many of the accident causes identified above. All of these technological advances are designed to be retrofittable and thus leveraged to existing aircraft.

- Weather and visibility causes - preventing CFIT and night accidents with synthetic vision and improved cockpit availability of weather information.
- Pilot workload / situational awareness - preventing IMC/IFR procedural accidents and loss of control through Heads Up Displays (HUDs) and moving maps.
- Midair collisions - preventing midair collisions through TCAS type systems
- Fuel exhaustion - preventing fuel exhaustion accidents through fuel flow based fuel management systems with warning annunciation.

Inadvertent Stalls

The SAT examined several proposals for addressing the inadvertent stall accident cause:

- Active flight control system - an active system will not allow stalls or departures from any axis and help perfect stability and envelope control.
- Stall resistant designs-- The SAT recommends promoting new policies and guidance in stall resistant design, such as the NASA stall/spin resistance research report.
- Better stall warning - AOA indicators and warning systems.
- Ballistic parachute recovery systems--systems that will complement the enhanced stall resistant characteristics in new airfoils or in retrofits to existing airfoils.

General Aviation Propulsion (GAP) Program

The SAT studied the ongoing research to developing new, affordable propulsion technologies for GA aircraft. These include:

- Small turbojet engines in the 700 lbs thrust range
- Turbo diesel research
- Improving reliability and workload on existing reciprocating engines.

Fuel Exhaustion/Starvation

The SAT examined various fuel issues, such as:

- Requiring installation of low fuel warning lights.
- Installing “smart” fuel flow indicators that display time remaining and match with navigation systems that display time to destination.
- Improved pilot training in preflight and operation of fuel systems.

Engine Failures (Actual and Training) in Multi-engine Aircraft

- Encourage more simulator training.
- Develop better stall handling characteristics.
- Larger stall/minimum single engine control speed (V_{MC}) margins.
- Center line thrust eliminating asymmetric thrust issues.
- “Dual pac” type engine installations, where two engines drive one propeller.
- Continue studying aerodynamics of wing loading vs. power loading vs. accident rate.

Poor Pilot Judgment

- Continued pilot education on the inadvisability of buzzing and unnecessary low level operations.
- Continued pilot education on the inadvisability of untrained aerobatics.
- Continued pilot education against alcohol and drug abuse.

Recommendations

The SAT urges acting on the above intervention strategies, and provides the following additional recommendations:

Airplane Specific Accident Rate Study

The SAT recommends continuing the studies published by the AOPA ASF on specific airplane type characteristics and accident rates. The team recommends analyzing each airplane in an attempt to determine airplane specific desirable and undesirable qualities.

Operation Specific Accident Rate Study

The SAT recommends researching more closely accident causes during specific flight operations, such as IFR procedures during precision and non-precision approaches.

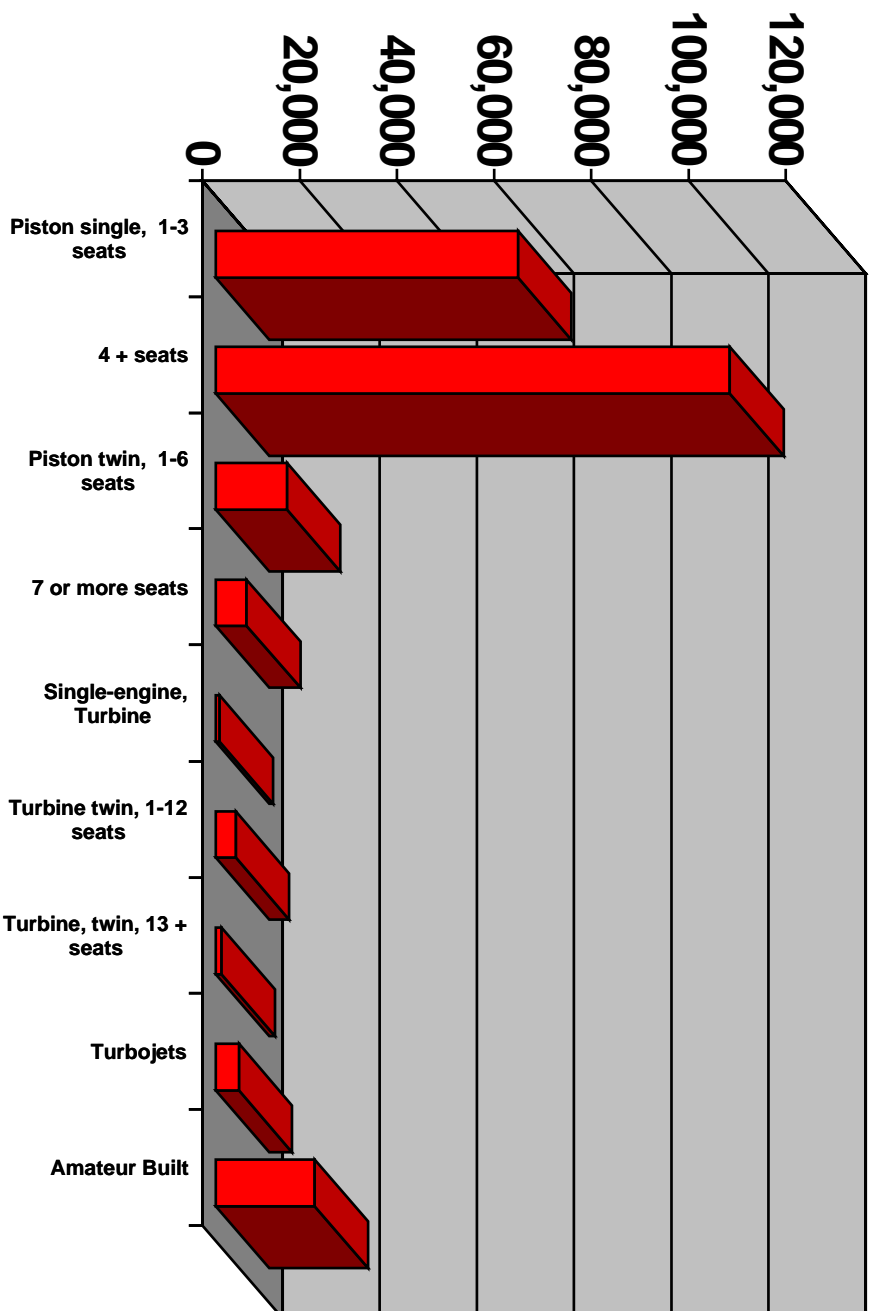
Type Ratings and Pilot Training Requirements

The SAT recommends studying the current approach to type ratings and pilot training in regards to the ease or difficulty of flying specific airplane types. All turbojet powered aircraft require type ratings, but propeller driven aircraft, no matter how easy or tricky the operational characteristics, do not require type ratings. The SAT recommends addressing issues such as wing loading (stall speed), power loading (performance), and the pilot's workload (handling qualities and/or equipment/avionics) in developing aircraft-specific type ratings for small airplanes.

Display Symbology

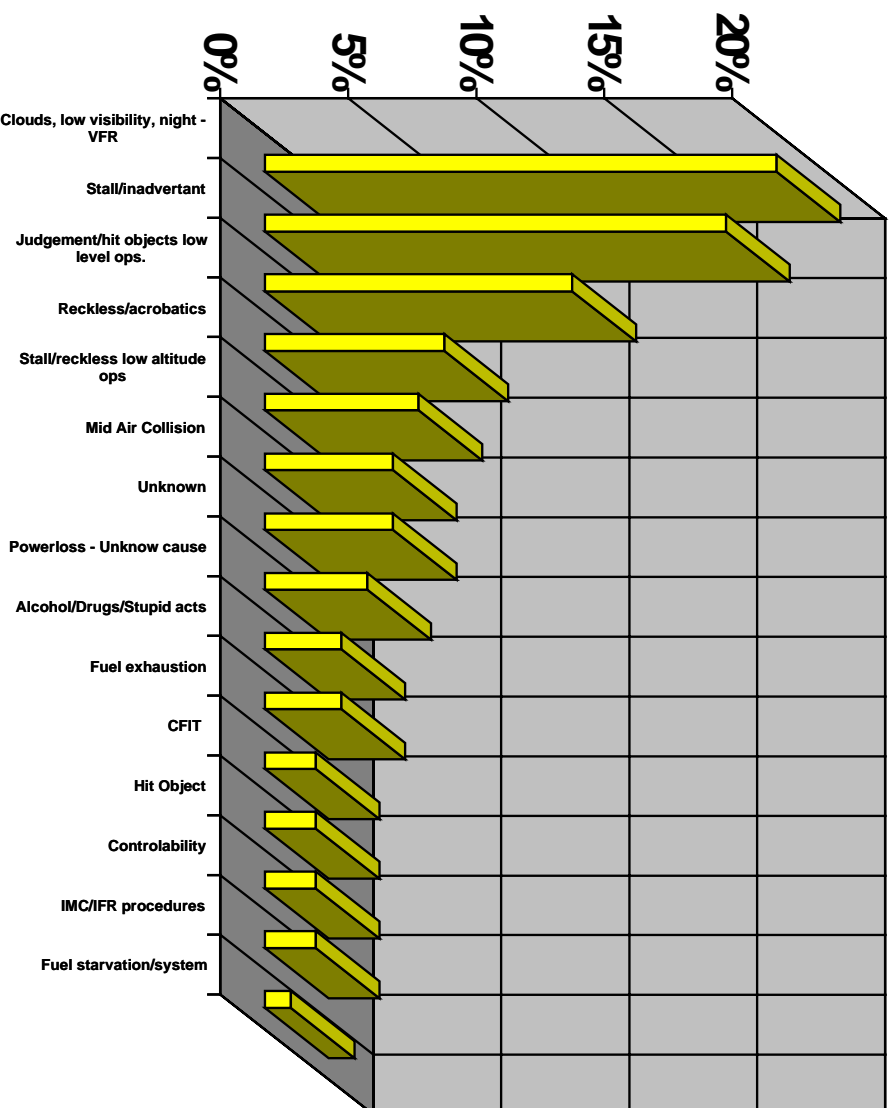
The SAT recommends defining a set of minimum standards for symbology on both Head Down Displays (HDD) and HUDs, rather than evaluating each one independently with no standard as is the current practice.

1995 GA Total Population

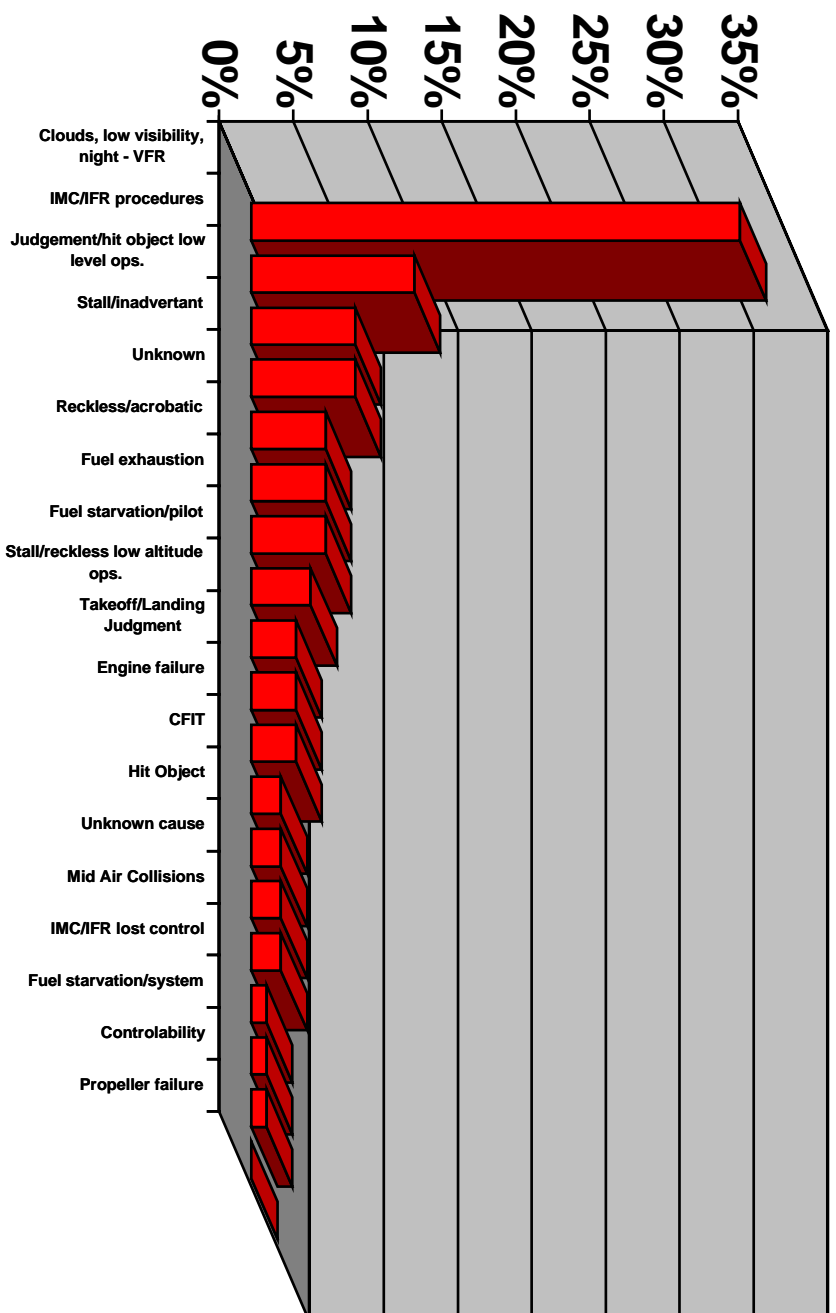


FAA 1995 GA and Air Taxi Activity and Avionics Survey

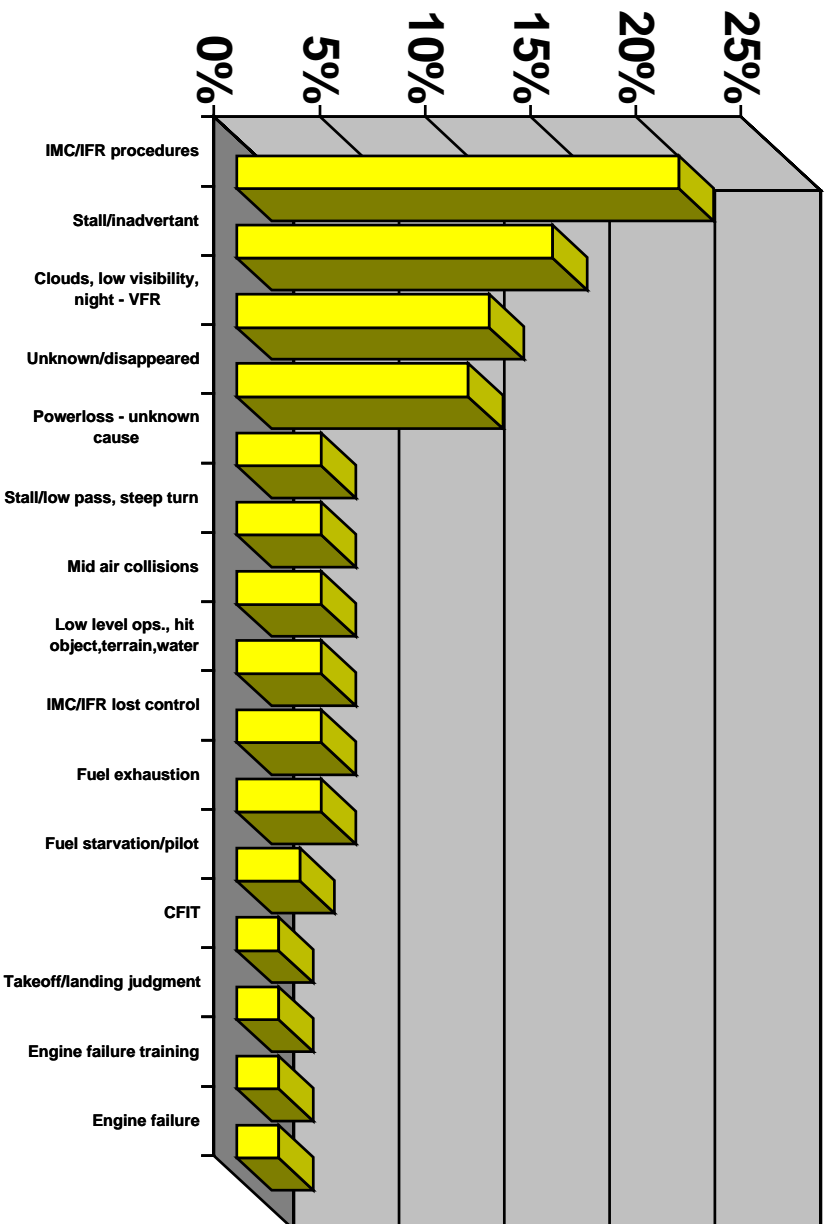
Fixed Gear Fatal Accident Causes - All Causes



Retractable Gear Fatal Accidents - All Causes



Multi-Engine Fatal Accidents - All Causes





Engines

Data

Sources

The SAT used many data sources in preparing this section of the report. These sources vary across engine types because of the disparate organizations involved in the different types of aviation. The SAT took advantage of specialized in-depth studies of particular types of events. Wherever possible, multiple sources within an engine category were compared for consistency. In general, across different time periods and different sources, the top-level contributors to accidents remain constant.

CAAM

For turbofan/turbojet and turboprop engines installed on transport aircraft (Part 25), an in-depth top-level cause study was already available. This was the Continued Airworthiness Assessment Methodologies (CAAM) review of world-wide events on Western-built aircraft. Engine-related events for the period 1982-1991 were reviewed in detail and assigned to various cause categories. For purposes of the SAT, the turbofan/turbojet data were brought up to date with level 4 events from 1992 through 1996. Turboprop events were augmented with events summarized in International Air Transport Association (IATA) Safety Record (Turboprop) reports for the years 1995 and 1996. In addition, the SAT performed further research into all the events to determine root causes.

Analysis

The events included in the turbofan/turbojet and turboprop Pareto's and this section of the report are serious incidents and accidents. The CAAM study refers to these as level 3 and level 4 events, respectively. These are defined as follows:

Level 3 (Serious Consequences):

- Substantial damage to aircraft or unrelated system
- Uncontrolled fire
- Rapid depressurization
- Temporary or permanent inability to climb/fly 1000 feet above terrain
- Temporary or permanent impairment of aircraft controllability

Level 4 (Severe Consequences):

- Hull loss
- Fatal or serious injury
- Forced landing

Disk Uncontainment

For turbofans/turbojets, the leading cause of level 3 and 4 events is disk uncontainment. The root cause Pareto for disks was supplemented with data on all uncontainment events retrieved from the Society of Automotive Engineers (SAE) “SP-1270 Uncontained Turbine Engine Rotor Events” report. The conditional probability that a disk uncontainment results in a serious or severe event is considered independent of the reason why the disk fractured (corrosion, defect, fatigue, etc.) Therefore, it is important to examine all possible causes of disk fracture.

Engine Malfunction Plus Inappropriate Response

The second leading cause in the top-level turbofan/turbojet Pareto is engine malfunction plus inappropriate response. This category represents events that began with an engine problem which, by itself, did not have safety significance. However, the engine problem was followed by inappropriate crew response, leading to a more serious event. Additional events dating back to 1969 were available for the root cause Pareto because of the work of the Aerospace Industries Association (AIA)/Association Europeenne des Constructeurs de Material Aerospatial (AECMA) workshop on Propulsion System Malfunction Plus Inappropriate Crew Response. These events were not included in the top-level Pareto, as they represent only one category of accident cause rather than the comprehensive list. Note that for level 4 (severe) events only, malfunction plus inappropriate response is the top contributor. (Selection of level 4 events only also causes rearrangement of the contributors within the root-cause Pareto.)

Malfunction plus inappropriate response is the leading contributor to level 3 and 4 events for turboprops as well. No other single cause stood out as a top contributor.

Multiple Engine Failure for Common Cause

Combining a number of causes into the generic category of “multiple engine failure for common cause” does provide a clear second in the turboprop top-level Pareto. This category covers environmental hazards (birds, ice, etc.), fuel exhaustion, mismanagement and contamination, and maintenance activity affecting multiple engines.

Auxiliary Power Units (APUs)

Events involving APUs were also contained in the CAAM study. A Pareto of the causes for those events is presented. None of the events have been level 4; however, egress injuries have occurred (egress injuries are not considered in the event level determination). The leading contributor is on-ground fires.

Turboshafts

World-wide fatal and serious injury accidents involving Western-built rotorcraft from Airclaims data 1990-1995 comprise the Pareto for turboshafts. Single-engine powerloss was the highest contributor for these accidents. To provide additional verification of the reasons for engine failure, the SAT reviewed the U.S. Accident/Incident Database (AID) for engine failure causes. The top three specified root causes were identical in both the Airclaims and AID data (all accidents). A serious accident due to powerloss in a helicopter implies a failure to successfully autorotate to a safe landing. This failure can be attributed to any or all of the following: lack of suitable terrain; low altitude at the time of engine failure; or pilot error (failure to maintain rotor RPM). The last is comparable to the “malfunction plus inappropriate response” category in the other types of turbo engines.

Reciprocating Engines

For reciprocating engines, the Pareto is based on U.S. accidents involving engine failure. Data were compared from two sources: an Aircraft Owners and Pilots Association (AOPA) safety study for the period 1982-1988 and a review of engine failures performed by Bruce Edsten of the FAA’s Kentucky Flight Standards District Office (FSDO) for accidents in the late 80’s and early 90’s. Both show the same top three specified reasons for engine failure. Interestingly, none of the three involves engine hardware. The causes are fuel exhaustion/mismanagement, fuel contamination, and carburetor ice.

Fuel Problems

Fuel problems are also the second-leading cause for turboshaft accidents; in addition, the problem is represented, albeit on a lesser scale, in the turboprops and turboprops/turbojets.

Intervention Strategies

The SAT broke down the intervention strategies by engine type.

Turbofans/turbojets:

Disks

- Enhance shop visit inspection of critical locations for components with high hazard potential.
- Damage tolerant design.
- Enhance mitigation at the aircraft level.
- Enhance manufacturing practices and increase FAA oversight of critical manufacturing activities.

Malfunction Plus Inappropriate Response

- Simulator training reflective of critical engine failure modes: surge at takeoff (rejected takeoff contributor); quiet spooldown at altitude (loss of control contributor due to asymmetric thrust).
- Install asymmetric thrust annunciators.
- Install engine failure annunciators.
- Increase awareness of V1 decision requirements.
- Enhance automatic flight control design.
- Increase commonality of cockpit instrumentation and annunciation design.
- Enhanced mitigation of asymmetric thrust at the aircraft level.

Environmental Common Cause

- Enhanced airport bird control.
- Improved fan blade FOD resistance (birds/ice/hail).
- Enhanced core engine resistance to the effects of water/hail ingestion.
- Increased emphasis on airframe deicing requirements.
- Enhanced radar (to avoid volcanic ash; inflight icing conditions).
- Air traffic control (worldwide) routing awareness (to avoid potential hazards).
- Increased emphasis on pilot situational awareness.

Turboprops:

The SAT determined that the intervention strategies devised for turbofans/turbojets (malfunction plus crew error and environmental common cause) would also apply to turboprops, with the addition of:

- Increased emphasis on avoiding overloading.
- Enhanced ground maintenance procedures to avoid contamination and mixing of fuel and water/methanol.
- Adherence to proper fuel requirements.
- Standardize fuel tank and switching design requirements.
- Install low fuel warning lights in all aircraft.

Turboshafts:

The SAT determined the following intervention strategies for turboshaft engines:

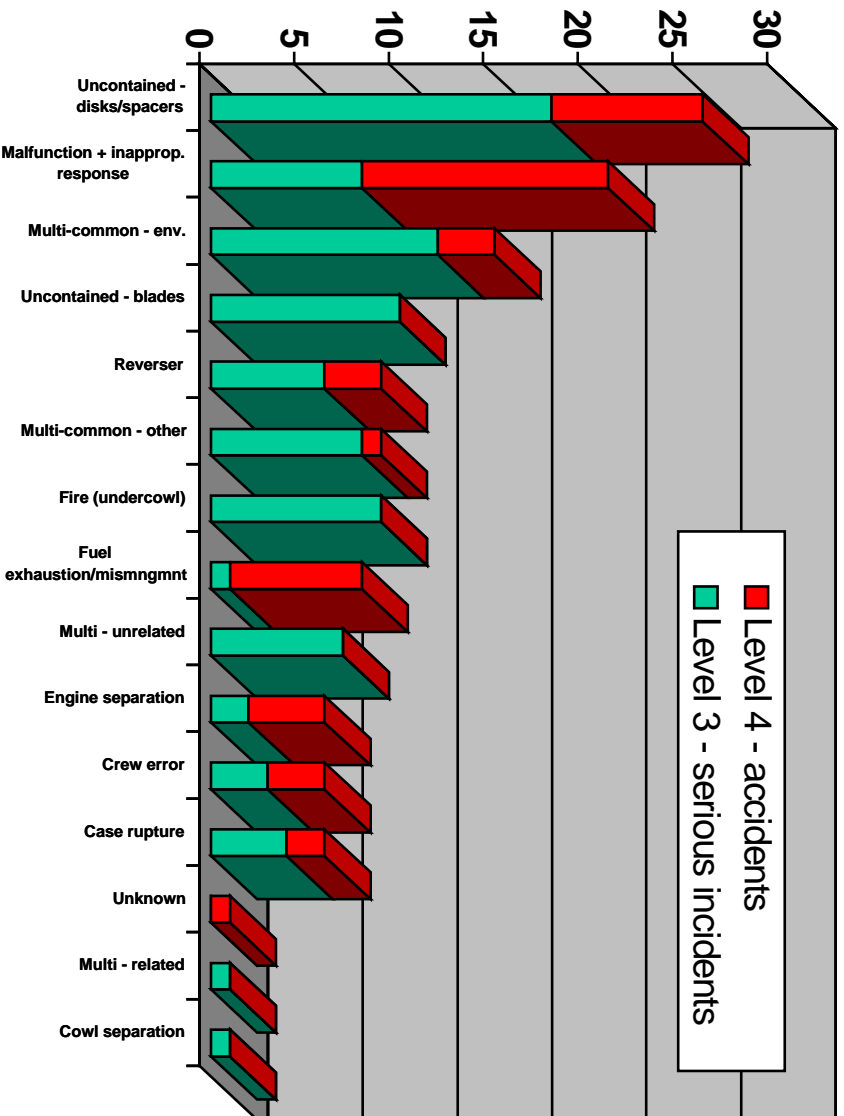
- Increased emphasis on autorotation training.
- Emphasis on fuel planning.
- Install low fuel warning lights in all aircraft.
- Improved drain and filter inspections to check for fuel contamination.
- Revised fuel burn guidelines to allow more margin in poor conditions.
- Follow-on review of engine reliability rates.
- Enhanced reporting of engine events.

Reciprocating Engines:

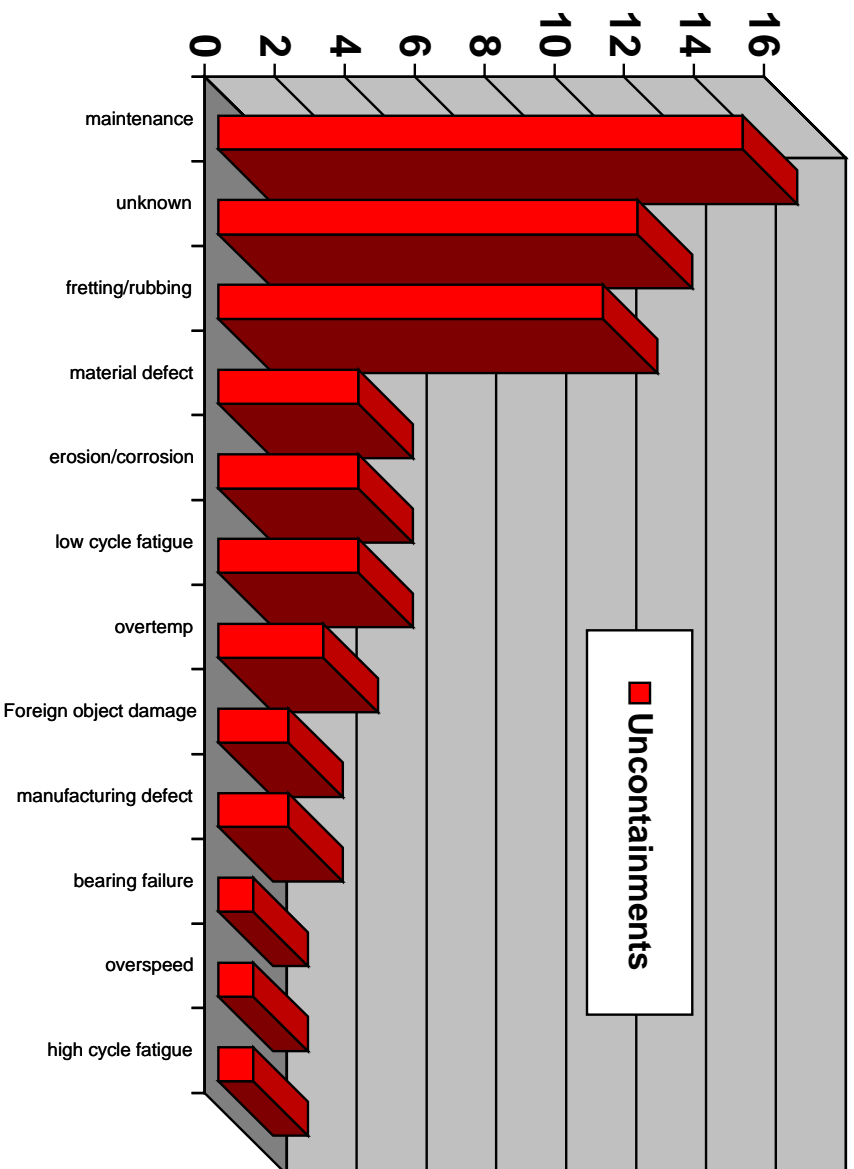
The SAT determined the following intervention strategies for reciprocating engines:

- Increased flight school emphasis on fuel planning, contamination, and carburetor heat.
- Issue informational mailings (pamphlets, etc.) on fuel exhaustion, contamination and mixture, and proper use of carburetor heat.
- Revised fuel burn guidelines to allow more margin in poor conditions.
- Equip engines with fuel injection systems (eliminate carburetors).
- Locate all fuel tank drains in easily accessible locations.
- Install low fuel warning lights in all aircraft.
- Ensure chemical compatibility of fuel additives (to avoid corrosive effect on tank seals).
- Enhanced seal maintenance.
- Install "smart" gauges to warn on attempt to switch to empty tanks.
- Install full authority digital engine controls (FADECs) for automatic mixture control/cylinder head temperature/etc.
- Combine throttle linkage with carburetor heat such that idle throttle automatically gets carburetor heat.
- Easy-read fuel gauges with common panel placement for Part 23 aircraft.
Eliminate cockpit fuel tank selector switches with an OFF position. Keep the shutoff switch separate and out of the way.

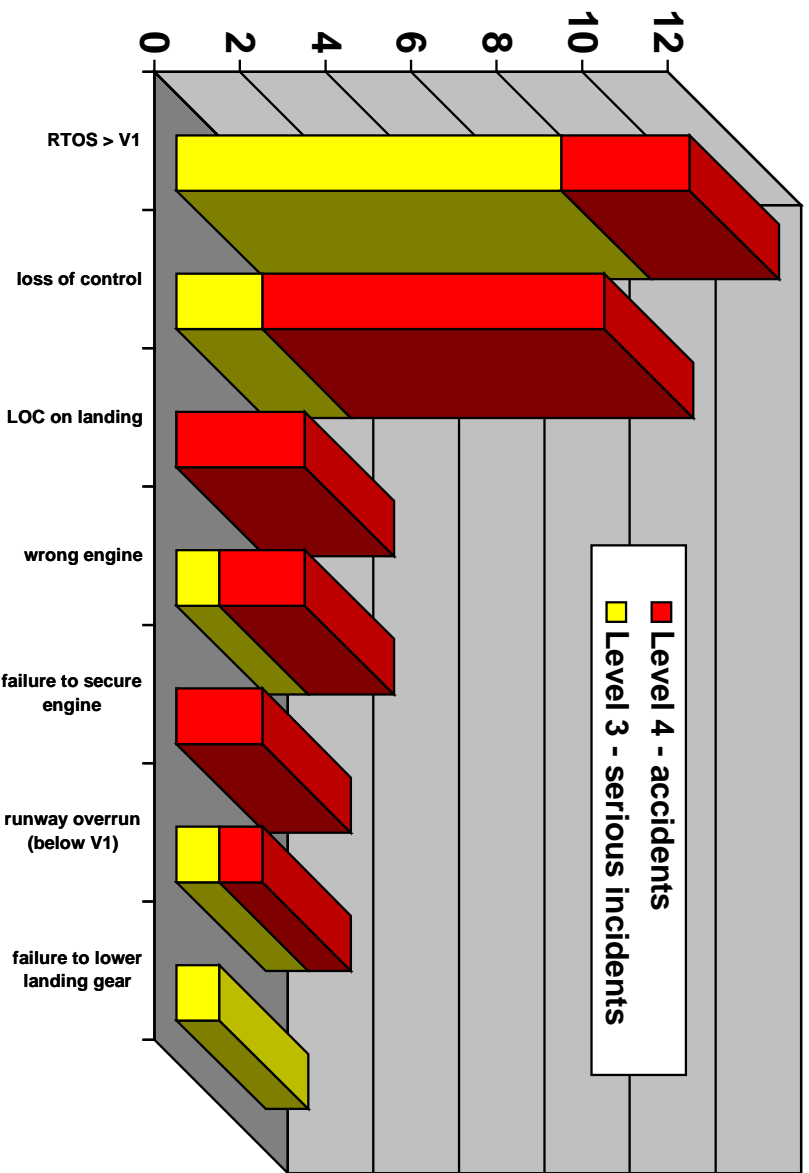
Turbofans/Turbojets Installed on Part 25 Aircraft



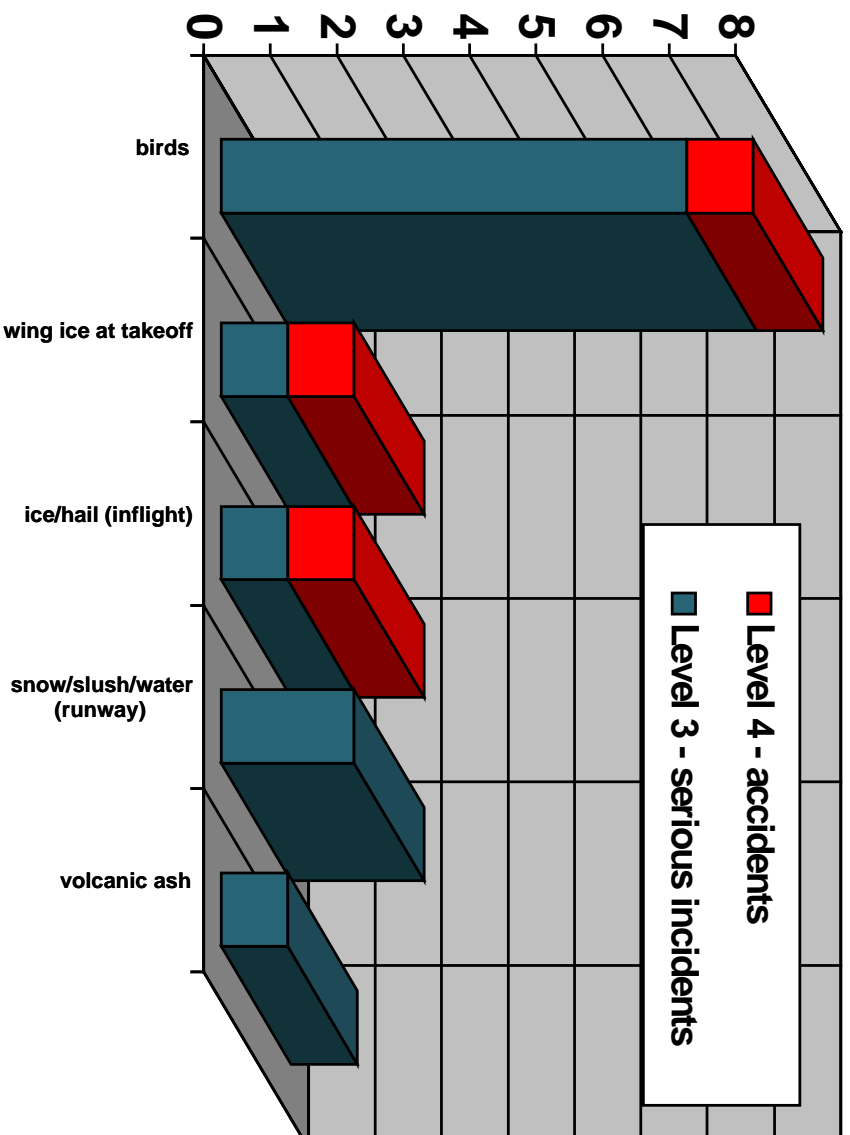
Turbofans/Turbojets - Disk Uncontainment



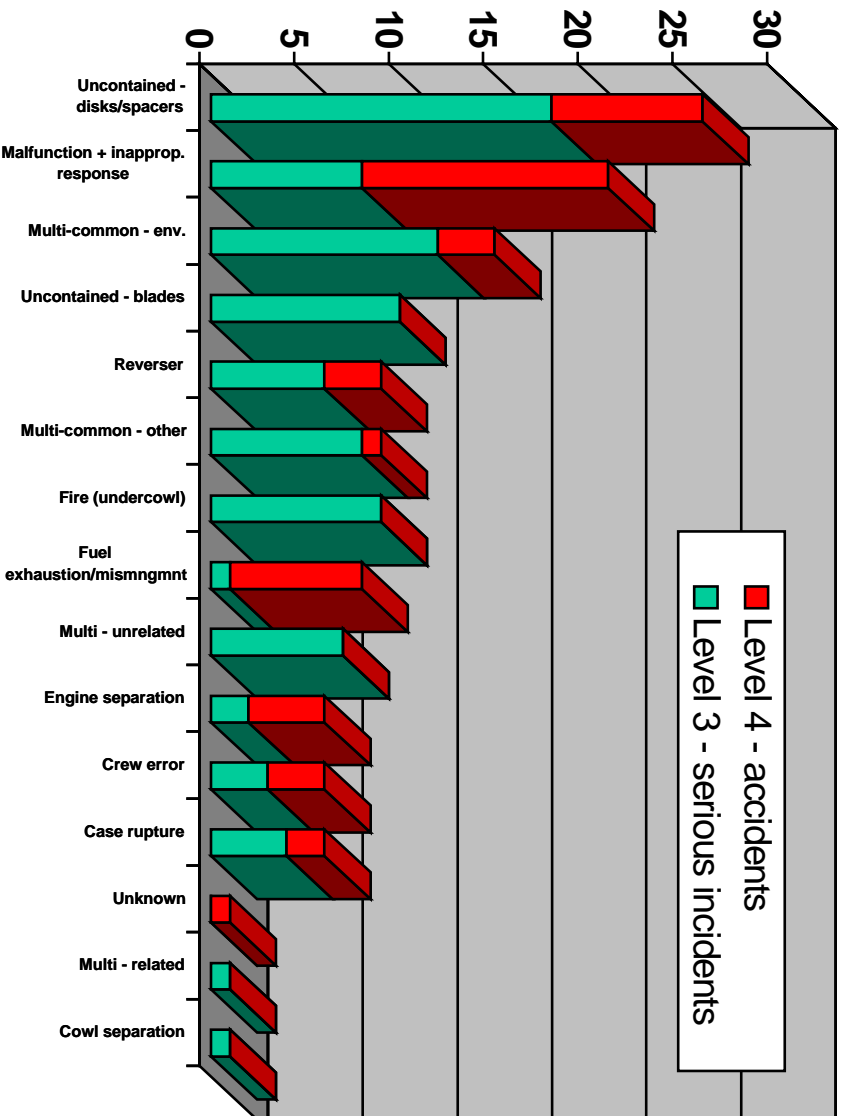
Turbofans/Turbojets - Engine Malfunction Plus Inappropriate Response



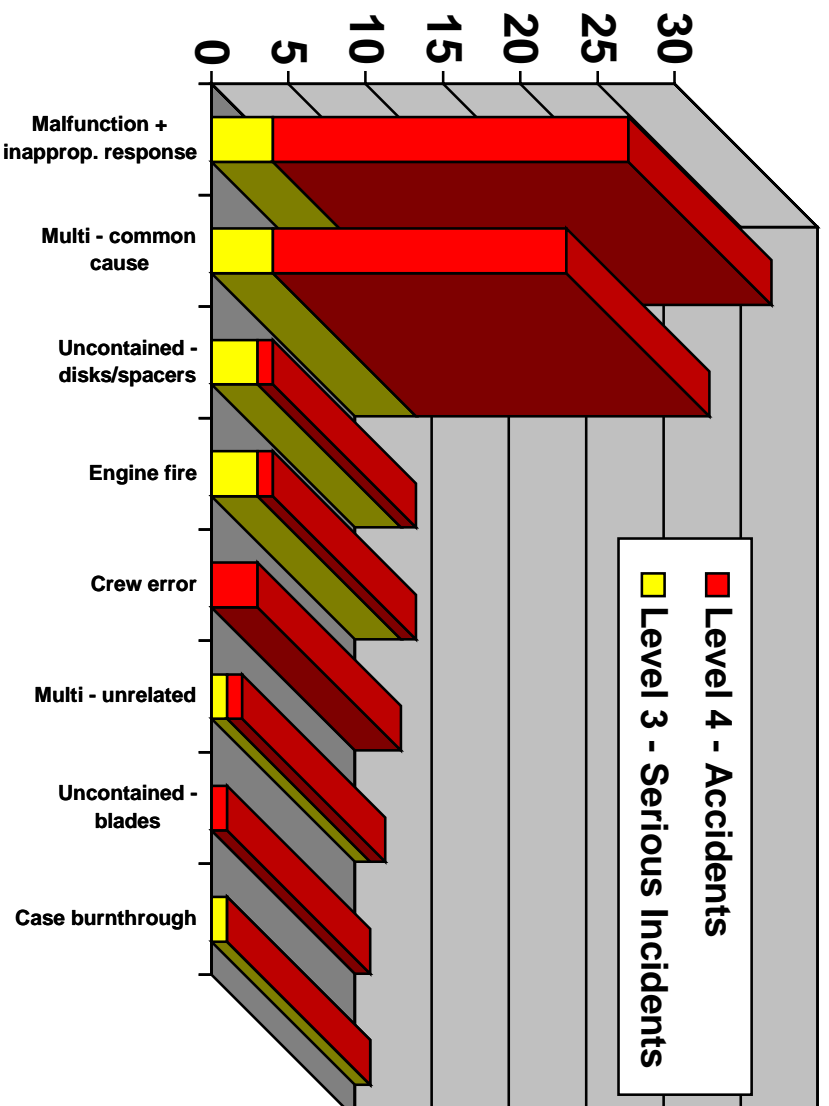
Turbofans/Turbojets - Multi-Engine Common Cause - Environmental



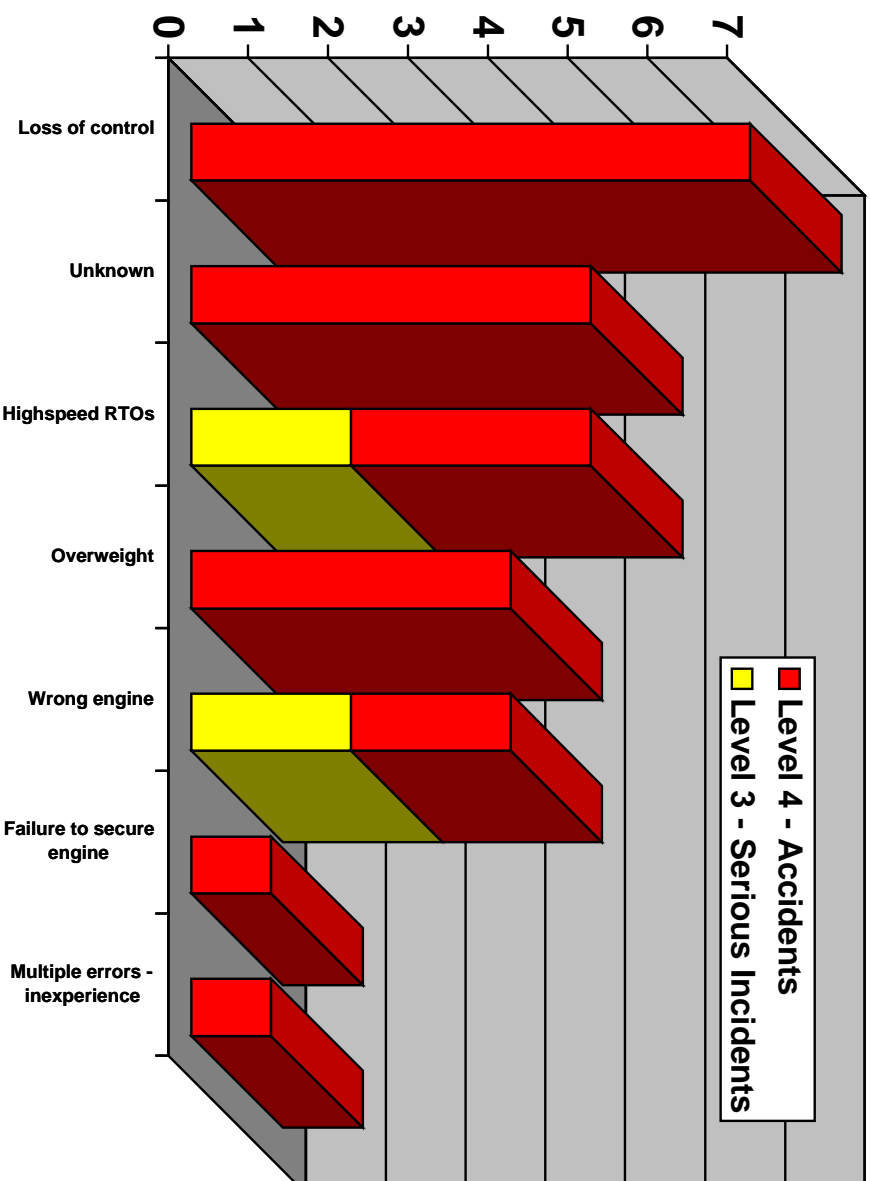
Turbofans/Turbojets Installed on Part 25 Aircraft



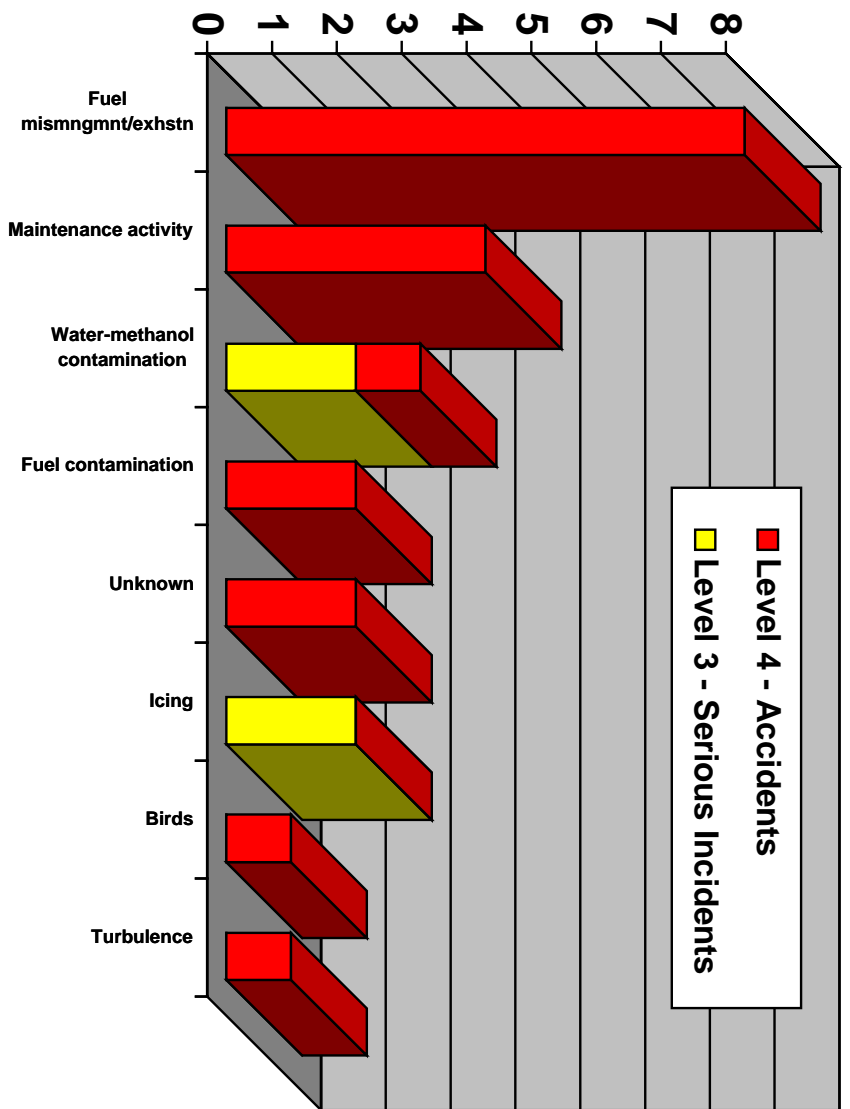
Turboprops Installed on Part 25 Aircraft (Combined Multi-Engine Common-Cause Categories)



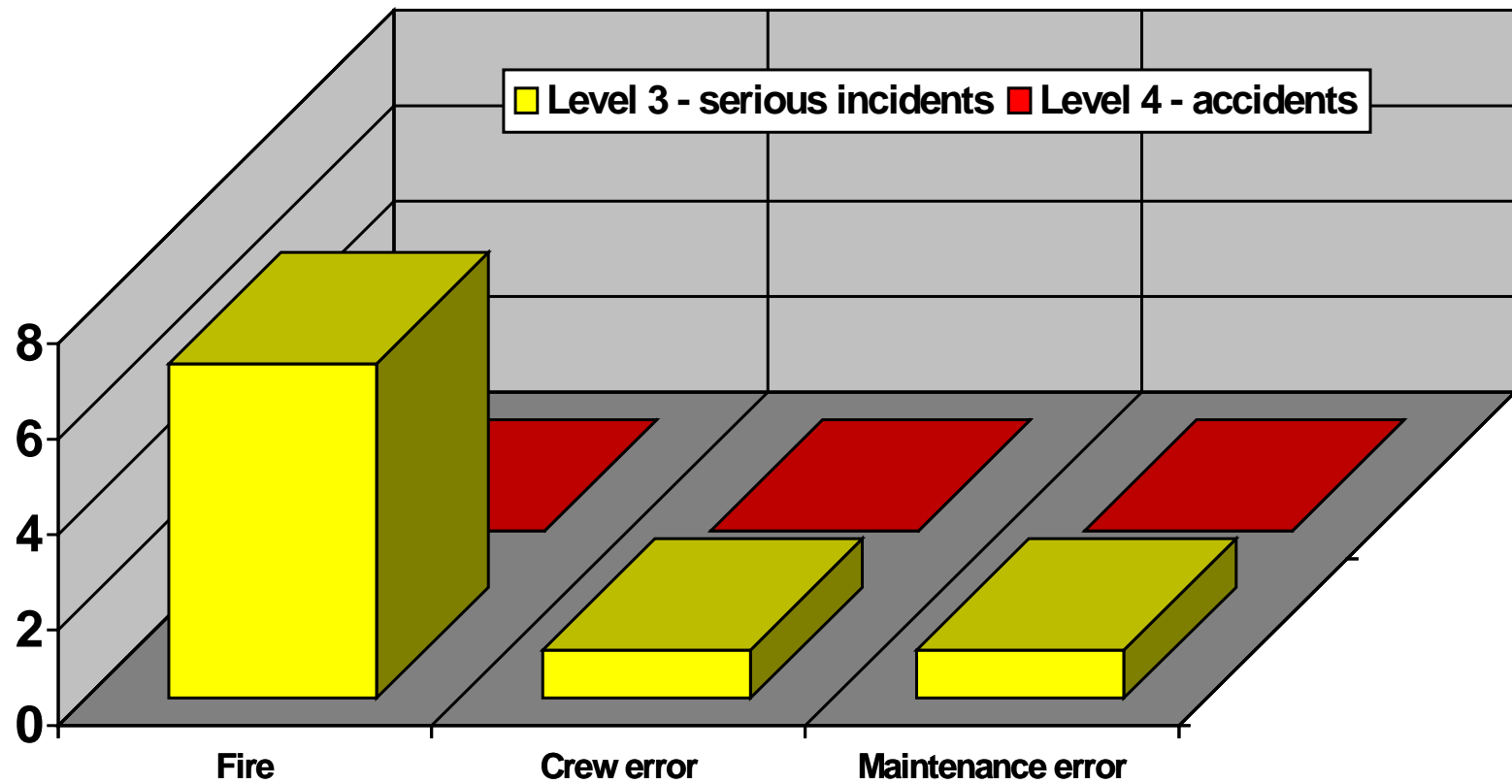
Turboprops - Engine Malfunction Plus Inappropriate Response



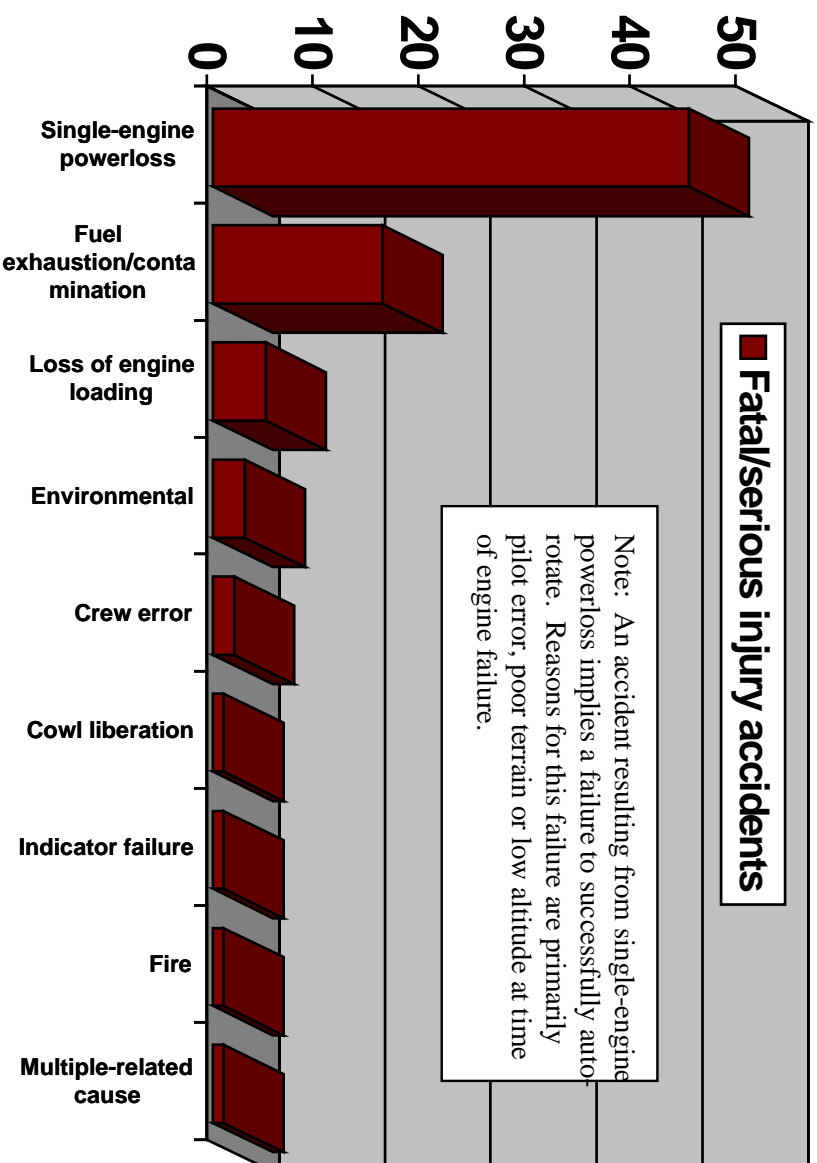
Turboprops - Multi-Engine Common Cause



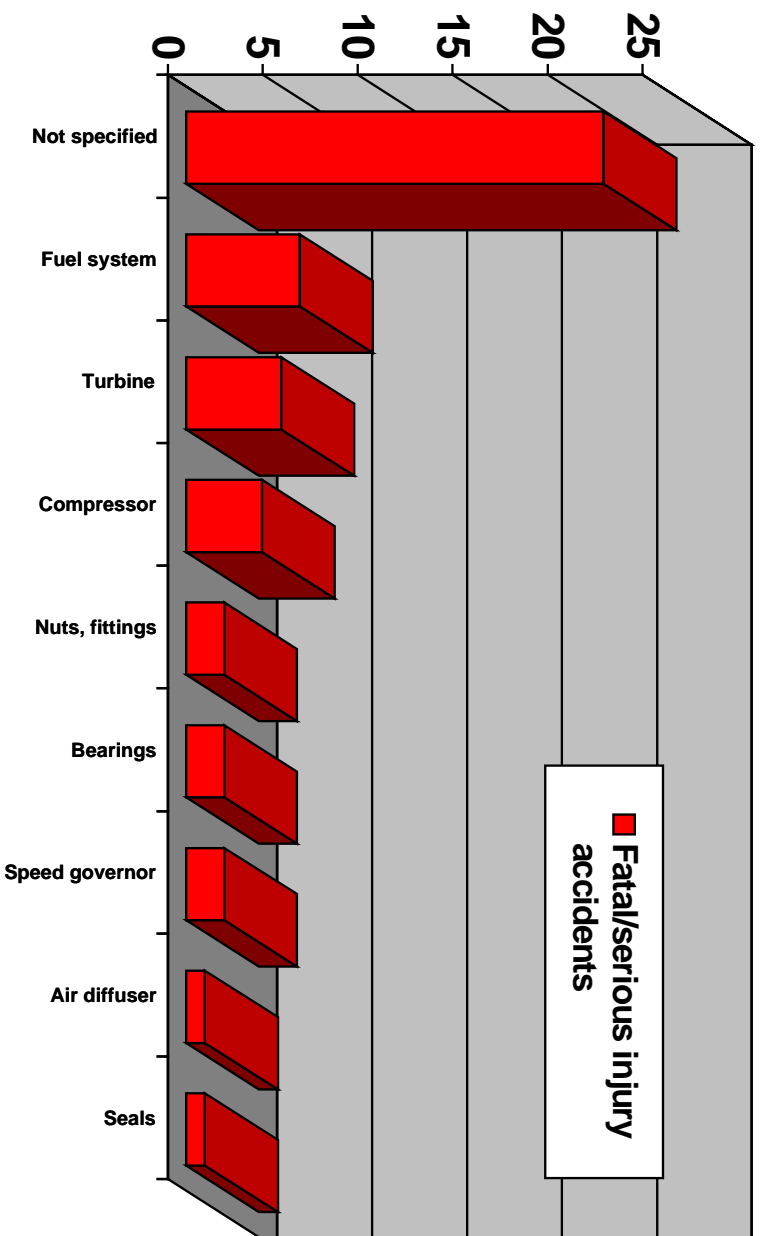
APUs Installed on Part 25 Aircraft



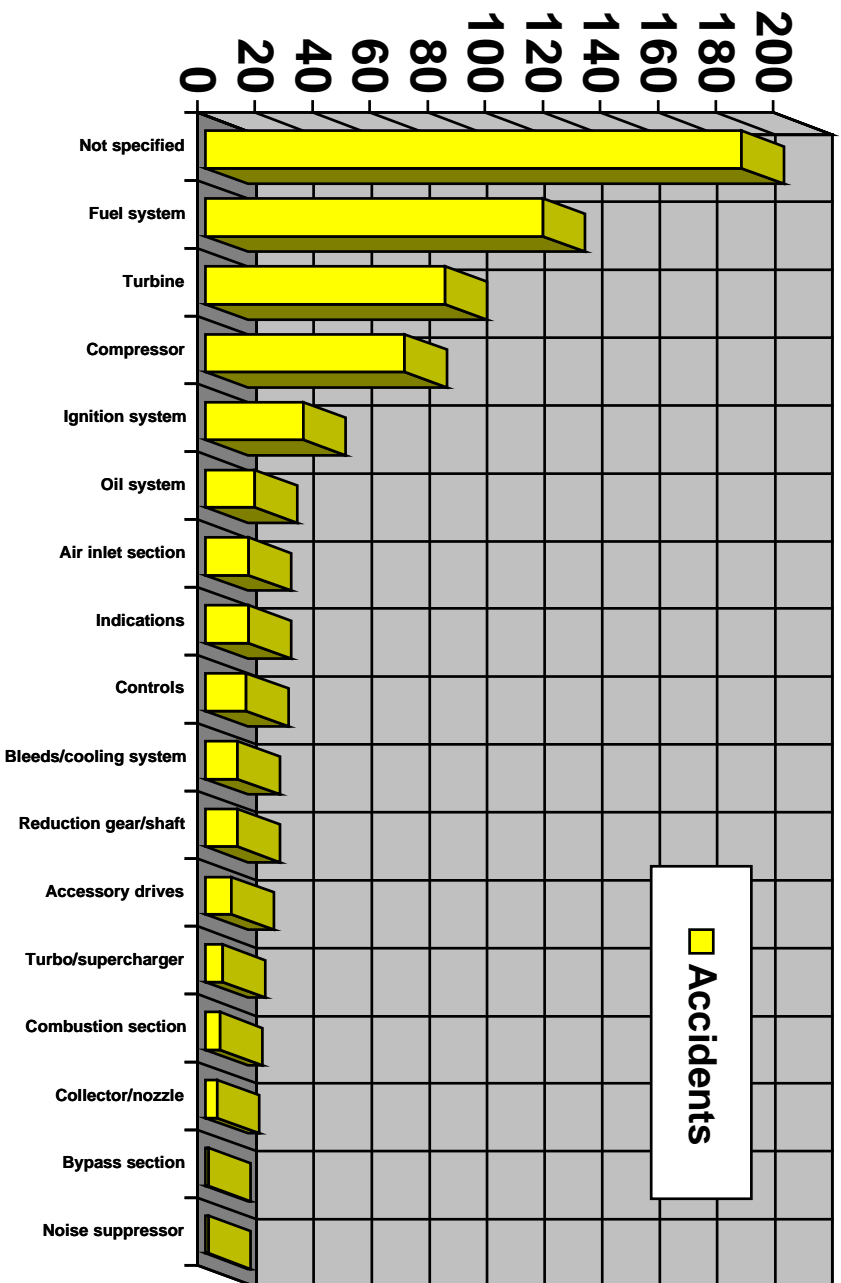
Turboshifts Installed on Rotorcraft



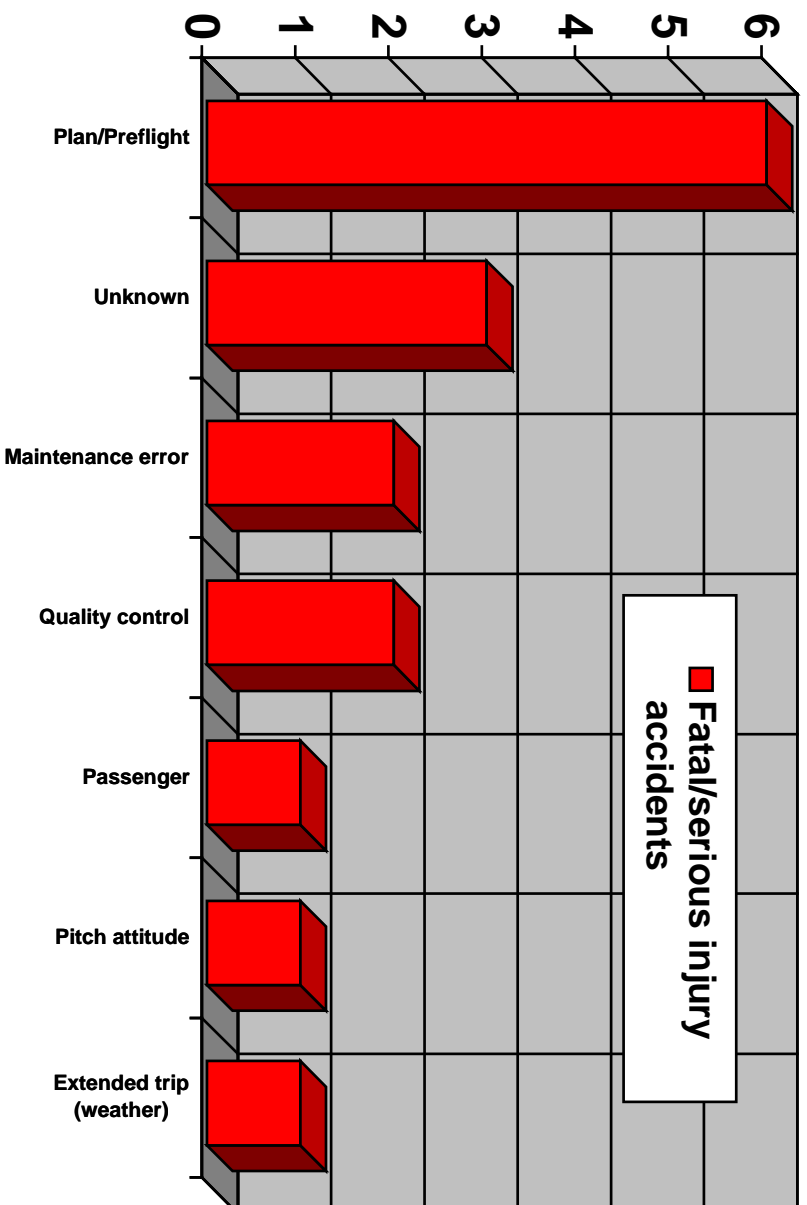
Turboshafts - Single-Engine Powerloss (Airclaims)



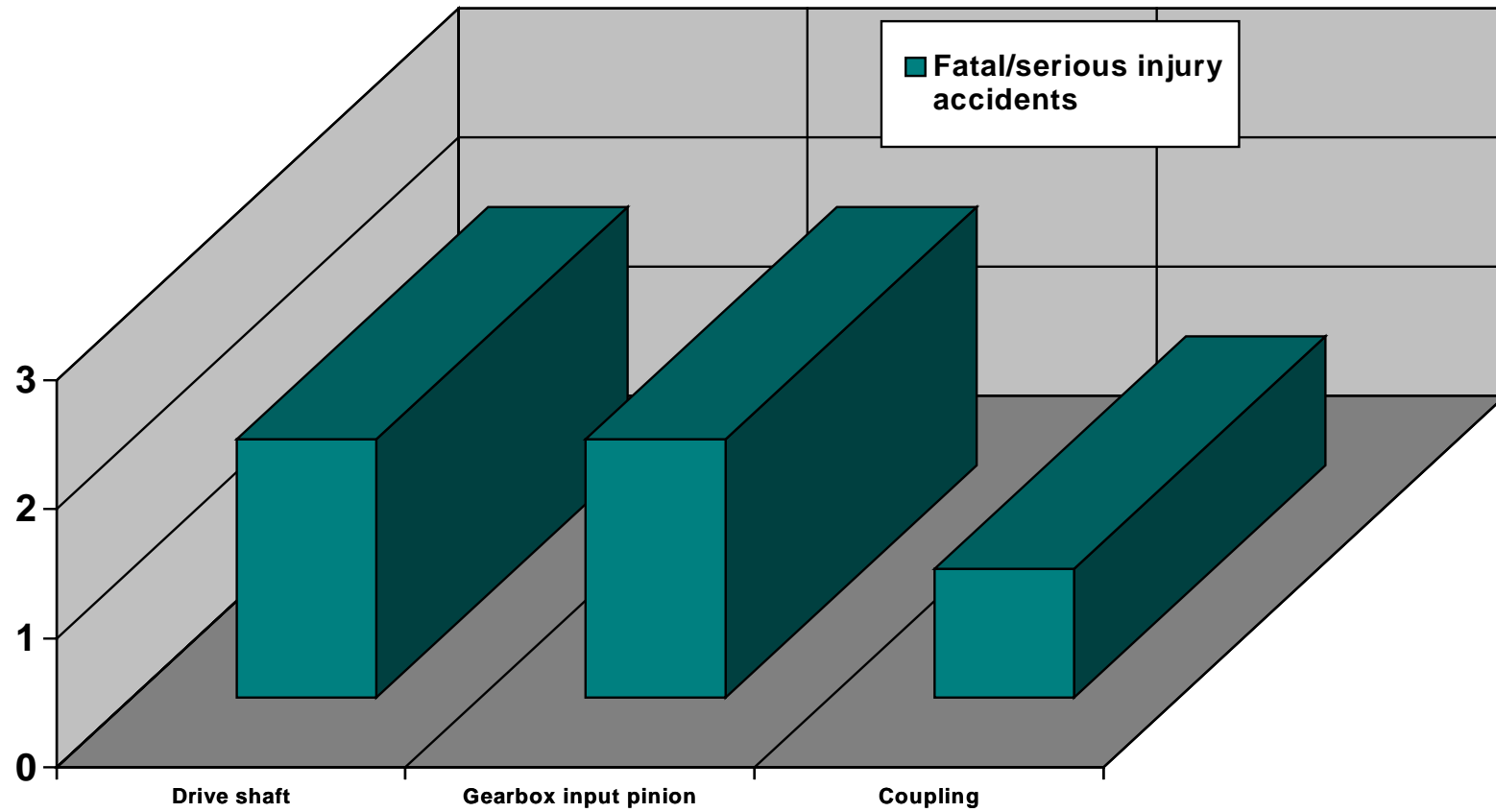
Turboshafths - Single-Engine Powerloss (AID)



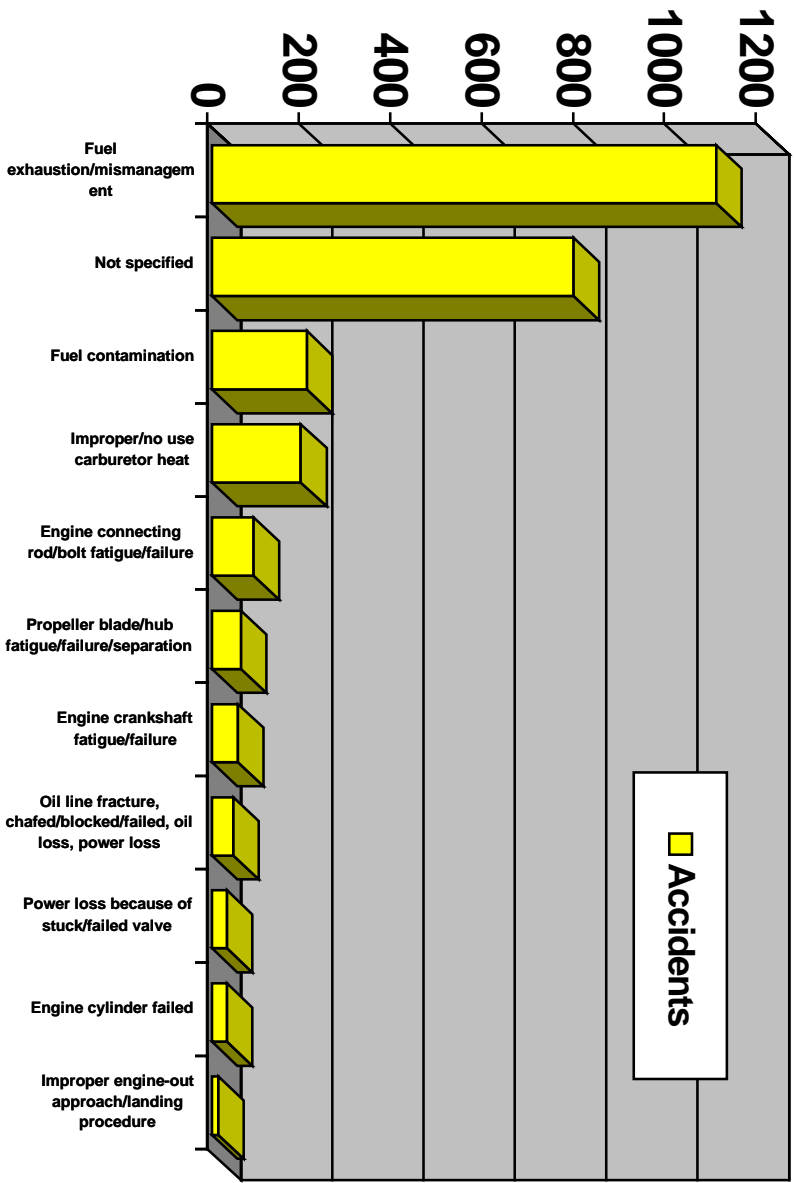
Turboshafts - Fuel Exhaustion/Contamination



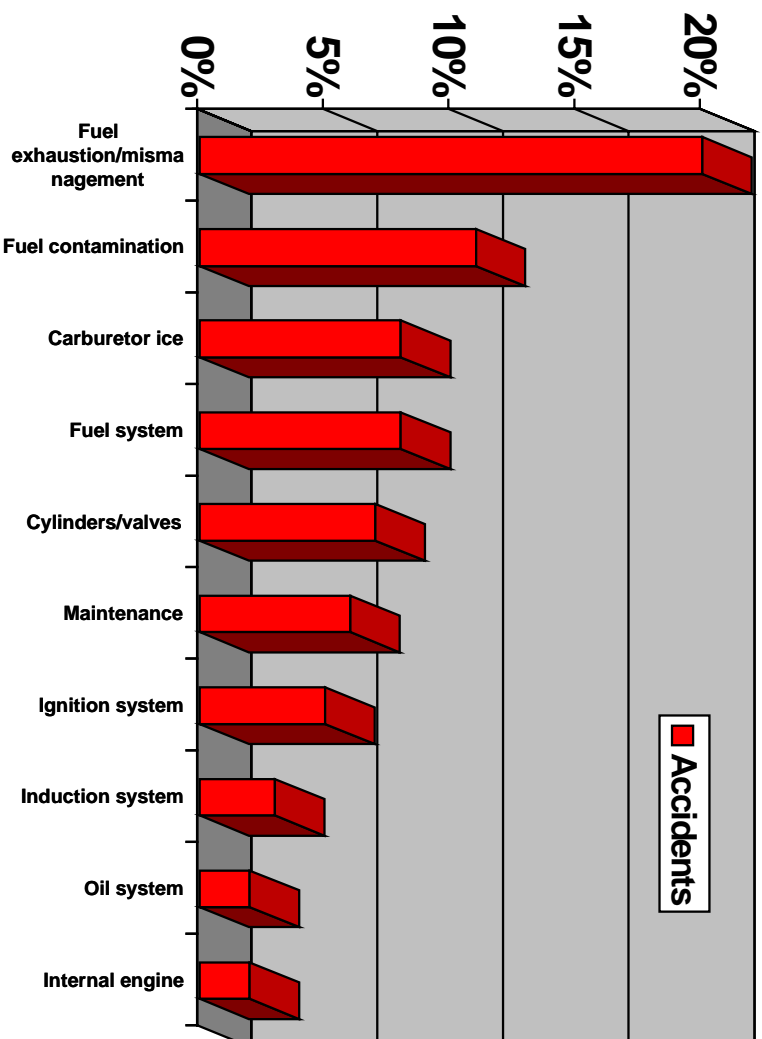
Turboshafts - Loss of Engine Loading



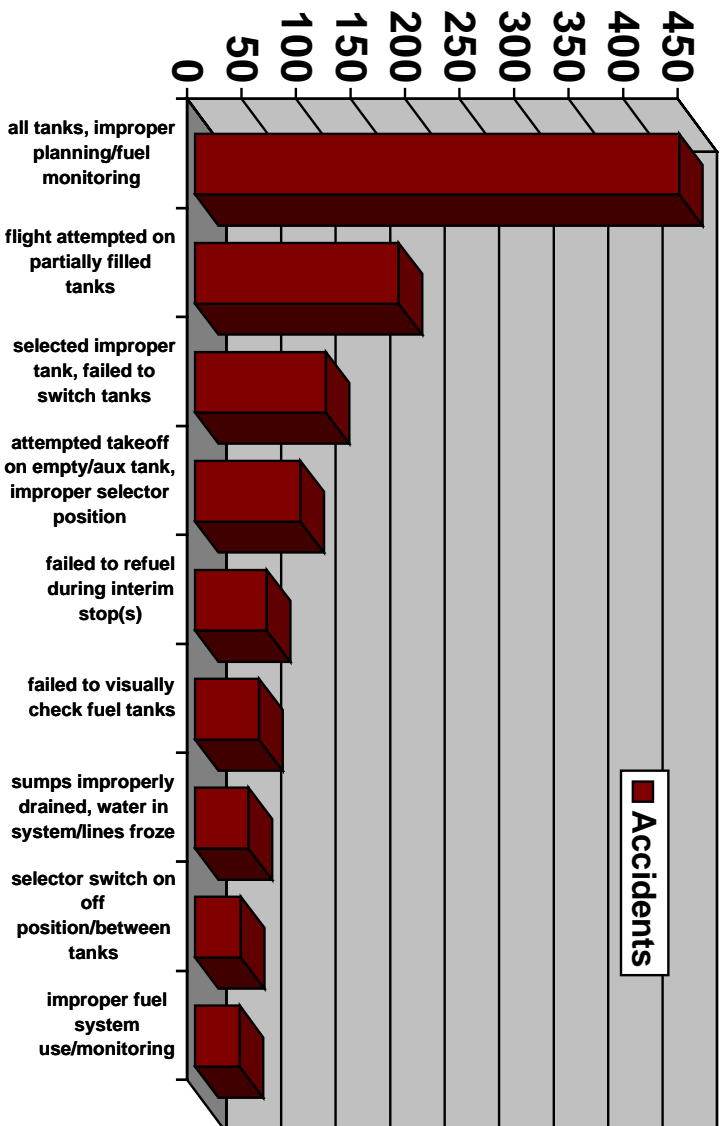
Reciprocating Engines Installed on General Aviation Fixed-Wing Aircraft (AOPA)



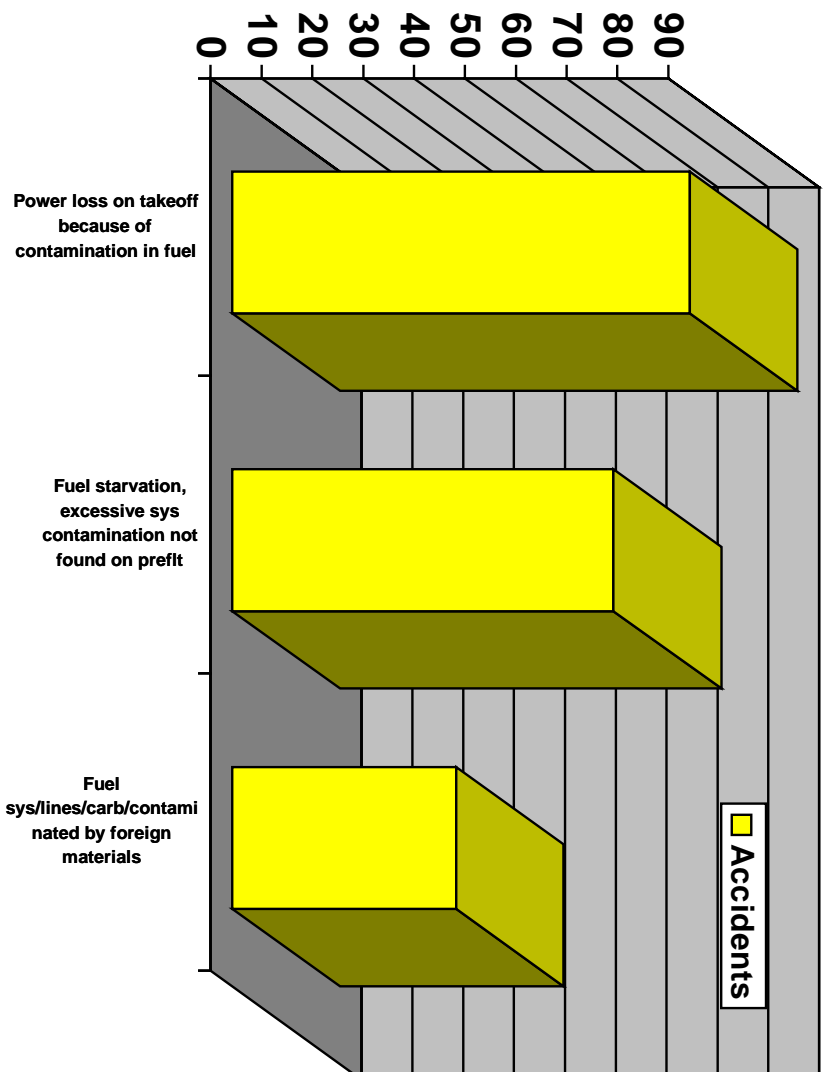
Reciprocating Engines Installed on General Aviation Fixed-Wing Aircraft (KY FSDO)



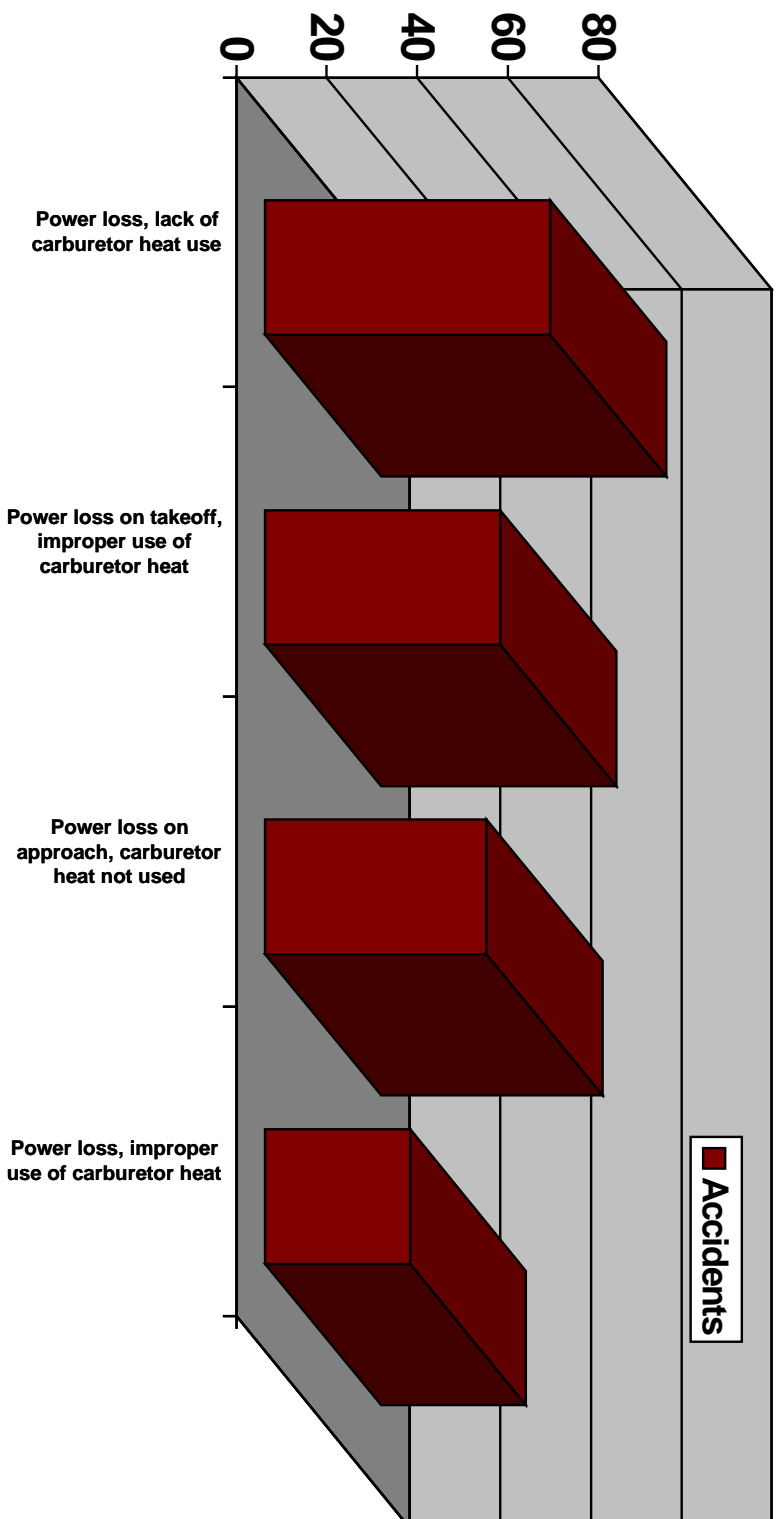
Receipts - Fuel Exhaustion/Mismanagement



Recips - Fuel Contamination



Recips - Lack of Carburetor Heat





Propellers

Data

Turboprop

The SAT collected CAAM level 3 and 4 event data for propellers on turboprop engines installed on transport and regional transport aircraft from several sources. Events from the period 1982-1991 were contained in the CAAM database. These events were supplemented by the “Propeller Failure” events from the Airclaims listings for 1992-1996. Additional information on blade separation root causes was obtained from an Aviation Rulemaking Advisory Committee (ARAC) Powerplant Installation Harmonization Working Group (PPIHWG) listing. Similar to the reasoning for turbofan disk uncontainment, the conditional probability of a serious event given a blade separation is not considered dependent upon the underlying reason for the separation. (Issue could be taken here for the case of a hub fracture that releases multiple blades.) The blade separation root cause Pareto therefore includes additional events not included in the top-level Pareto of CAAM level 3 and 4 events.

General Aviation (GA) Propellers

The SAT obtained accident data for propellers installed on GA (Part 91) aircraft from AOPA reviews of accidents between 1982-1996.

Analysis

Causes

The same top causes of propeller events appear in both transport and regional aircraft and general aviation aircraft: blade separation and loss of control due to pitch control system failures. The underlying causes of blade separation are similarly represented within each group, although their relative contributions vary. Maintenance, for example, is a larger proportion in general aviation than in transport. Note that the category “fatigue” can cover fatigue due to inadequate design, nicks or scratches, corrosion and others.

GA Data Issues

The GA data do not differentiate between blade and hub initiation for blade separations. Review of cause codes for accidents and incidents from the National Transportation Safety Board (NTSB) database indicates an 83%/17% breakdown for blades versus hubs. This is fairly consistent with the transport results.

Pitch Change Failures

Pitch change (loss of control) events are caused by mechanical failures of the pitch control system resulting in either system lockup or flat pitch (high drag).

Malfunction plus Inappropriate Response

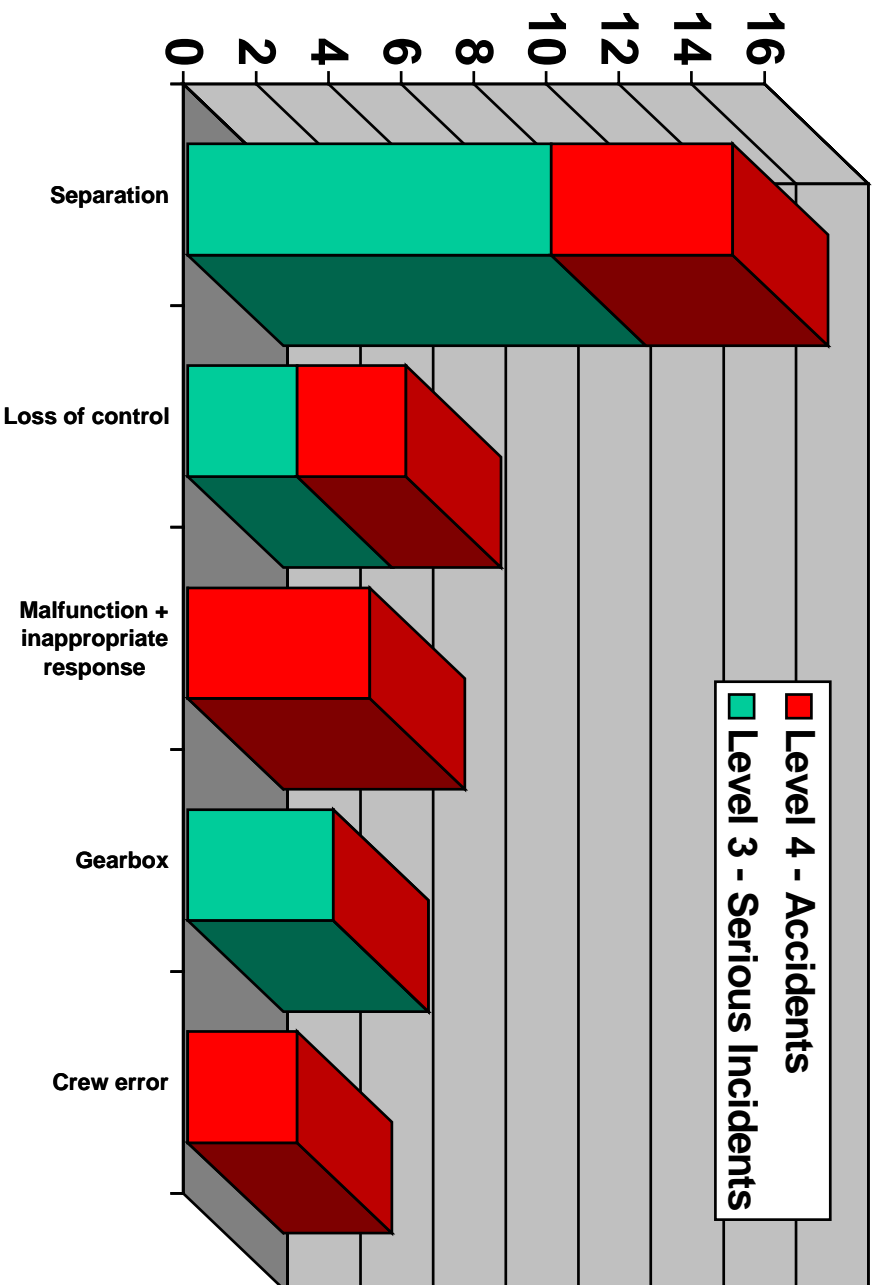
The information necessary to develop a root cause Pareto for propeller malfunction plus inappropriate response was not yet available as of the printing of this report.

Intervention Strategies

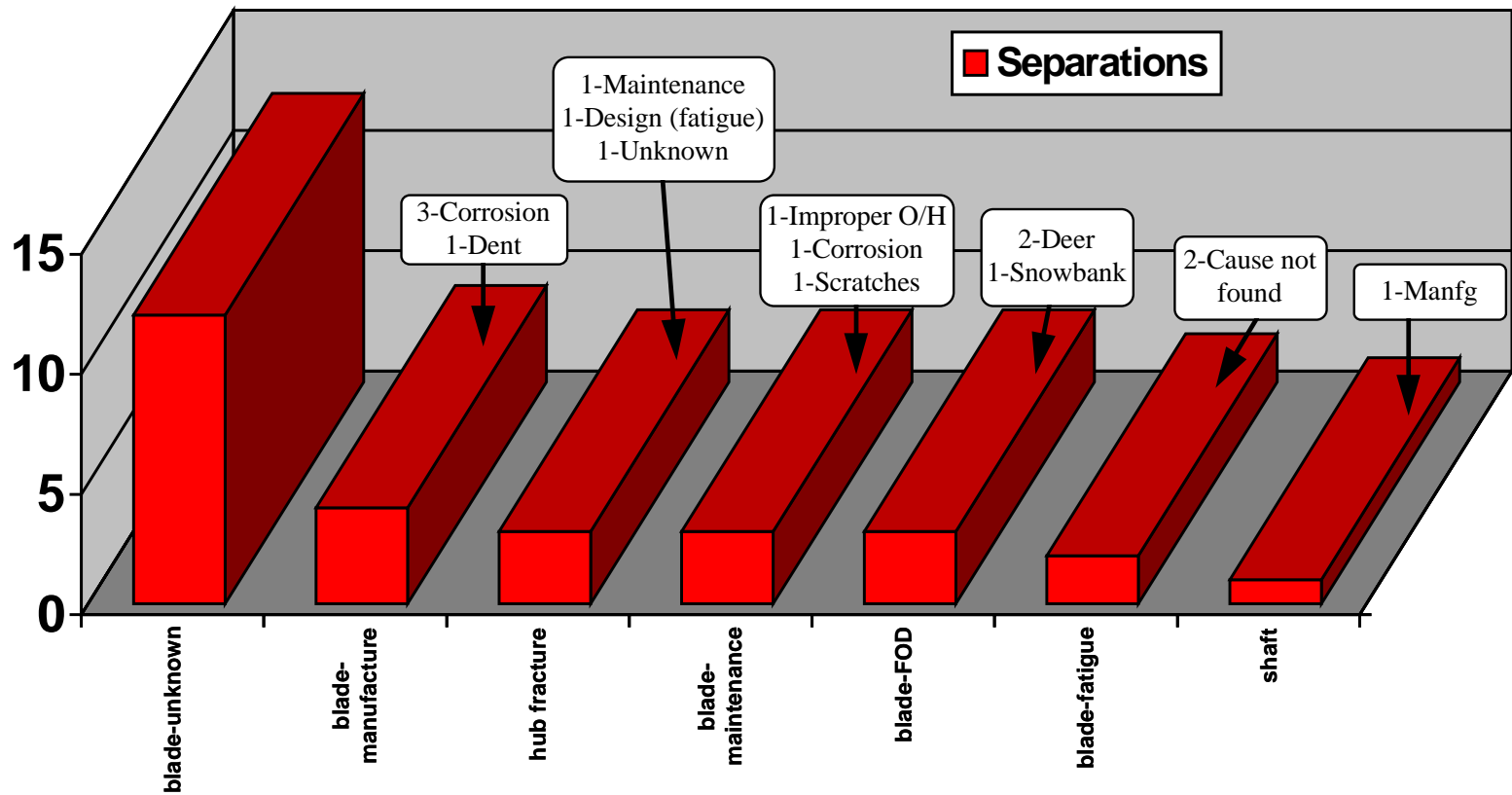
- Update overhaul and maintenance manuals to enhance maintenance instructions.
- Enhanced inspection methods, including the use of fluorescent penetrant (FPI), eddy current (ECI) and ultrasonic in place of dye penetrant.
- Increased FAA oversight of propeller overhaul shops, especially those used by GA.
- Improved fatigue and corrosion tolerance of propeller materials. (Conduct a study to identify propeller materials and determine corrosion, damage, and fatigue interaction. Publish the results in an Advisory Circular (AC) highlighting recommended practices.)
- Improved propeller maintenance awareness. (AC 20.37 - Propeller Maintenance is being updated to address common problems dealing with maintenance, such as leading edge evaluation and repair, corrosion identification and inspection methods.)
- Improved damage tolerance of propeller designs. (Part 35 is being rewritten, with advisory material, with this aim. Existing designs are being controlled by Airworthiness Directives (ADs) where problems have been identified. The ADs mandate replacement or modification of old hardware with more damage-tolerant configurations and establish component inspection intervals.)
- Install beta-mode lockout systems on all propeller-driven aircraft.
- Periodic inspection of all flight-critical hardware, including pitch change and structural components.

- Enhance annual inspection instructions to include a tachometer check to ensure the propeller is not operating in a restricted range.
- Enhance hub corrosion inspection procedures by developing a method using oil or grease samples to detect internal corrosion.
- Flight school emphasis on engine out procedures (timely propeller feathering).

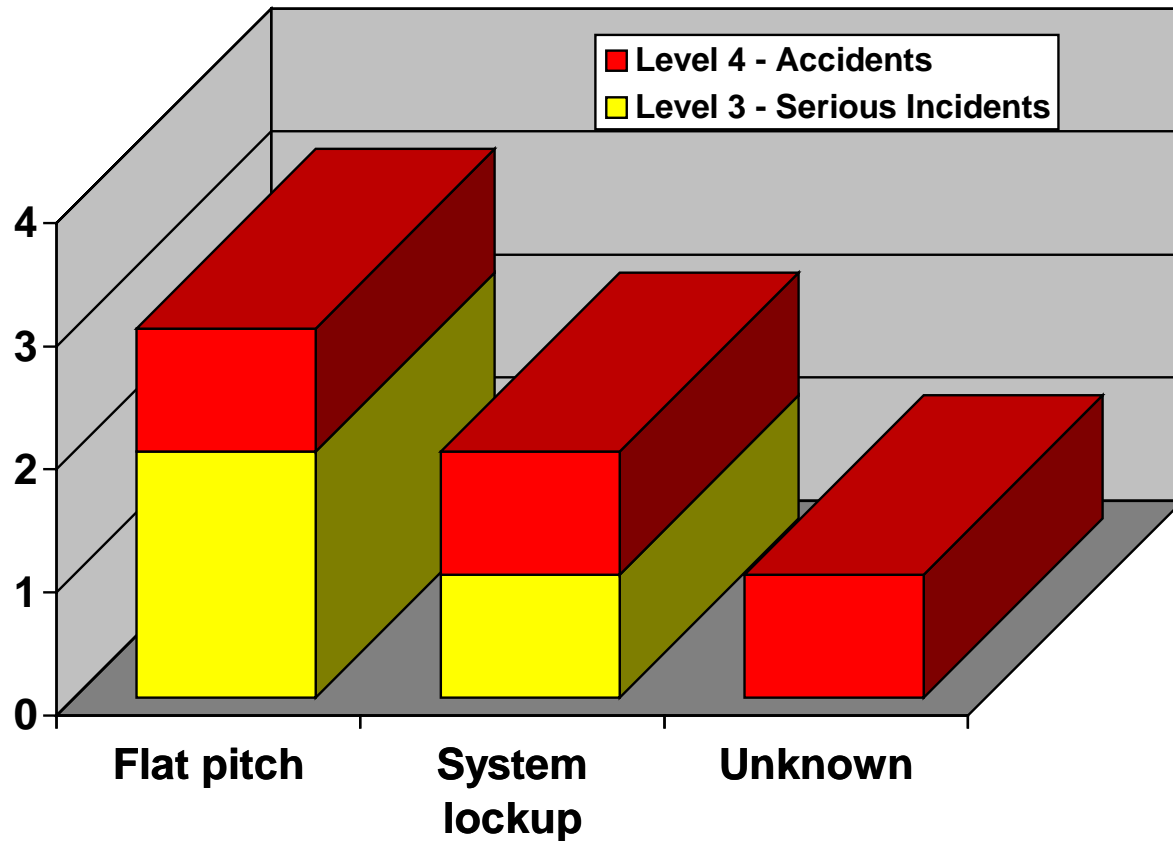
Propellers Installed on Turboprops on Transport Aircraft



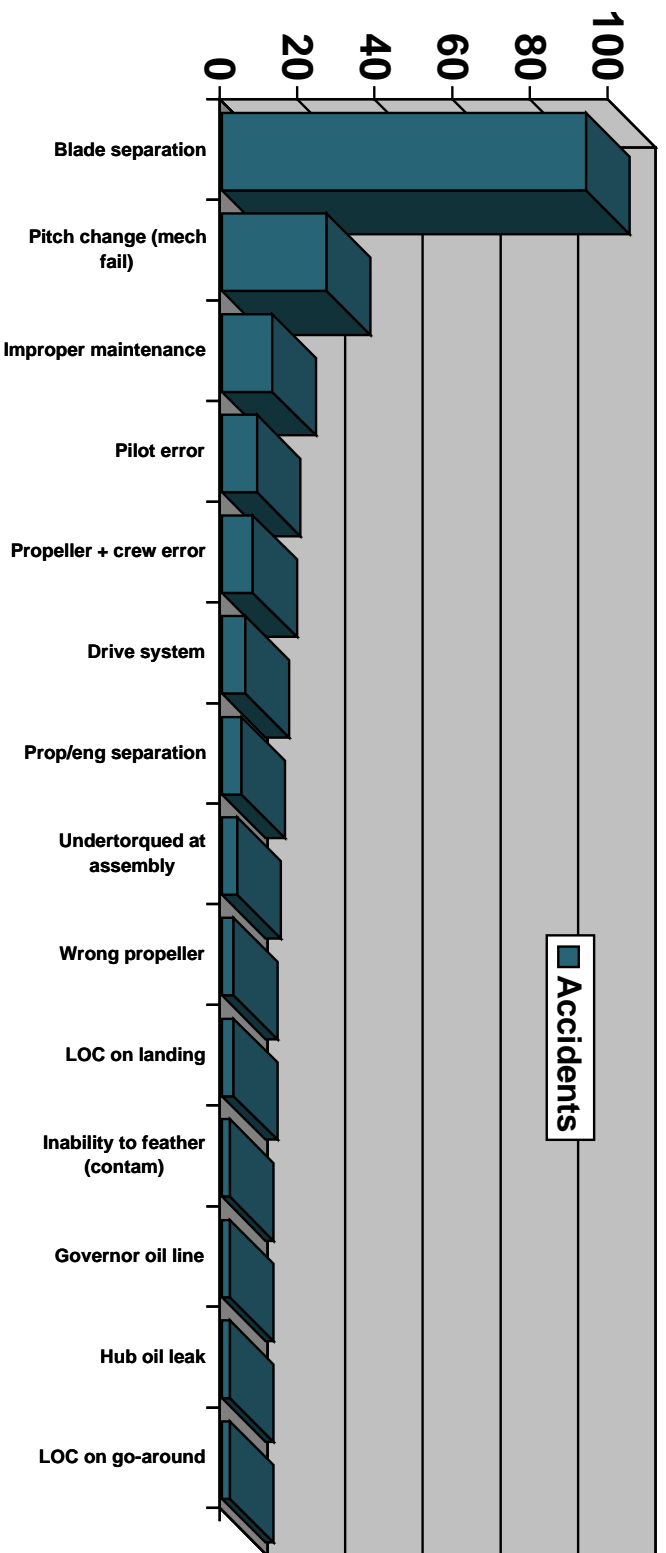
Turboprop Propellers - Blade Separations



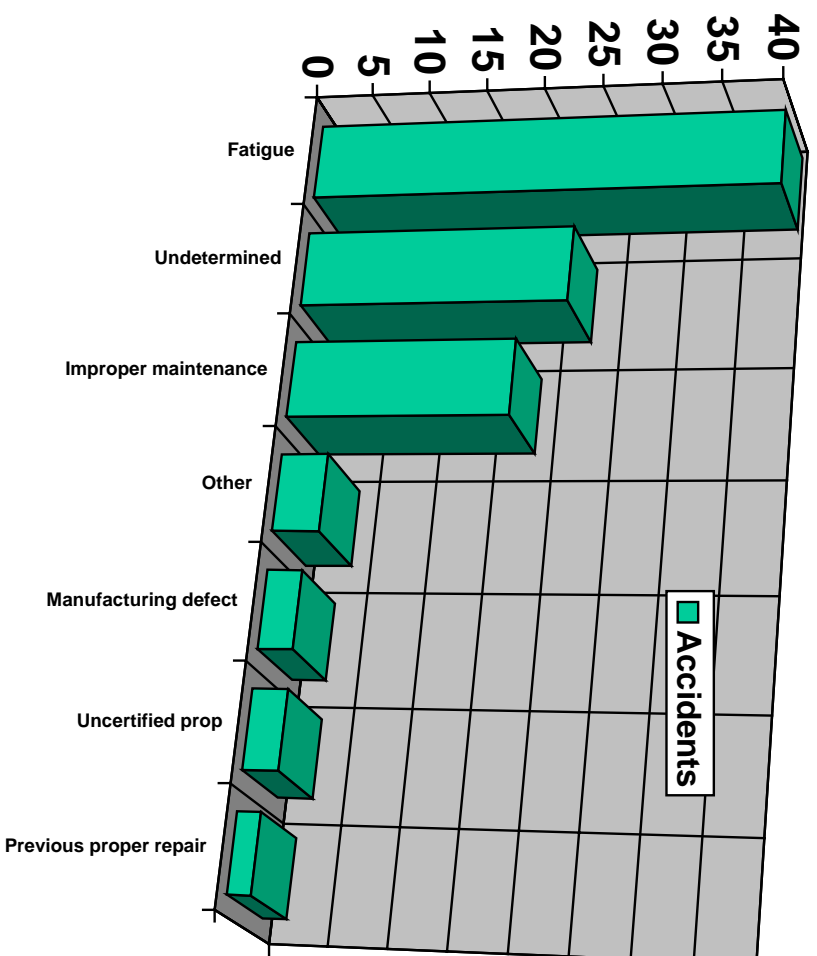
Turboprop Propellers - Loss of Control



Propellers Installed on General Aviation Aircraft



General Aviation Propellers - Blade Separations





(SB).

NTSB reports and the issuance of a complementing Airworthiness Directive (AD) or Service Bulletin

ADs

The SAT manually reviewed a sample of ADs for calendar year 1996. The review concluded that a majority of problems discovered after an aircraft is in service are addressed by the manufacturer in the form of revised maintenance procedures, updated component design, modified procedures, or additional technical information. This information may be provided to the operators via SBs or technical notes. The SAT noted that when all other avenues of compliance have been exhausted, the Directorates of AIR issue an AD to require a mandatory conformance to correct a safety related issue.

Intervention Strategies

Insufficiently Comprehensive Data

The SAT concluded that there is insufficiently comprehensive data on accidents attributed to Part 21. The SAT's primary intervention strategy is to gather improved data relating to manufacturing-related safety issues by means of coding. The SAT believes that coding the NTSB accident and incident reports, as well as ADs, would provide an analysis of the generated data to incorporate in the Aircraft Certification System Evaluation Program (ACSEP) Resource Targeting Model. The coding concept, such as the one for categorizing the data into systems/processes, i.e., design, manufacturing, maintenance, inspection, as well as a further breakdown into aircraft system, fuel systems, electrical systems, and structure, would allow a more capable database to be developed for more rigorous safety analysis. This database can then be analyzed for trends. ADs can be used as a tool to determine the present state of the certification process as well as a tool to focus the FAA's resources during scheduled ACSEP evaluations. Incorporating this coded data would be another means to focus the FAA's evaluation of Production Approval Holder (PAH) facilities.

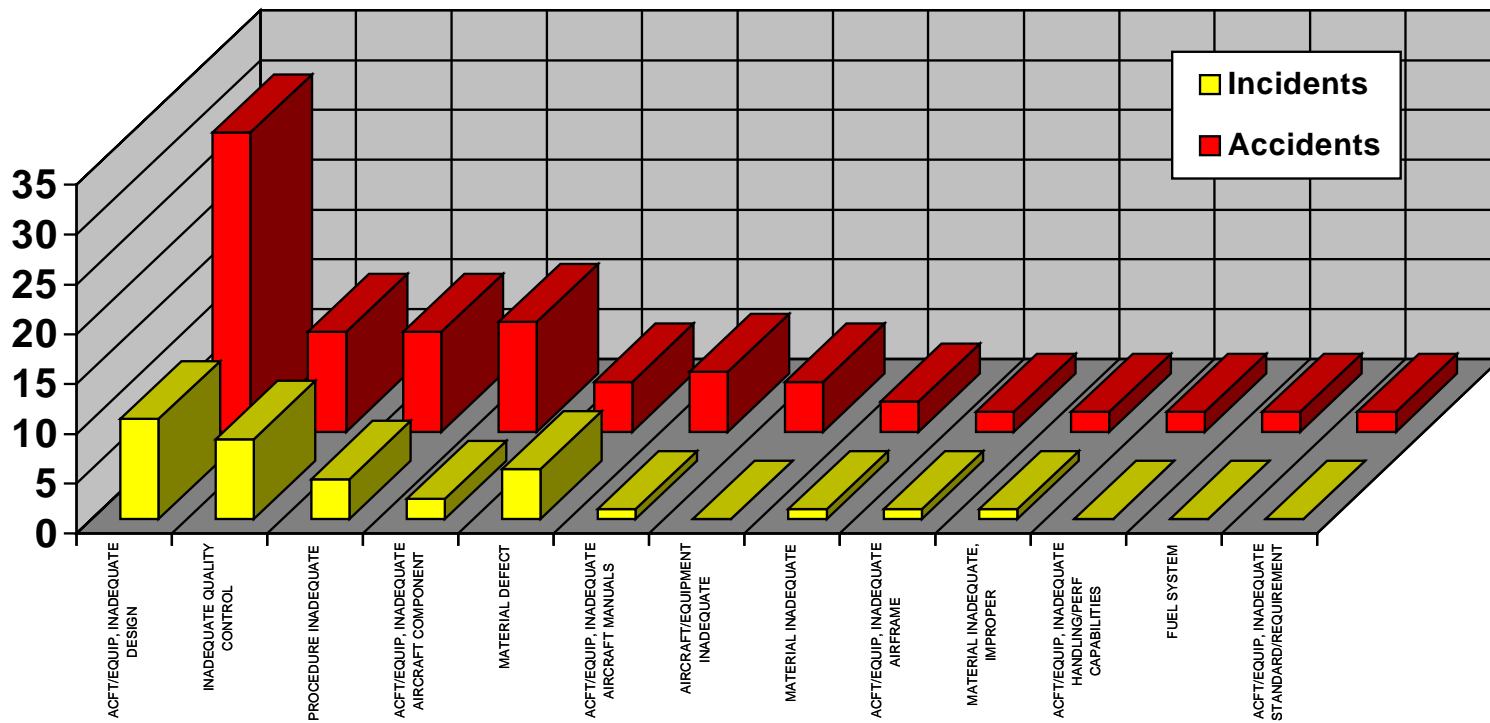
Recommendations

The SAT recommends coding NTSB accident/incident reports and studying AD's as a vehicle to correct design and certification shortcomings. The SAT also recommends that new codes be developed and incorporated in future studies for the actual root cause evaluation and analysis performed prior to the issuance of future ADs.

FAR Part 21

Accidents/Incidents Causes

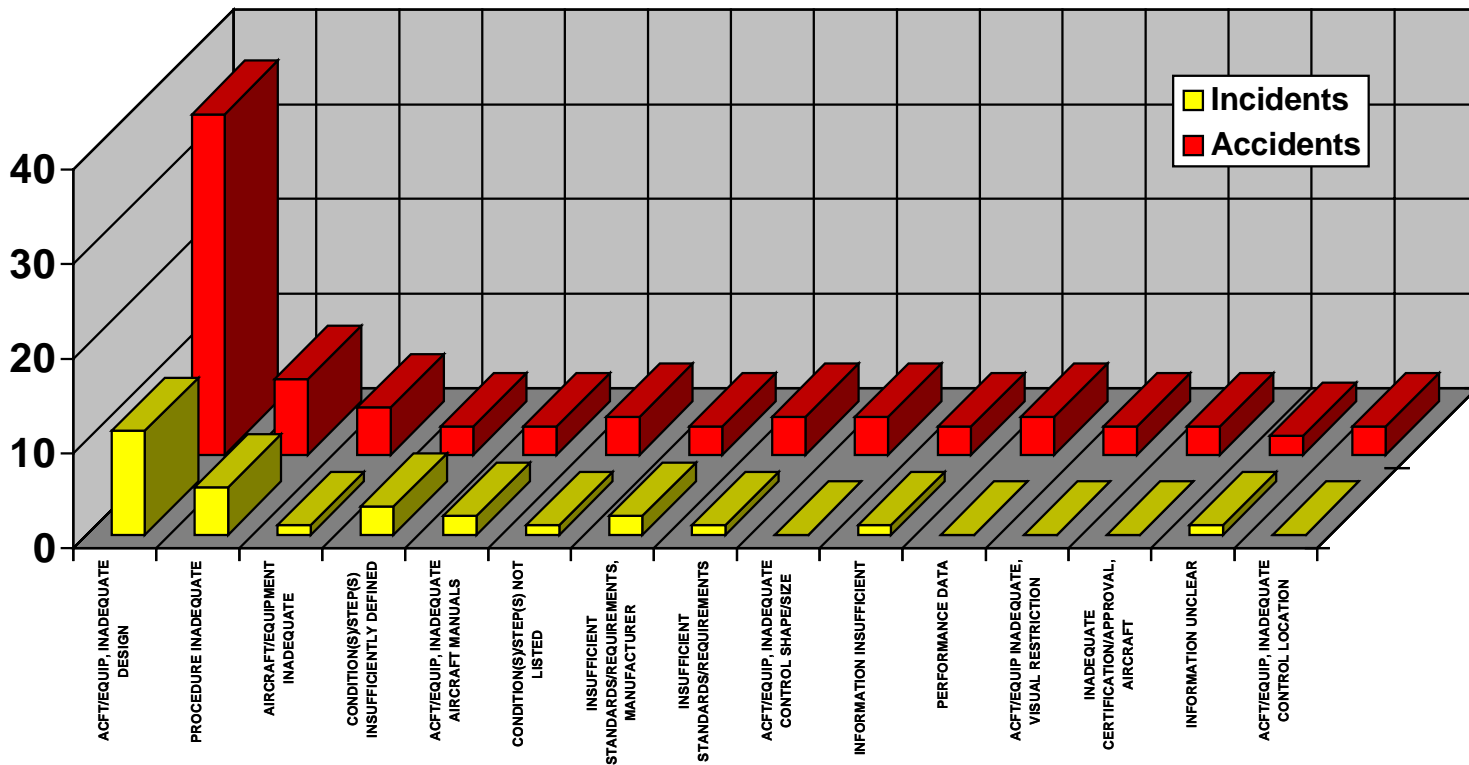
1987 - Current



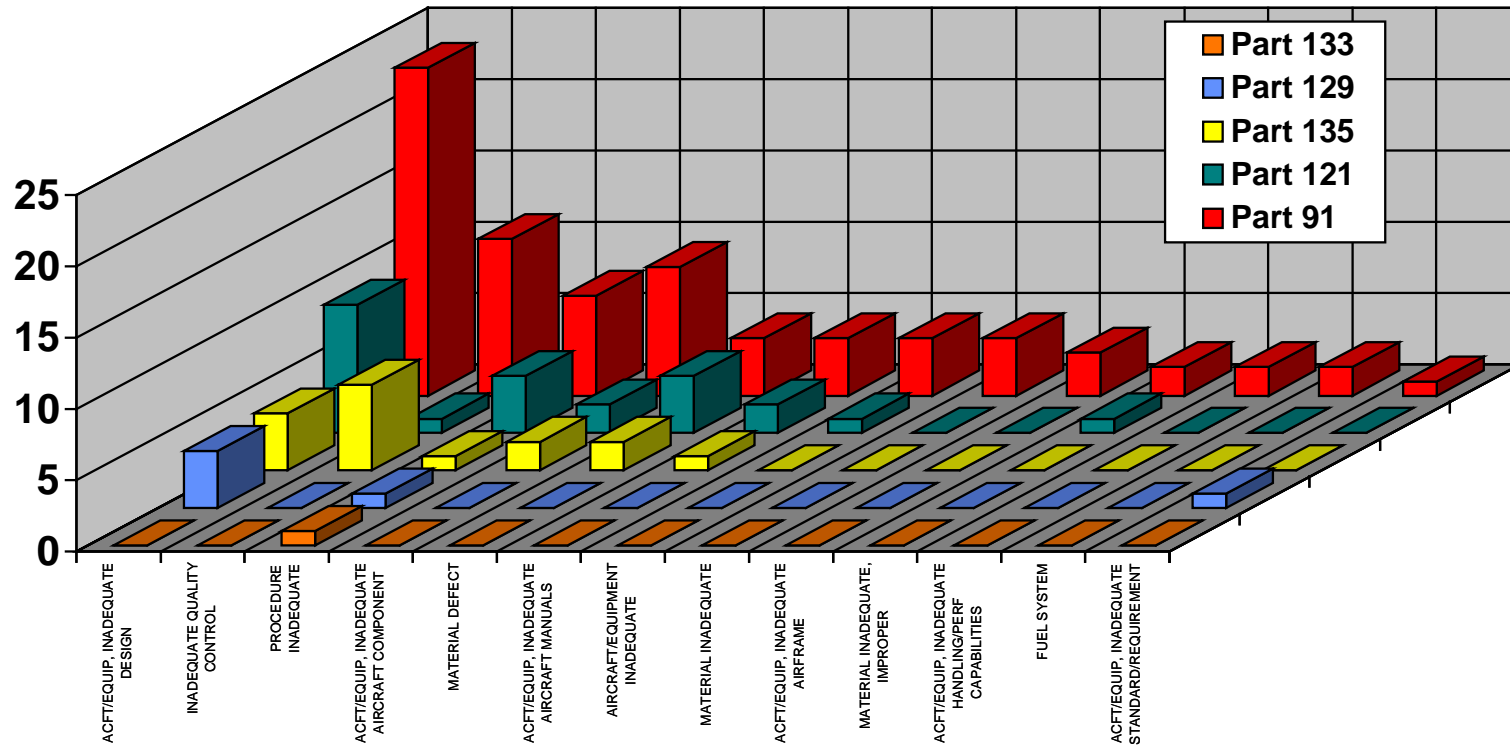
FAR Part 21

Accidents/Incidents Factors

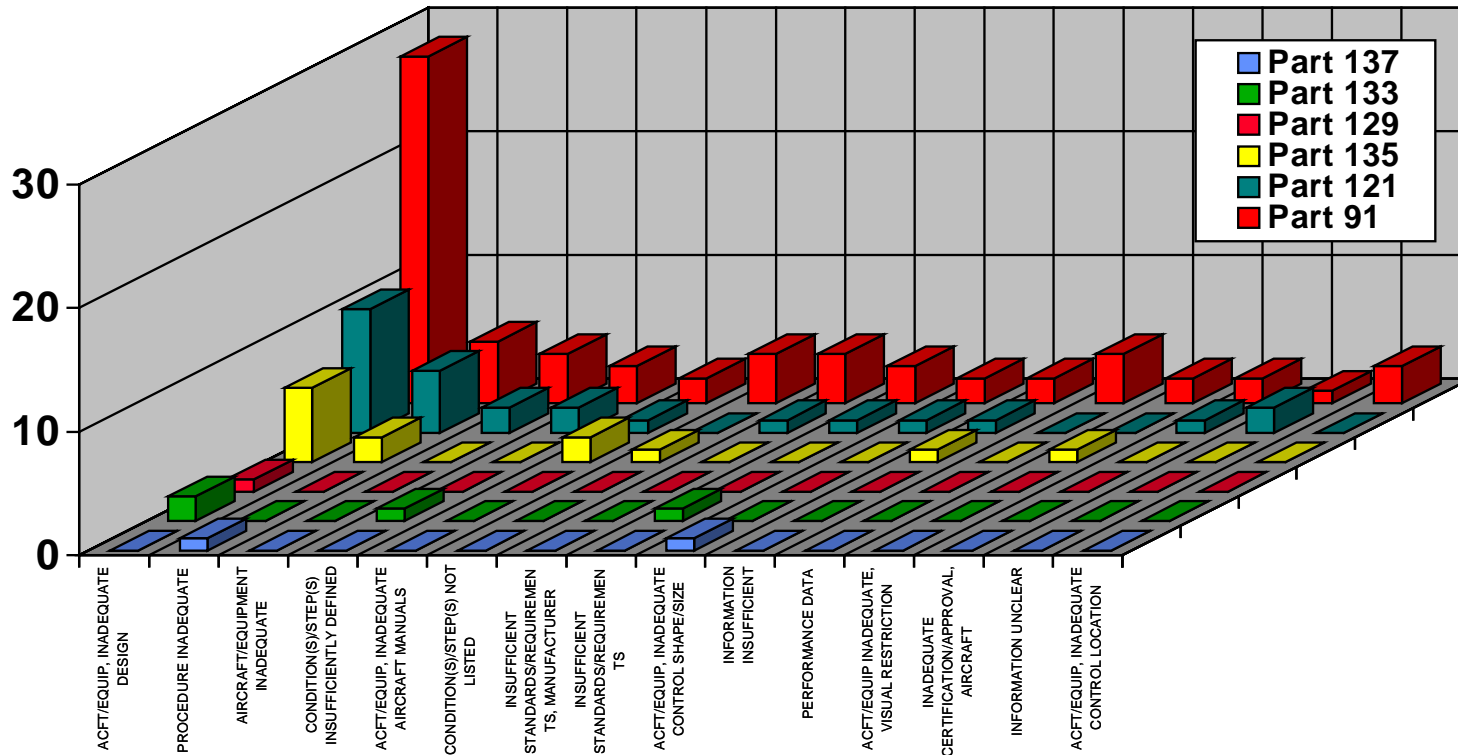
1987 - Current



FAR Part 21 Accidents/Incidents Causes By FAR Part Operations 1987 - Current



FAR Part 21 Accidents/Incidents Factors by FAR Part Operations 1987 - Current



Appendix 1

<i>As of</i>	<i>July 17, 1997</i>						
SOURCE SYSTEM	DATA RANGE	ACCESS	Load Date	Freeze Date	RETRIEVAL TOOLS	SOURCE MEDIUM	SOURCE SUBSET
National Transportation Safety Board Aviation Accident Database(NTSB)	1983 - Current	on-line	13-Jul-97	6-Jul-97	IQ, Q&E, SQL, TOPIC, Web browsers	Internet	All data from NTSB's prelim & final accident and incident reports (without supplements)
NTSB Safety Recommendations / FAA Responses	1963 - Current	on-line	8-Jul-97	7-Jul-97	TOPIC, Web browsers	Internet	All data from NTSB recs
NAIMS - Pilot Deviations(PDS)	1987 - Current	on-line	24-Jun-97	5-Jun-97	IQ, Q&E, SQL, TOPIC	Oracle Export File	All prelim and final reports
NAIMS - Operational Errors & Deviations(OEDS)	1985 - Current	on-line	24-Jun-97	5-Jun-97	IQ, Q&E, SQL, TOPIC	Oracle Export File	All prelim and final reports
NAIMS - Near Midair Collisions(NMACS)	1987 - Current	on-line	24-Jun-97	5-Jun-97	IQ, Q&E, SQL, TOPIC, Web browsers	Oracle Export File	All prelim and final reports
NAIMS - Vehicle/Pedestrian Deviations(VPDS)	1988 - Current	on-line	24-Jun-97	5-Jun-97	IQ, Q&E, SQL, TOPIC	Oracle Export File	All prelim and final reports
NAIMS - Runway Incursions(RI)	1988 - Current	on-line	24-Jun-97	5-Jun-97	IQ, Q&E, SQL, TOPIC	Oracle Export File	All prelim and final reports
NAIMS - Aircraft Operations	1987 - Current	on-line	24-Jun-97	5-Jun-97	IQ, Q&E, SQL	Oracle Export File	Entire database
FAA Accident/Incident System (AIDS)	1978 - Current	on-line	16-Jul-97	10-Jul-97	IQ, Q&E, SQL, TOPIC, Web browsers	SQL Server Database	Incidents only
Service Difficulty Reporting System (SDRS)	1986 - Current	on-line	24-Jun-97	18-Jun-97	IQ, Q&E, SQL, TOPIC	SQL Server Database	Entire database
Aviation Safety Reports (ASRS)	1988 - Current	on-line	10-Jul-97	24-May-97	IQ, Q&E, SQL, TOPIC	Text File Via Email	Entire releasable database
General Aviation Activity Survey (GA)	1992 & 1993	on-line	29-Apr-96	92&93	IQ, Q&E, SQL	Diskette	Entire database
NFDC - Landing Facilities(LF)	Current	on-line	9-May-97	22-May-97	IQ, Q&E, SQL	9-Track Tapes	NFDC databases at NASDAC does not include ARB, DES, ILS, SSD, AWY, FSS, HPF or SUA
NFDC - Air Route Traffic Control Center(AF)	Current	on-line	9-May-97	22-May-97	IQ, Q&E, SQL	9-Track Tapes	
NFDC - Radio Fix(FX)	Current	on-line	9-May-97	22-May-97	IQ, Q&E, SQL	9-Track Tapes	
NFDC - Location Identifier(LI)	Current	on-line	9-May-97	22-May-97	IQ, Q&E, SQL	9-Track Tapes	
NFDC - Navigational Aids(NA)	Current	on-line	9-May-97	22-May-97	IQ, Q&E, SQL	9-Track Tapes	
Aircraft Registry(AR)	Current	on-line	12-Jun-97	30-Apr-97	IQ, Q&E, SQL	9-Track Tapes	Entire database
Aviation System Indicators(SI)	1983 - Current	on-line	4-May-97	2nd Qtr 97	Excel	LAN	Entire document
BTS - Form 41 Activity (T1) for large carriers	1974 - Current	on-line	16-Jan-97	1-Nov-96	IQ, Q&E, SQL	9-Track Tape	Entire T1 Schedule database
BTS - Form 41 Activity (T2) by carrier/acft. type	1968 - Current	on-line	16-Jan-97	1-Oct-96	IQ, Q&E, SQL	9-Track Tape	Entire T2 Schedule database
BTS - Form 41 Activity (T3) by carrier/airport	1990 - Current	on-line	16-Jan-97	1-Oct-96	IQ, Q&E, SQL	9-Track Tape	Entire T3 Schedule database
BTS - Form 41, 298-C, etc. (A1)	Current	on-line	13-Mar-97	Jun-93	IQ, Q&E, SQL, Web browsers	9-Track Tape	Entire A1 Schedule database
BTS Bulletin Board System (Form 41 financial data)	1992 - Current	DOT *	N/A	N/A	BTS's electronic BBS	Not imported by NASDAC but login in requires official system ID	
AirClaims Database (AC)	1952 - Current	on-line	16-Jul-97	1-Jul-97	CASE, QBE	CD-ROM	Entire database
The Aviation Data	Current	on-line	13-Mar-97	1-Mar-97	Proprietary software	CD-ROM	Entire database
ATP Navigator	Current	on-line	16-Jul-97	14-Jul-97	Proprietary software	CD-ROM	Entire database
Airworthiness Directive	Current	on-line	20-Jun-97	8-May-97	Proprietary software	CD-ROM	Entire database
Aviation Publications	Current	on-line	14-Jul-97	Jul-97	Proprietary software	CD-ROM	Entire database
Jane's	Current	on-line	1-Sep-96	1-Aug-96	Proprietary software	CD-ROM	Entire database
FAA Aviation Safety Analysis Systems (ASAS)	Current	CORN *	N/A	N/A	FAA's ISIS retrieval system	Not imported by NASDAC but login in requires official system ID	
FAA Flight Standards Info. Systems (FSIS)	Current	CORN *	N/A	N/A	FAA's ISIS retrieval system	Not imported by NASDAC but login in requires official system ID	

NASDAC DATABASES

National Transportation Safety Board Aviation Accident data System (NTSB): Source: NTSB--received weekly, applied to NASDAC monthly. Contains information collected during investigations of accidents or incidents involving civil aircraft within the U.S., its territories and possessions, and international waters. NTSB is the official source of accident data and their causal factors. Information is from 1983 to Current and includes preliminary and final reports, narratives, and findings. Size: 513 Megabytes as of June 1997.

NTSB Recommendations and FAA Responses: Source: FAA/AAI -- monthly. Contains brief NTSB accident/incident summaries together with relevant NTSB recommendations and FAA letters in response.

National Airspace Information Monitoring System (NAIMS): Source: FAA/ASY100 -- monthly. Contains subsystems PDS, OEDS, NMACS, and VPDS as described below. Reports are from 1987 to Current.

Pilot Deviation System (PDS): Contains pilot deviation reports resulting from violation of a federal aviation regulation or a NORAD Air Defense ID Zone tolerance. New reporting forms went into effect in 1992. Size: 46 Megabytes as of June 1997.

Operational Error and Deviation System (OEDS): Contains all operational error or deviation reports which have occurred in the NAS. Also contains causal factor information. Size: 17 Megabytes as of June 1997.

Near Midair Collision System (NMACS): Contains pilot-reported near midair collision incidents. Reporting is voluntary and often subjective; pilots may report to NASA (through ASRS) instead of FAA. New reporting forms went into effect in 1992. Size: 22 Megabytes as of June 1997.

Vehicle/Pedestrian Deviation System (VPDS): Contains information on incidents involving entry or movement on an airport movement area by a vehicle operator or pedestrian that has not been authorized by ATC. Size: 3 Megabytes as of June 1997.

Runway Incursion System (RI): Contains information derived from OEDS, VPDS, and PDS airport surface incidents that created a collision hazard or resulted in loss of separation with an aircraft taking off, intending to take off, landing, or intending to land. Size: 123 Kilobytes as of June 1997.

Aircraft Operations (Operations) (Tower Counts): This database contains operations conducted since 1987 at air traffic control facilities and is used to normalize accident and incident rates. Size: 4 Megabytes as of June 1997.

FAA Accident/Incident Data System (AIDS): Source: FAA/AFS -- monthly. Contains data records for incidents gathered from FAA Incident Report Form 8020-5, and teletype preliminary data. AIDS is most useful for incidents since NTSB is the official source of accident information. Reports are from 1985 to Current. Size: 226 Megabytes as of June 1997.

Service Difficulty Reporting System (SDRS): Source: FAA/AFS -- monthly. Contains general aviation malfunction and defect reports and air carrier mechanical reliability report subsets. Data is submitted by air carriers, field offices, manufacturers, and individuals. Reports are from 1986 to Current. Size: 1227 Megabytes as of June 1997.

Aviation Safety Reporting System (ASRS): Source: NASA/Ames Laboratory -- Quarterly. Contains voluntary reports of occurrences that could impact aviation safety. Reports are submitted by pilots, controllers, mechanics, other interested parties, and users of the NAS. Includes useful human factors information in the narratives. All privacy or identifying data is expunged or "sanitized." Reports are from 1988 to Current. Size: 285 Megabytes as of June 1997.

General Aviation Activity Survey (GA): Source: FAA/APO -- Annually. Contains all information taken from the respondents to the 1992 and 1993 General Aviation Activity and Avionics Survey. Each record describes aircraft characteristics, estimated flying time, landings, fuel consumption, lifetime airframe hours, avionics, and engine hours of the active general aviation aircraft. Size: 60 Megabytes as of June 1997.

National Flight Data Center (NFDC): Source: NFDC -- Every 56 days. Contains subsystems AF, LF, LI, NA, and FX as described below. (Source: FAA/NFDC)

Landing Facilities (LF): Contains information from National Flight Data Center on all private and public use landing facilities (airports, heliports, gliderports, etc.) including location, services, runway, lighting, administrative, and remarks. Size: 47 Megabytes as of June 1997.

Air Route Traffic Control Center (AF): Contains records for each Air Route Traffic Control Center Facility. The Air Route Traffic Control Center Facility File (ARTCC) contains all Remote Air/Ground Facilities (RCAG), Air Route Surveillance Radars (ARSR), Secondary Radar (SECRA), and Center Radar Approach Control Facilities (CERAP), under US area of responsibility. The database does not include any foreign facilities and/or radars. Size: 467 Kilobytes as of June 1997.

Radio Fix (FX): Contains named and numbered radio fixes used in airway navigation. Includes waypoints, reporting points, turning points, military fixes, ARTCC boundary crossing points, and airway intersections. Information includes positional, charting, and fix facility makeup. Size: 8 Megabytes as of June 1997.

Location Identifiers (LI): One record for each identifier assigned to an active facility. Describes all facilities (airports, instrument landing systems, navigational aids, Flight Service States, Air Route Traffic Control Centers, and special use) assigned to that identifier. Size: 6 Megabytes as of June 1997.

Navigational Aids (NA): Description of all VHF Omni-directional Range (VOR), Non-directional Beacon (NDB), Tactical Air Navigation (TACAN), Fan Marker, and Consolan facilities used in airspace navigation. Information includes location, position, class, features, frequencies, and associated fixes. Size: 4 Megabytes as of June 1997.

Aircraft Registry (AR): Source: FAA/AFS. The FAA aircraft registry is a data system used to record and track civil aircraft registered in the United States. Registration occurs at the Federal Aviation Administration in Oklahoma City where the appropriate information is obtained and recorded from the aircraft purchaser. The database is updated in real time as the registry staff obtain and enter the data into the data system. The Registry maintains the permanent records of over 320,000 active civil aircraft and provides approximately 700 copies of aircraft records daily for review to users of the Public Documents Room located in the Registry Building at the Mike Monroney Aeronautical Center in Oklahoma City, Oklahoma. Information recorded in the registry includes the aircraft registrant's name, address and state. Information on the aircraft includes the engine manufacturer and type, the aircraft N number, serial number, make model code, year of manufacture and much more including special use of the aircraft (agricultural or patrolling for example) and number of seats. Size: 89 Megabytes as of June 1997.

Aviation System Indicators (SI): Source: FAA/ASY. Excel spreadsheets containing monthly flight hours data and accident/incident rates categorized according to large air carriers, commuters, air taxis, general aviation and rotorcraft. While published System Indicator reports cover limited time periods, the database contains all data from 1987 to Current and is updated quarterly.

Bureau of Transportation and Statistics (BTS) (Formerly RSPA): Source: BTS. Contains subsets T1, T2, T3 and A1 as described below. Size: 197 Megabytes as of June 1997.

BTS Form 41 Reports - Traffic Schedule (T1): Monthly totals since 1990 for large certified air carriers of capacity and traffic data including departures, passenger and cargo traffic, available seats and cargo capacity; all classified as scheduled or nonscheduled, first class or coach, civilian or military.

BTS Form 41 Reports - Traffic Schedule (T2): Delivered quarterly by summarizing data submitted since 1991 by U.S. carriers in their monthly T-100 Segment/Market reports and their quarterly supplemental Schedule T-2. All data items summarized by carrier, date, and aircraft type.

BTS Form 41 Reports - Traffic Schedule (T3): Quarterly totals since 1991 for reporting carriers, for each airport served, of departures and passenger and cargo traffic enplaned, in both scheduled and nonscheduled service; as well as departures by each aircraft type which served the airport.

BTS Form 41, 298-C (A1): Contains statistics pertaining to the commuter air carrier.

BTS Bulletin Board System: Form 41 Financial Data, consisting of balance sheets, profit and loss statements, and aircraft operating expenses since 1992.

DATABASES ON CD-ROM

AirClaims Data System (AC): Source: AirClaims Group, UK. Contains worldwide accident data from government sources and insurance claim information on accidents involving fatalities or major financial loss, as well as exposure and other operations data. Information is from 1952 to Current.

Aviation Data contains the following information:

1. Pilots
2. Aircraft Owners
3. Mechanics
4. Medical Examiners
5. Airports
6. SDRS
7. Air Taxis
8. Schools

ATP Navigator contains the following information:

1. Airworthiness Directives(AD)
2. Associated Service Information
3. Type Certificates
4. Supplemental Type Certificates
5. Advisory Circulars
6. Orders
7. Federal Aviation Regulations(FARS)

Airworthiness Directives contains the following information:

1. Revisions for 97-10
2. Airworthiness Directives(AD)
3. Advisory Circulars
4. Federal Aviation Regulations(FARS) 1-199
5. Service Bulletins
6. Type Certificates V1-6

Aviation Publications contains the following information:

1. Federal Aviation Regulations(FARS)
2. Airman's Information Manual(AIM)
3. Advisory Circulars
4. Airworthiness Directives

Jane's

Aviation Safety / Accident Prevention (ASAP)

ASAP is an Aircraft Certification effort to greatly multiply the ability of accountable technical personnel to perform their continued airworthiness function. With limited resources the Aircraft Certification Service must face the increased technology diversity of aviation. ASAP provides the resources to meet that challenge in the managing of service problems. Every month Aircraft Certification is faced with analyzing a multitude of safety related events in addition to its certification and regulatory requirements. These events include (but are not limited to):

- ◆ Some 2,700 Service Difficulty Reports (SDRs) from operators.
- ◆ Some 440 Accident/Incident (AID) reports from Flight Standards and NTSB.
- ◆ Preparation of approximately 30 Airworthiness Directives (ADs) providing mandatory actions for safety problems.
- ◆ And the review of numerous requests for Parts Manufacturing Approval.

Prior to the advent of the computer revolution, this task required an exhaustive number of man-hours in assimilating, categorizing, reviewing, and recommending solutions that strained Aircraft Certification's resources to the limit. In today's world of shrinking government resources the accountable technical person is clearly in need of some help. ASAP is that help.

People are vastly superior to computers in logical thinking and intuitiveness. Computers are superior in speed at tracking/displaying related information. ASAP marries the accountable technical person to the computer in a manner that maximizes these desired attributes. The ASAP system is comprised of the following relational databases:

<u>Database</u>	<u>No. of Reports</u>	<u>Source</u>
Service Difficulties	427,414	National database
Accident/Incidents	65,631	National database
Airworthiness Directives	9,124	National/FAR
Life Limited Parts	14,768	Local
Type Certificate Data Sheets	839	Commercial
NTSB Recommendations	2438	NTSB
Significant SDRs	32	ASW-100
Daily Alerts	1104	AAI
Suspected Unapproved Parts	51	AFS-600

The SDR database, which is input daily from the operators, lies at the center of the ASAP system. As the accountable technical person reviews an SDR, this computer based system provides dynamic links to each of the other databases. A warning is provided if the part:

- ◆ has previously been involved in an accident.
- ◆ is the subject of an Airworthiness Directive.
- ◆ is a life limited part.
- ◆ is an unapproved part.

Additionally, the past history of each part is displayed in the form of the following trends:

- ◆ Two-year trend
- ◆ One-year trend
- ◆ Six-month trend
- ◆ Three-month trend
- ◆ Two-year Safety Assessment

As the accountable technical person reviews each SDR, a safety assessment is accomplished. A set of criteria for catastrophic, hazardous, major, minor and no effect classification is displayed. This criteria is developed by Aircraft Certification Staff. The SDR displays not only the safety assessment associated for the displayed SDR, but also the number of catastrophic, hazardous, major, minor and no effect events for the past two years for the malfunctioning part. Displaying the cumulative safety assessment on each SDR helps to prevent the buildup of safety related events that the accountable technical person might have overlooked in previous years.

Using the ASAP system allows Aircraft Certification to become proactive in addition to being reactive. Queries can be made covering all databases -- queries similar to the following:

- ◆ How many reports are there on corrosion for a part, model, or manufacturer?
- ◆ AD xx-xx-xx replaces part A with part B due to part A's history of cracking. How many SDRs involving cracking on part B has occurred since the AD became effective?
- ◆ If an AD is issued on one model for a particular problem, how bad is the same problem on other models?
- ◆ A manufacturer request a parts manufacturing approval on part A. ASAP allows approval or disapproval by answering the following question in a matter of minutes:
 - Does the part have a significant SDR history?
 - Have there been any accidents attributed to this part?
 - Has the part ever been the subject of a previous AD?

When a safety event becomes significant the accountable technical person can track the SDR. The project maintains a history of the problem with actions to date that have been taken to solve the problem. The information in the project may be used for:

- ◆ Airworthiness Directive (AD) justification.
- ◆ future reference when the problem occurs again.
- ◆ automatically feeding a newsletter for feedback to the submitters.
- ◆ other actions short of ADs.

ASAP places all conceivable safety related information at the accountable technical person's fingertip. ASAP makes no judgments. Computers do not do this very well. Aircraft Certification people make the necessary safety related decisions.















The future of ASAP is virtually unlimited. As new databases of aviation safety interest are compiled, they can be related in similar fashion to those already included. Technical aviation specialists in the agency and in industry have, in ASAP, a highly intelligent, up-to-date tool for

basing safety judgments on which to take timely action that can resolve chains of service problems short of their developing into aviation accidents. Thus the program title "Aviation Safety / Accident Prevention (ASAP)".

Definitions

Aircraft Accident: An occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and until such time as all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage.

Aircraft Incident: An occurrence other than an accident associated with the operation of an aircraft, which affects or could affect the safety of operations. Note that NMACS, PDS, OEDS, and VPDS are special kinds of incidents.

ID	Task Name	Aug 3, '97	Aug 10, '97	Aug 17, '97	Aug 24, '97	Aug 31, '97	Sep 7, '97	Sep 14, '97	Sep 21, '97
		8/3	8/10	8/17	8/24	8/31	9/7	9/14	9/21
1	Team Building Skills								
2	NASDEC [item II.a.]								
3	FAR 21								
4	FAR 23								
5	FAR 25								
6	FAR 27								
7	FAR 29								
8	FAR 33								
9	FAR 35								
10	ANAYSIS [item II.b.]								
11	FAR 21 Pareto								
12	Root Cause								
13	Intervention/Doc/Pre-Coor								
14	Presentation - Draft								
15	FAR 23 Pareto			