Rejected Takeoffs: Causes, Problems and Consequences

Rejected takeoffs involve multiple risks and require a high level of pilot perception, judgment and procedural skill. This study looks at human factors associated with rejected takeoffs.

by
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... As we started our taxi, I asked the captain if he preferred using normal or alternate takeoff power ... My thoughts were occupied with the upcoming takeoff procedure since it was my leg. After receiving takeoff clearance, I advanced the throttles ... to the normal takeoff power setting. I first heard the aural takeoff configuration warning horn ... Looking down at the flap handle I was absolutely ... surprised to see that it was in the up position. We aborted ... before reaching 40 knots. [National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS) record number 78074]

Rejected Takoffs Involve Multiple Risks

Accidents and incidents involving air transport aircraft have renewed interest in the process and problems associated with a rejected takeoff (RTO). The La Guardia Boeing 737-400 runway overrun in 1989 involved flight crew performance deficiencies before, during and after the takeoff rejection. [The accident occurred September 20, 1989, at La Guardia Airport, Flushing, New York. There were 63 persons involved, including two fatalities.] Contributing to these human performance errors were external conditions that were not perceived by the flight crew as being relevant to their operating decisions.

The 1987 Detroit DC-9-82 and 1988 Dallas Boeing 727-232 no-flap takeoffs also underscored the possibility that flight crews could fail to properly configure their aircraft for takeoff and not detect their acts of omission. [The DC-9 accident occurred August 16, 1987, at Detroit Metropolitan/Wayne County Airport, Romulus, Michigan. There were 162 persons involved, including 156 fatalities. The Boeing 727 accident occurred August 31, 1988, at Dallas International Airport, Texas. There were 108 persons involved, including 14 fatalities.]

RTOs introduce multiple risks — those associated with the takeoff abort and those associated with the events that may follow the abort. RTOs are also symptomatic of a breakdown in human performance that can lead to improper aircraft conditions or configurations. A successfully managed RTO involves a skillful blending of pilot perception and appropriate action to conclude the abort procedure safely and avoid dangerous follow-on events.

The following data present a small part of a larger ongoing effort that seeks to categorize the causes, problems and effects of rejected takeoff events as reported through ASRS.

Study Focuses on Human Error RTOs

Human errors associated with rejected takeoffs reported to ASRS were analyzed. Incident reports were studied to understand the flight crew human factors that led to RTOs; to identify decision-making and procedural issues associated with RTO initiation and execution; and to analyze problems that occurred in the wake of rejected takeoffs.

Initially, 507 incidents occurring between January 1, 1983, and November 30, 1990, were retrieved from the ASRS database. Only reports submitted by flight crew members of transport category aircraft (in excess of 60,000 lbs./27,000 kg. gross weight) were considered. Of these, 168 were found to be relevant to flight crew decision-making and procedures. The findings of this study are based on this 168-report subset (Table 1) and focus on the flight crew performance problems that are factors before, during and after an RTO.

Table 1
Distribution of Study Reports

Category	Number of Incidents*
Flight Crew Errors Leading to RTOs	94
RTO Initiation and Execution Problems	13
Post-RTO Problems	84

*Some reports apply to more than one category

Source: Aviation Safety Reporting System

Causal Factors Sought

The reports were read and analyzed for causal factors underlying the rejected takeoff event. Primary causal factors were labeled as flight crew procedural errors or conditions that predispose such errors. Secondary contributing factors were also considered. In each incident, the abort maneuver was examined for potential problems with its initiation and execution. Finally, flight crew decisions made in the wake of the rejected takeoff were also evaluated.

The RTO study subset was limited to reports submitted by flight crew members, since only they could shed light on the cockpit procedures employed, crew members' roles and crew perceptions of aircraft operating conditions.

Data collected by the ASRS are subject to both known and unknown biases. Since reports are voluntarily submitted, they constitute a nonrandom sample of the actual population of aviation safety incidents. In addition, reporters' incident descriptions are colored by their individual motivations for reporting. They usually give only one perspective of the event, and this is not balanced by any additional investigation or verification.)

Flight Crew Errors Leading To RTOs Identified

Ninety-four RTOs were caused by crew errors. Five categories of crew-induced rejected takeoff scenarios were identified. These were:

Unauthorized Takeoffs. An aircraft departed prematurely or used the wrong runway for takeoff. In wrong-runway takeoffs, the aircraft was authorized onto a runway but then deviated from air traffic control (ATC) directives (22 incidents).

Taxiway Takeoffs. An aircraft departed from a taxiway rather than a runway (seven incidents).

Off-runway Takeoffs. An aircraft erroneously aligned with the runway edge lights instead of the centerline lights while positioning for takeoff (three incidents).

Aircraft Configuration Anomalies. An aircraft was improperly configured before, during or following the RTO. The aircraft configuration anomalies included four conventional abnormals often practiced in recurrent training: improperly set flaps; unstowed spoilers or spoiler handle; stabilizer trim not in agreement with preset parameters; and failure to observe that a cockpit window was unlatched (34 incidents).

Loss of Aircraft Control. An initial mismanagement of thrust levers created a loss of aircraft heading control. Loss of control was often worsened by misuse of primary ground steering devices (10 incidents).

The remaining 18 incidents involved aircraft discrepancies unrelated to configuration that were attributable to flight crew errors.

In addition to identifying RTO event categories, flight crew procedural errors contributing to RTOs were also determined. Procedural errors were classified as improper information transfer, deficiencies in task management and crew coordination, and aircraft configuration anomalies.

Some reports revealed that the interaction between the flight crews and tower controllers was not effectively monitored by the captain.

Improper Information Transfer. Some reports revealed that the interaction between the flight crews and tower controllers was not effectively monitored by the captain. The lack of an ATC response to a flight crew communication was often interpreted as approval by the flight crew. Other communication failures were associated with unauthorized and premature takeoff incidents. In these, flight crews failed to challenge partial or doubtful clearances. These findings suggest that intra-crew communications can be compromised by insufficient cross-checking.

Deficiencies in Task Management and Crew Coordination. Flight crews did not always choose the right time to perform a required function. Often, the error was in allowing the other pilot to change radio frequency to make a company radio call at an inappropriate time. Wrong-runway takeoffs usually were associated with a rushed cockpit environment and poor crew coordination in the areas of cross-checking, mutual support and use of proper charts. Off-runway takeoff and taxiway takeoff events also were characterized by rushing and lack of flight crew coordination. In the latter events (which usually occurred at night), it was common for one pilot to be head-down in the cockpit while performing the checklist during the runway entry.

Failure to monitor control inputs and to detect inappropriate control movements led to five loss-of-control incidents. These typically were caused by improper throttle application and the resulting uneven spool-up of large bypass engines. Asymmetrical thrust was further exaggerated by snow, ice, moisture or rubber deposits on the runway surface. Sometimes, a misapplication of corrective control and throttle movements placed the aircraft off the runway, because the loss of control was so unexpected.

Aircraft Configuration Anomalies. Improperly performed checklists were the leading cause of aircraft configuration anomalies. Most reporters stated that they missed a checklist item — most frequently the flaps — during a period of busy cockpit activity or during interruptions of routine monitoring and cross-checking functions. There were eight incidents where leading edge flaps created a warning, usually because of a circuit breaker being out of normal position. Another six reports cited errors in trim setting.

Several conditions were identified as potentially predisposing flight crew procedural errors. These consisted of radio frequency congestion, schedule pressure, environmental factors and transfer of control to the first officer.

Frequency Congestion. This was often associated with clipped transmissions, missed clearances and readbacks and flight crews responding to wrong call signs. Pilots were more prone to act on their expectations, during periods of excessive radio traffic rather than on ATC's actual instructions. Frequency congestion was the most frequently cited predisposing condition.

Schedule Pressure. Other reports reflected schedule-related pressures that compelled flight crews to hurry. Driven by company "on-time" considerations or ATC traffic flow priorities, flight crews improvised callouts and altered cockpit procedures to meet schedule demands. These procedural shortcuts led crews into incomplete readbacks, nonstandard phraseology and inadequate intra-cockpit communication. Hurrying also led to missed items in the checklist. The assumption of too many tasks in too brief a time overloads a flight crew and results in "forgetfulness" that the U.S. Federal Aviation Administration (FAA) has identified as a causal factor in runway incursions. This work load-induced forgetfulness was also associated with many RTO events in the study data.

The role of the tower controller as a safety factor in RTO events reported to ASRS was significant.

Environmental Factors. Weather adversely affected visibility and lighting conditions and contributed to flight crew performance errors in 10 reports. In some cases, runway lighting was also instrumental in creating disorientation and resulted in either wrong-runway takeoffs or taxiway takeoffs at night. A few flight crews requested that tower controllers dim or turn off the lights on inactive runways.

Transfer of Control to the First Officer. As represented by the opening report excerpt, a disproportionate number of RTOs occurred when the first officer was conducting the takeoff and had control of the throttles. These events included off-runway and unauthorized takeoffs, improper aircraft configurations and loss of aircraft control. From the character of these reports, it appeared that problems sometimes resulted from the first officer's failure to execute the initial phase of the takeoff in the manner expected by the captain. The captain's expectations were often shaped by the first officer's past performance. However, when the first officer and the captain were unfamiliar with each other, a captain was prone to assess a first officer's capabilities only by his length of experience. In either circumstance, captains exhibited complacency regarding their responsibility to monitor first officers' actions.

Tower Controllers Cited As Significant Safety Factor

The role of the tower controller as a safety factor in RTO events reported to ASRS was significant. RTOs were most often initiated by the tower controller during unauthorized, wrong-runway takeoffs and taxiway takeoffs. These events were usually caught in the controller's scan, and a low-speed abort resulted. In contrast, runway excursions and off-runway takeoffs were often detected by the flight crew. The flight crew disorientation inherent in these events usually resulted in relatively high-speed rejections; however, off-runway incidents sometimes continued into takeoffs where potential aircraft damage could go undetected by the flight crew.

Aircraft configuration problems that resulted from flight crew procedural errors were usually announced by the takeoff warning system and typically resulted in a low-speed abort. The low-speed RTO was generally a reactive closing of the throttles and coasting to the next turn-off.

Abort decisions related to aircraft system failures — including engine failures — were more apt to be derived from multiple warnings and to result in high-speed aborts. There were 13 reports where the abort speeds were at V_1, and in some cases the speed was as high as V_r and into liftoff. Most crews seemed to base their go/no-go decisions not only on speed but also on the number of warnings received, runway remaining and their perception as to whether the aircraft could safely fly. The sensory advisories stimulating crew decision-making were audibles, such as compressor stalls, tower alerts and warning systems; visual indications of engine problems; and tactile sensing of vibrations. The most common audible was the compressor stall.

Some flight crews were more likely to initiate a second takeoff if their RTO was in response to a false or corrected cockpit warning.

It appeared that if pilots received two related engine indications such as a compressor stall and a fire warning, they were more likely to abort at a speed above that which training dictates. Another decision factor was that aircraft vibration by itself appeared to create doubt in the flight crew as to the ability of the aircraft to continue safely. The visual aspects of runway remaining also entered into pilots' perceptions and decision-making. Lower-speed aborts at V_1 or less were related to the pilots' perceptions of runway remaining and braking required. Tire considerations were the main decision factor in these cases.

Crew Perceptions Determined Decisions Following an RTO

Decisions made by flight crews in the wake of a rejected takeoff were based largely on their perceptions of aircraft integrity. These perceptions were shaped by warning system alerts, tactile sensing, engine instrument indications, aircraft-generated noises and observations radioed by tower controllers or other external observers.

Request for Emergency Equipment. The perceived requirement for emergency equipment was based again on whether there were two or more warnings associated with the condition of the aircraft. A compressor stall by itself did not produce a call for the fire truck, but if it was accompanied by a tower warning or a system warning of an engine fire, the crew would usually call for the emergency equipment. More often than not, a compressor stall would result in engine damage or engine fire. Severe vibrations also led to a call for assistance. Control tower operators were of great assistance to RTO aircraft and in many cases actually initiated the call for emergency equipment when fire was indicated. Other RTOs were triggered by door lights and other system light warnings. These were false warnings in many cases, but they usually appeared when the aircraft had reached a high speed, thereby requiring not only great finesse in execution of the RTO but also generating heat within the braking systems.

In the aftermath of an RTO, flight crew decisions regarding emergency equipment were based largely on their perceptions of aircraft integrity and passenger safety. Flight crews did not always call for emergency vehicles after a successful RTO if they believed that everything was under control. The same mindset that prevents a crew from declaring an emergency during takeoff or landing seemed to drive the crew's decision not to ask for assistance from the emergency vehicles. Data indicate that this is not always a correct assumption or position to maintain.

Use of Brake Energy Charts. To determine tire condition, the brake energy chart is one of the decision tools available to flight crews after an RTO. Crews did not always use the charts, and sometimes they misinterpreted them. A few reporters indicated that the charts did not take into account long taxi distances; thus, subsequent takeoffs resulted in deflated tires. Another result of nonuse or misuse of these charts was a return to the gate area by an aircraft with exceedingly hot brakes. In one incident, maintenance called the fire trucks to the gate area because the aircraft's brakes were glowing red and the crew was not aware of the danger to the aircraft or to ground crew personnel. Data indicated only occasional use of hot-brake areas by flight crews following an RTO.

Takeoffs Following RTOs. Some flight crews were more likely to initiate a second takeoff if their RTO was in response to a false or corrected cockpit warning. The decision factors involved were schedule pressure and the flight crew's assessment of brake and tire conditions. Schedule pressure at times allowed unqualified ramp personnel to verify cargo door integrity to preclude a return to the gate. There were many problems with landings on deflated tires as a result of second takeoffs.

Crew Communication with Emergency Ground Vehicles. Some reports indicated that flight crews wanted to communicate directly with ground vehicles and that tower transmissions sometimes interfered with that capability. During one aircraft evacuation, a ground vehicle blocked an exit door as the vehicle crew was assisting the flight. Another reported that a fire crew identified the wrong engine that was on fire. In each of these examples, there was no communication between the aircraft crew and ground vehicle/fire crew.

Aircraft Evacuation. A flight crew decision to evacuate an aircraft was most often driven by a concern of fire in an engine or landing gear. Smoke in the cabin was another reason for evacuation. Although data did not consistently reveal the level and quality of flight crew interactions, there were some indications that, during aircraft evacuations, flight crews advised passengers of the situation and cabin crews functioned as trained. Calling for emergency equipment provided the flight crew with assurance regarding the condition of the aircraft, in some cases, and led to a decision to evacuate when fire was observed from outside the aircraft by emergency personnel.

The data indicate the following conclusions and recommendations:

In these data, the most significant causes of crew-induced RTOs appeared to be improper communications procedures influenced by external conditions of frequency congestion and schedule pressure. These external factors induced a hurry-up attitude and lowered the exchange of information required to manage a well-coordinated cockpit. They also predisposed a lack of coordination and vigilance where one pilot could monitor the other, particularly during runway entries at night.

Rushing caused by schedule pressure and ATC traffic flow priorities also interfered with the accurate completion of cockpit checklists. Data indicated that high work loads, operations distractions and complacency were involved in most cases of checklist errors and omissions. The most serious of these resulted in no-flaps takeoffs, leaving the takeoff warning systems as the only "safety straps."

Some flight crews deviated from their training guidelines when a high-speed abort decision was involved and did not adhere to V_1 as a go/no-go boundary. This may indicate that current training scenarios lack realism when modeling RTO conditions. To reduce these errors, the problem of risk assessment may have to be addressed in either simulator training or ground school classes.

Some flight crews were overly optimistic in their assessment of aircraft condition after rejecting a takeoff. Flight crews should be encouraged to ask for assistance after just one indication of a problem, as external examinations and communication are vital for a true understanding of aircraft condition.

Some flight crews failed to use brake energy charts following an RTO and often did not consider other pertinent factors, especially taxi distances. In some circumstances, brake energy-chart estimates may be unrealistically low. This can lead to inadequate cooling times and may result in tire failure either on the ground or in the air.

Simulator and crew resource management programs may improve aspects of pilot performance associated with aborted takeoffs by:

- Incorporating real-life scenarios into simulator sessions, including the presence of vibrations and multiple warnings;
- Introducing subtle equipment failure into simulator training such as engine instrument fluctuation, door warning light activation, stick shaker activation and abnormal control column force;
- Demonstrating proper radio procedures using tower-tape examples of misunderstood clearances to promote the use of readbacks by flight crews and to encourage intracockpit communication procedures to verify or question vague clearances; and,
- Promoting rigorous methodologies for the execution of checklists, especially flap settings.

It may be helpful to consider formal criteria for allowing takeoffs by the first officer. Such criteria might address:

- First officer performance;
- First officer experience level; and,
- Weather factors.

The captain's responsibilities during the first officer's takeoffs should also be formalized.

Real-life scenarios, such as those described in ASRS reports, could serve as a beneficial element of a complete training curriculum. Incorporating these reports into ground school video presentations and simulator line-oriented flight training (LOFT) programs would provide, at the very least, the realism that is needed to expose flight crews to the subtleties of the human factor problems of rejected takeoffs. ♦

About the Author

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Training for Advanced Cockpit Technology Aircraft

A group of 100 pilots was asked to assess safety issues related to line operations of new generation, high technology aircraft. In an earlier study, another group of 48 pilots identified a variety of training and procedural concerns.

by
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Shortly after advanced cockpit technology (ADVTECH) aircraft were introduced, the Aviation Safety Reporting System (ASRS) was asked by the National Aeronautics and Space Administration (NASA) and others in the aviation community to determine pilot opinions of the overall safety of these new-generation aircraft in line operations.

A group of 48 pilots who flew ADVTECH aircraft in regular service and who had reported incidents was selected for comprehensive telephone interviews using a stratified, random sampling procedure. The pilots identified training and, on some airlines, operating procedures as problem areas. Their views supported a general industry consensus that training practices had not kept pace with cockpit technology.

Although flight crew training and operating procedures are obviously interrelated (they provide the interface between aircraft and the pilots who fly them), a follow-up study was restricted to training issues for several reasons. First, training and training concepts are relatively independent of variations in operating procedures. Second, if specific problem areas in training can be verified, improvements can be made with relative ease. Third, this subject was particularly amenable to exploration with the data-gathering tools available to the ASRS. Finally, because the adequacy of training directly affects cockpit work load (particularly during high work load periods), a training study could be expected to provide additional data on the controversy of cockpit work load in ADVTECH aircraft.

The follow-up study's objectives were identified as follows:

- Determine line pilots' views of the initial and recurrent training that they received to fly ADVTECH aircraft;

- Determine the strengths and weaknesses of current training and the sensitivity of this training to widely varying needs;

and,

- Identify the most effective methods for instructing flight crews of ADVTECH cockpit aircraft with the hope of identifying model training curricula.

Preliminary findings focused on training for crew coordination and communication with ADVTECH aircraft and maintenance of basic flying skills.

One of the great strengths of the ASRS is its ability to contact the pilots who report to it during the very short period that ASRS holds reporter identification slips. Between October 1988 and February 1989, approximately 100 pilots, who were flying ADVTECH aircraft and reported incidents to the ASRS, were called and asked to participate in the survey. No one refused, although they were under no obligation to cooperate. Participants were selected from the much larger base of ADVTECH pilot reports to obtain a reasonable (albeit not perfect) distribution between captains and first officers among current ADVTECH transports, from established trunk and international carriers to newly established commuter airlines.

The surveyed pilots represented 12 airlines and included the following aircraft:

A300-600; Boeing 737-300/400/500; Boeing 757/767; MD-80; and MD-88. Selected pilot population variables are shown in Table 1.

Pilots were sent a list of the general subjects to be discussed before the telephone interviews, which required about one hour. The pilots stated this had been helpful because they were able to present well-thought opinions, not snap judgments.

In addition to basic demographic data, the questions were based on nearly 30 training issues identified by ADVTECH pilots in the earlier study or developed from *Working Paper on Training for Advanced Technology Aircraft*.

Interviews were conducted by experienced airline pilots because they were able to establish a rapport with the respondents quickly and they understood the technical aspects of the questions. These interviewers were given training on interviewing techniques, with emphasis on the importance of controlling interviewer bias.

Table 1
Pilot Survey Demographics

	Captains	First Officers
Flight Hours		
Average	13,000	6,777
Range	4,500-25,000	2,500-12,500
Years with Present Airline		
Average	17.7	6.9
Range	1.5-35.0	0.5-17.5
Hours in Type		
Average	1,025	720
Range	50-3,500	50-2,500
First Time in Present Cockpit Position	27%	19%
Transitioned From 3-person Crew	52%	63%

Source: Aviation Safety Reporting System

Even without the complication of advanced cockpit technology aircraft, airline pilot training is a complex subject. Its complexity is increased by many factors. These include a broad range of aircraft, differences in airline operations and operating philosophies, and a variety of airline training resources. In addition, there are different training needs for pilots with a wide range of skills and experience and for pilots who operate in an air traffic control (ATC) system that is not always sensitive to aircraft performance characteristics.

Two training issues examined closely are:

- Intracockpit communication and crew coordination in ADVTECH aircraft; and,
- Maintenance of basic flying skills.

Communication and Crew Coordination Viewed as Primary

Table 2
Responses to Question:

"As a professional pilot, do you think there is a real need for a crew resource management (CRM) program?"

Captains' Comments

"YES"

"However, one year the programs are good, the next year no good."

"Pilots are mechanical — not people-oriented (i.e., people managing). Our program still doesn't recognize this."

"It's needed for some individuals."

"Timid crew members are sometimes afraid to voice their opinions."

"Have less personality conflicts than in the past. Captain regards the rest of the crew as human beings and accepts inputs from the rest of the crew."

"NO"

"Has diluted Captain's authority. Not necessary!"

First Officers' Comments

"YES"

"Everyone's opinions are considered."

"Puts things into perspective and recognizes F/O intelligent input."

"Don't feel free to volunteer input with certain types of captains (personality)."

"Not enough feedback to company on line operations being used in training."

"Have noticed changes in crews recently, but I'm not flying with the old timers."

"NO"

As suggested in the previous study, many of the surveyed pilots believe that good crew coordination and good cockpit communication are more important in ADVTECH aircraft than in non-ADVTECH airplanes.

Their importance is also recognized in industry practices. For example, approximately 70 percent of the surveyed pilots received their transition training utilizing a "full-crew concept" during simulator training. Nearly one-half of the remaining 30 percent, who were trained instead by cockpit position (i.e., captains with captains and copilots with copilots), believed this was not a good practice.

One of the major innovations in airline flight crew training during the past decade has been the development of formalized crew resource management (CRM) training, which stresses crew coordination and intracockpit communication. Companies for 85 percent of the pilots had formalized CRM training programs. In an almost unanimous response, 97 percent of the surveyed pilots believed that "there is a real need for such programs."

The comments listed in Table 2 illustrate the variety of reasons for the support of the line pilots for CRM training, despite some criticism of their airlines' current programs, and other qualifications.

Pilots Expressed Concern about Maintenance of Basic Flight Skills

Although there is nothing new about the problem of maintaining basic flying skills, there is considerable evidence that this difficulty has been exacerbated with ADVTECH operations. Prior to the introduction of ADVTECH aircraft, the problem was largely confined to long-range flight operations marked by fewer takeoffs and landings. However, when highly automated ADVTECH aircraft were introduced, the policies and procedures of many companies stressed the maximum use of their automatic systems. This policy, which has been sometimes called the "we bought it, you use it" philosophy, created a maintenance-of-skills problem for the pilots flying these aircraft. (Several airlines have modified their policies since the earlier ADVTECH study.)

One captain explained that maintenance of manual skills had indeed been a problem until his airline had moderated its policy regarding maximum use of the automatic systems. He said that it is still a problem for low-time pilots, but in this case the problem is in the initial development of skills — not in the maintenance of skills that have already been developed. He said, "It's not their fault, but many of the new copilots have never had a chance to learn these skills and they don't have enough opportunity to practice." Table 3 presents typical comments made by captains and first officers when asked if the maintenance of skills was a problem for the low-time pilot.

Table 3
Responses to Question:

"Do you think that attainment and retention of manual flying skills is a particular problem for low-time pilots?"

Captains' Comments

"NO"

"Most fly manual too much when they should use auto."

"Has to do with personal discipline — not low time."

"YES"

"They get so enthralled with all the magic they forget how to flip switches back to raw data."

"You can develop additional skills without flying. When you need to hand fly, you need your highest skills. The only way to attain and maintain them is to fly manually."

"Yes, but also for everybody else."

First Officers' Comments

"NO"

"Because most of us fly a lot manually and company encourages this."

"YES"

"Have to force yourself to fly manually. Some captains are more comfortable if you are on auto. Some captains are not good on PNF [pilot-not-flying] duties."

Even without the additional complication of advanced cockpit technology, airline pilot training is a very complex business. There are many variables, and some of them are critical. With few exceptions, industry-wide generalizations can be made only at considerable peril.

The data indicate the following conclusions:

- Pilots like these airplanes;
- The addition of sophisticated automated systems has not reduced the level of basic airmanship skills required of an airline pilot;
- Automation has not reduced training needs;
- Computer-designed or computer-assisted training is not yet an unqualified success, despite glowing testimonials in its support; and,
- Major advances in information display, as exemplified in glass cockpits, have created some problems that may be related to training. Moving map displays are an exception; they are universally liked.

There have been significant improvements in the quality of ADVTECH pilot training since these airplanes were introduced. This is not surprising because there are usually shakedown periods in new training programs. The quality of individual programs still varies, and individual needs are not always recognized.

However, pilot attitudes toward ADVTECH training and operating policies have changed. The pilots who were interviewed for this study believe that current operating policies and training show greater sensitivity to line operating needs, unlike their peers who were surveyed in the earlier study.

Still, there is room for improvement. Some training methods seem more effective than others. Some carriers appear more adept at training their crews for service in ADVTECH aircraft. Future studies should identify those operating policies and training procedures that have demonstrated their value and should be implemented universally. ♦

About the Authors

William A. Wheeler, a research scientist and former naval flight officer, joined Battelle (which operates NASA's Aviation Safety Reporting System ASRS) in 1982. He is assigned to Battelle's Human Affairs Research Center in Seattle, Washington. In addition to his flight experience, Wheeler has more than 20 years of experience working in naval aircraft maintenance, both as a technician and as a manager.

Wheeler has been involved in a wide range of research projects, many of which focused on human performance on complex systems while under stress. He holds advanced degrees in psychology and human resources management from Pepperdine University.

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In 34 years as a United captain, Orlady logged more than 31,000 hours of flight time and flew all of the airline's routes in 12 different aircraft. He flew as captain on the DC-3, DC-4, DC-6, DC-7, DC-8, Boeing 720 and the Boeing 747.

Orlady has worked with NASA's Aviation Safety Reporting System (ASRS) since 1982 as an aviation safety research consultant specializing in air carrier multi-crew operations, with a focus on aeromedical and human factors. He is president of Orlady Associates, an aviation consulting firm affiliated with Battelle's ASRS program.

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Aviation Statistics

Survey Tracks U.S. General Aviation Fleet Activities

by
Editorial Staff

The recently released annual *General Aviation Activity and Avionics (GAAA) Survey* conducted by the U.S. Federal Aviation Administration (FAA) provides information about the activities and avionics equipment of the general aviation aircraft fleet for calendar year 1991. The information obtained from the survey enables the FAA to monitor the general aviation fleet so that the FAA can, among other activities, anticipate and meet demand for airways facilities and services, assess the impact of regulatory changes on the general aviation fleet and implement measures to ensure the safe operation of all aircraft in U.S. airspace.

"General aviation" is not always defined the same in the aviation community. The general aviation aircraft represented in this report range in complexity from simple gliders and balloons to sophisticated four-engine turbojets. These aircraft are used for a variety of purposes such as air taxi, cargo, agricultural, executive/business, personal, research, instructional, and recreational. The survey excludes aircraft operated by scheduled airlines.

Following are some of the survey's significant findings.

- The estimated 198,475 active general aviation aircraft in the fleet flew more than 30 million hours, with an average annual flight time per aircraft of 149 hours. These active aircraft represent approximately 75 percent of the registered general aviation fleet, which is five percent lower than was estimated in 1990.

- Active general aviation aircraft undertook nearly 96 million operations (takeoffs and landings). About 69 percent were in local flight vs. 31 percent in cross-country flight.

- General aviation aircraft flew more than 3.9 million nautical miles.

- Approximately 87 percent of general aviation flying took place during the day.

- Forty-five percent of the hours flown by the general aviation fleet were flown with no flight plan, and an additional seven percent of hours flown were under some other/unknown flight plan. Only 25 percent of the aircraft hours were flown under visual flight rules/daylight visual flight rules (VFR/DVFR) flight plan, and 23 percent were flown under instrument flight rules (IFR).

- An estimated 930 million gallons of fuel were consumed by the active general aviation fleet. Approximately 38 percent of the total fuel consumed was aviation gasoline, and 62 percent was jet fuel.

- Almost 38 percent of the active general aviation fleet flew under instrument flight rules (IFR).

- The three regions with the greatest number of active aircraft were: the Western Pacific Region with 18.4 percent, the Great Lakes Region with 17.5 percent, and the Southern Region with 16.3 percent. The region with the smallest number of active aircraft was the Alaskan Region, which constituted 3.3 percent of the active general aviation fleet.

- States represented by the largest number of active general aviation aircraft include California with 14.7 percent, Texas with 8.2 percent and Florida with 6.2 percent.

Personal Use Ranks Highest

- Rotorcraft, turboprop and turbojet aircraft types averaged 452, 308 and 290 flight hours per aircraft, respectively. In contrast, active fixed-wing piston aircraft, which make up 78 percent of the active fleet and represent 68 percent of the total flight time, averaged only 137 flight hours per aircraft.

- Turbine rotorcraft had the most average hours flown per aircraft (592). The aircraft types with the least number of average hours flown were the "other" piston, averaging 41 hours, and aircraft types in the "other" category (e.g., gliders and balloons), which averaged 61 hours flown per aircraft.

- The most popular primary-use category of the active general aviation aircraft is personal use, with 58 percent of the active fleet falling into this category. The next closest primary-use category was business with 16 percent, followed by instructional use with nine percent.

Several Activities Measure Growth and Activity

Several aviation activity measures indicate growth trends and activity levels in the general aviation fleet, including measures of the size of the general aviation population, number of active aircraft, total flight hours, average flight hours per aircraft and number of landings. (Figures 1& 2, page 15; Figure 3, page 16)

The data indicate that:

- A great deal of variation in the number of active aircraft, total hours and average aviation hours exists among all types of general aviation aircraft.

- More than 30 million hours were flown by the estimated 198,475 active general aviation aircraft.

- The average flight time per active aircraft was 149 hours. Active aircraft constituted about 75 percent of the registered general aviation fleet, which is five percent lower than was estimated in 1990.

- Single-engine piston aircraft, with a population of 206,371 or 78 percent of the registered general aviation fleet, dominated the general aviation fleet, although the average hours flown (134) were lower than most aircraft types. This aircraft type accounted for 78 percent of the active aircraft but only 68 percent of the total flight time.

- Turbine rotorcraft averaged the most hours per aircraft of any aircraft type at 592 average hours. Fixed-wing turboprops with 13 or more seats were a close second with 589 average hours. This aircraft type's high average hours are most likely attributable to heavy commercial use as commuter air carriers.

- The two manufacturer/model groups with the largest representation in the general aviation fleet were the Cessna 172, with 23,918 registered aircraft (nine percent of the registered general aviation fleet), of which 88 percent were active, and the Piper PA28, with 21,423 registered aircraft (eight percent of the registered general aviation fleet), of which 86 percent were active. The Cessna 172 accounted for 13 percent of the total hours flown, and the Piper PA28 accounted for eight percent of the total hours flown.

- The percentages of registered aircraft active in each region are relatively similar, ranging from a low of 71 percent in the Alaskan Region to a high of 80 percent in the New England Region.

- The three regions with the greatest number of active aircraft were the Western Pacific Region with 36,545 active aircraft; the Great Lakes Region with 34,792; and the Southern Region with 32, 428.

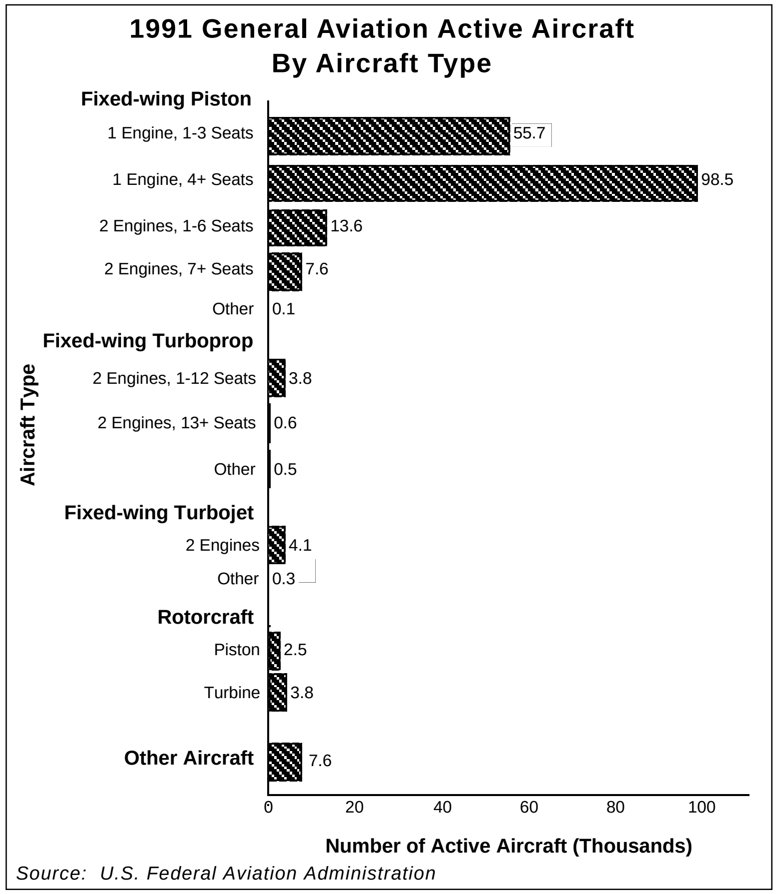


Figure 1

- The Western Pacific Region accounted for the most flight time of any region, 5.5 million hours, with the Southern, Southwestern and Great Lakes Regions close behind.

- The state with the largest estimated number of active aircraft was California with 29,261, followed by Texas with 16,206 and Florida with 12,336.

- The state with the highest estimated average flight hours was Hawaii, with 534.3 hours. Montana averaged the lowest flight hours at 86.1.

- The general aviation fleet made almost 48 million landings. About 69 percent of the landings were in local flight compared with 31 percent in cross-country flight.

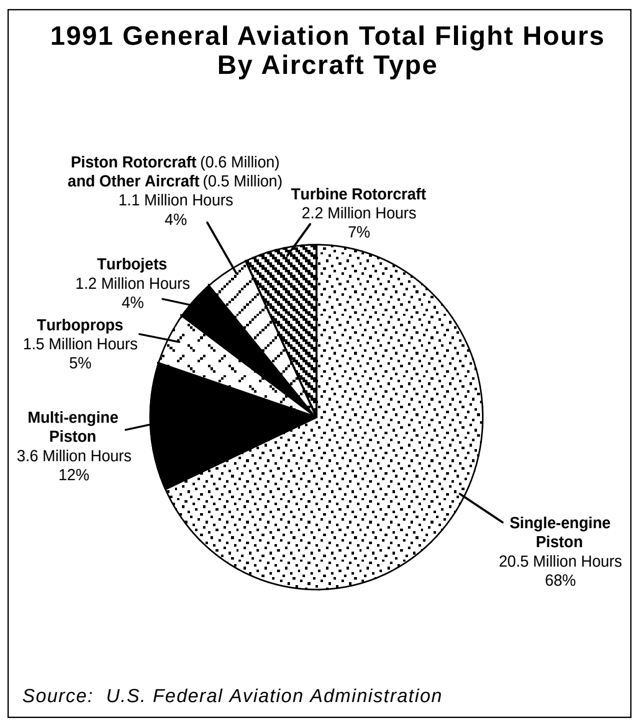


Figure 2

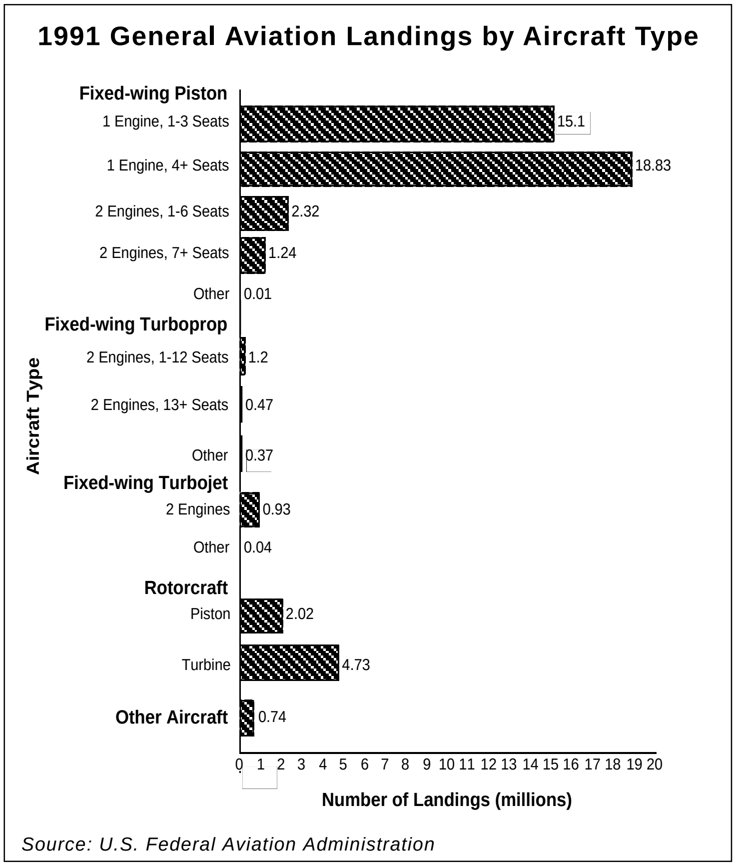


Figure 3

- Single-engine piston aircraft made the most landings, nearly 34 million, with 74 percent of the landings in local flight and 26 percent in cross-country flight.

- Turbojets and turboprops, which are used primarily for long, cross-country flying, made 91 percent and 69 percent, respectively, of their landings in cross-country vs. local flight.

- Rotorcraft had 6.7 million landings, with 81 percent in local flight.

Most Aircraft Flew VMC Conditions

A sample from the survey also presents statistics on the meteorological conditions under which the general aviation fleet flew. This includes the number of hours flown by visual flight rules (VFR)/daylight visual flight rules (DVFR) flight plan, no flight plan, and other/unknown flight plan, in addition to hours flown under IFR.

The data cover the number of active general aviation aircraft and total hours flown by aircraft type during the day and night, by aircraft type under visual meteorological conditions (VMC) and by aircraft type under IFR in instrument meteorological conditions (IMC), respectively. Additional data provide breakdowns by manufacturer/model (M/M) group; the number of active general aviation aircraft and total hours flown during the day and night by M/M group, and the number of active general aviation aircraft and total hours flown under IMC (based on IFR flight plan hours) and VMC (based on total hours flown) by M/M group.

Figure 4 (page 17) depicts the findings of the above data, showing the number of hours flown under VMC and under IFR flight plan in IMC conditions by day and by night. Figure 5 (page 17) shows the number of hours flown by IFR flight plan, VFR/DVFR flight plan, no flight plan, or other/unknown flight plan.

The data indicate that:

- Approximately 87 percent of general aviation flying took place during the day.

- Overall, 88 percent of VMC flying took place during the day.

- IMC flying under IFR took place 73 percent of the time during the day.

- Overall, 81 percent of the general aviation fleet's total hours were flown in VMC conditions during the day. The remainder of the total hours flown by the general aviation fleet were divided as follows: 11 percent night VMC, six percent under IFR in day IMC, and two percent under IFR in night IMC.

- The results show that 45 percent of the hours flown by the general aviation fleet were flown with no flight plan, and an additional seven percent of the hours flown were under some other/unknown flight plan. Only 25 percent of the hours were flown VFR/DVFR flight plan, and 23 percent were flown IFR.

Aircraft Consume More Jet Fuel

The general aviation aircraft fleet consumed 930 million gallons of fuel – 577 million gallons of jet fuel and 354 million gallons of aviation gasoline. Although data on propane fuel use were collected, they are not included because the data collected were not sufficient to provide reasonable estimates.

Figures 6 and 7 (page 18) show the fleet's fuel consumption rates and estimated fuel consumption by aircraft type, respectively. Figure 8 (page 18) depicts the percentage fuel consumption of the general aviation fleet by fuel grade.

The data indicate that:

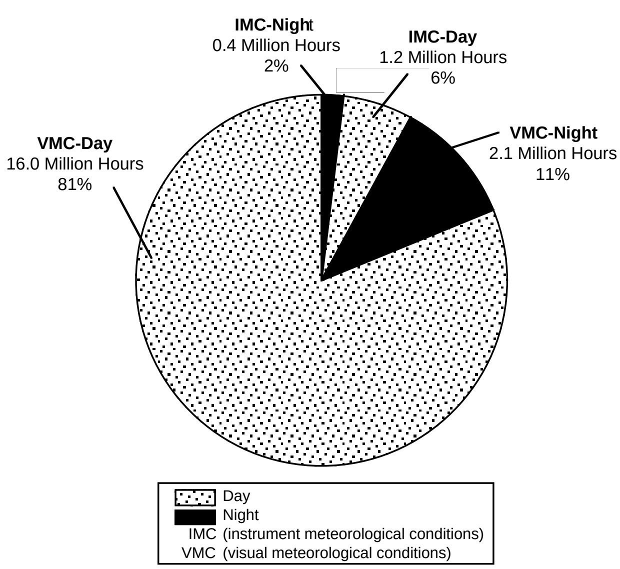
- Of the 930 million gallons of fuel consumed by the fleet, 38 percent was aviation gasoline and 63 percent was jet fuel.

- Fixed-wing piston aircraft, with a low average fuel consumption rate of 14 gallons per hour, nevertheless accounted for approximately 37 percent (341 million gallons) of the total fuel consumed by the general aviation fleet due to their large numbers. This aircraft type also accounted for 97 percent of the aviation gasoline consumed.

- Turbojet aircraft had the highest rates of fuel consumption – 412.7 gallons per hour for "other" turbojets, and 273.6 gallons per hour for twin-engine turbojets. In contrast, fuel consumption of single-engine piston aircraft averaged 11.2 gallons per hour.

- Turbojets, which accounted for 38 percent of active turbine-engine aircraft in

1991 General Aviation Hours Flown by Weather and Light Conditions

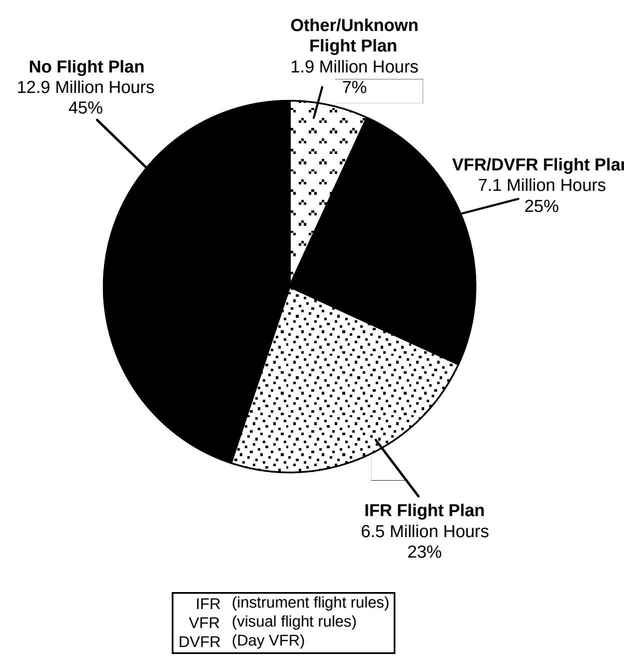


Note: These estimates are based on 19.8 million hours since data was not provided by all survey respondents. IMC hours listed represent IMC hours flown under an IFR flight plan.

Source: U.S. Federal Aviation Administration

Figure 4

1991 General Aviation Total Hours Flown by Flight Plan



Note: These estimates are based on 28.4 million hours since data was not provided by all survey respondents.

Source: U.S. Federal Aviation Administration

Figure 5

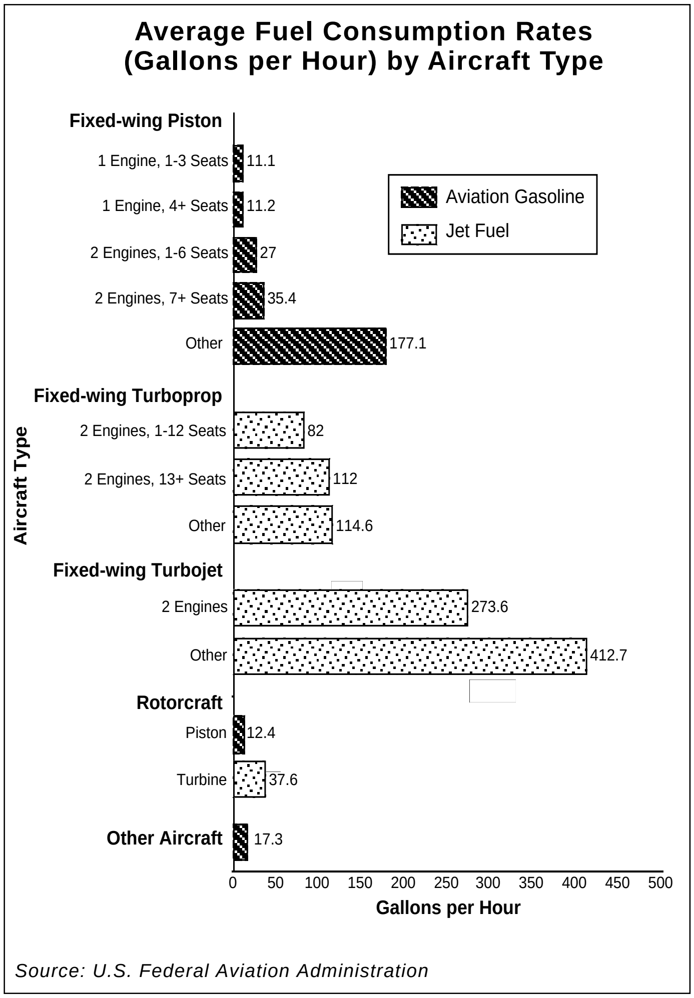


Figure 6

the 1991 general aviation fleet, consumed 61 percent of all jet fuel used by the general aviation fleet.

- Averaging 90 gallons per hour, turboprops consumed 133 million gallons of jet fuel (23 percent of the total jet fuel consumed). Overall, turboprops consumed 14 percent of the aviation fuel.

- Of the 354 million gallons of aviation gasoline consumed by fixed-wing piston aircraft, approximately 14 million gallons were 80 octane gasoline, 66 million gallons were 100 octane gasoline, 251 million gallons were 100 octane low lead gasoline and 17 million gallons were automobile gasoline. ♦

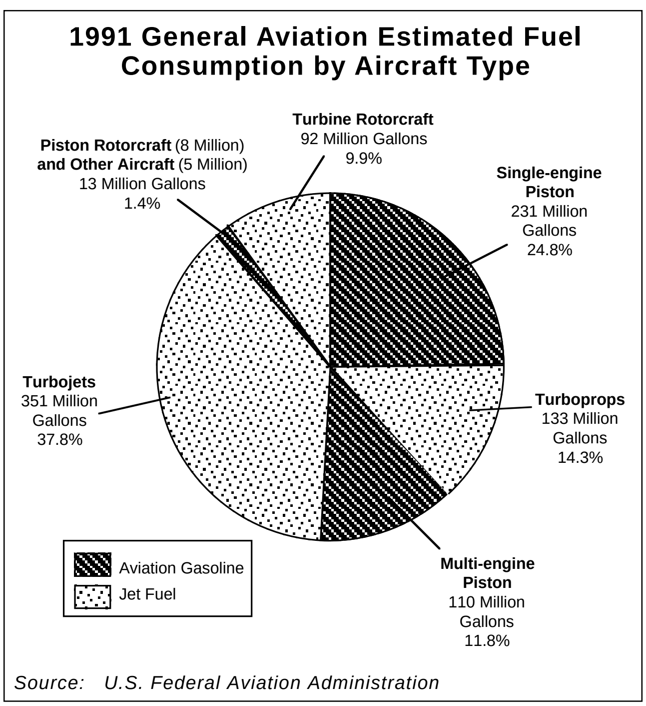


Figure 7

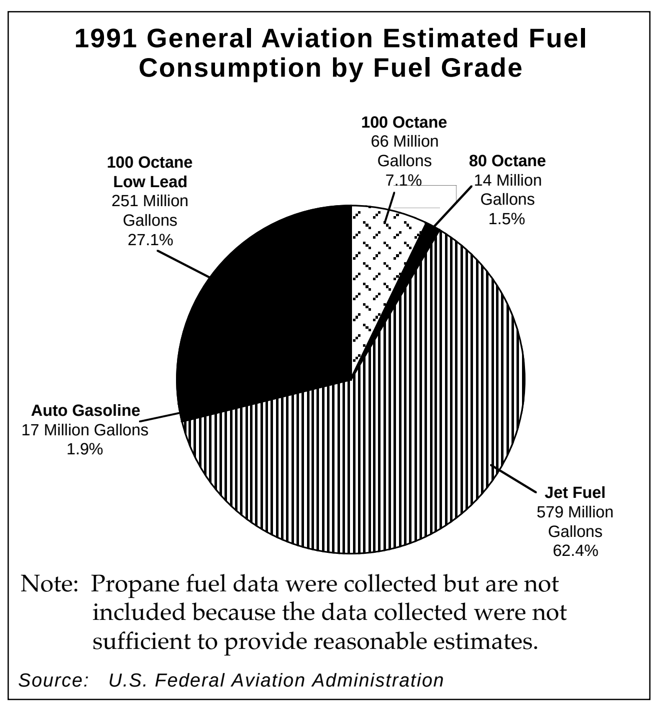


Figure 8

Reports Received at FSF Jerry Lederer Aviation Safety Library

Winter Operations Updated by U.S.

by
Editorial Staff

Winter Operations Guidance for Air Carriers and Other Adverse Weather Topics/ prepared by Flight Standards Service. Washington, D.C. U.S. Federal Aviation Administration, Office of the Administrator, 1992. 376 p. in various pagings. ill.

Keywords
1. Airplanes — Cold Weather Operation.
2. Airplanes — Ice Prevention.
3. Airplanes — Climatic Factors.

Summary: This second update to the FAA winter operations publication includes current advisory circulars, maintenance bulletins, air carrier bulletins as well as articles from manufacturers' and air carriers' publications. This comprehensive guide covers general winter weather operating for ramp operations, aircraft ground deicing, fuel system icing precautions, inflight considerations, takeoff and landing considerations, helicopters and adverse weather, such as wind shear and thunderstorms. This 1992 edition includes FAA advisory circular *Pilot Guide/Large Aircraft Ground Deicing*, and a comprehensive report, *Tailplane Icing*. Sources for associated material and an index are included.

Index of FAA Office of Aviation Medicine Reports: 1961 through 1991/ William E. Collins, Michael E. Wayda. Washington, D.C. U.S. Federal Aviation Administration, Office of Aviation Medicine; Springfield, Virginia, U.S. Available through the National Technical Information Service, [1992]. 69 p. in various pagings.

Keywords
1. Aviation Medicine — United States — Indexes.
2. United States — Office of Aviation Medicine — Bibliography.

Summary: This reference source is an index to Civil Aeromedical Research Institute Reports from 1961-1963 and Office of Aviation Medicine Reports from 1964-1991. It is intended as a guide to those engaged in aviation medicine and related activities. Its three indexes list all published FAA aviation medicine reports chronologically, alphabetically by author and alphabetically by subject. The chronological index also provides document numbers for NTIS. A supplement for 1992 reports is given in chronological order.[modified abstract]

TCAS Incident Reports Analysis/ National Aeronautics and Space Administration (NASA), Aviation Safety Reporting System (ASRS), Mountain View, California. Available through the National Aeronautics and Space Administration, Ames Research Center, [1992]. 123 p. in various pagings.

Keywords
1. Airplanes — Collision Avoidance.

2. Aeronautics — Safety Measures — Air Traffic Control.
3. Traffic Alert and Collision-avoidance System (TCAS).

Summary: At the request of the FAA Office of Aviation Safety and the National Transportation Safety Board (NTSB) for data from ASRS, this study of ASRS reports provides a general overview of traffic alert and collision-avoidance system (TCAS) data in the ASRS database for the period of January 1, 1988, to March 1, 1992. This study further provides a more focused analysis of a random sample of TCAS incident reports relating to the same time period. The study is presented in three sections: a review of the 1,124 TCAS-related reports in the ASRS database, an analysis of 170 randomly sampled TCAS reports and a discussion of key findings. An appendix containing reports illustrative of the kinds of TCAS-related events reported to the ASRS is also included. While the data collected from these voluntarily submitted incident reports reflect reporting biases, the authors believe that the real power of the ASRS lies in the report narratives where pilots, controllers and others disclose aviation safety incidents and situations in detail.[modified synopsis and caveat]

Human Factors in Aviation Maintenance: Phase 1, Progress Report/ William T. Shepherd ... [et al.] Washington, D.C. U.S. Federal Aviation Administration, Office of Aviation Medicine; Springfield, Virginia, U.S. Available through the National Technical Information Service, [1991]. 158 p.: charts. Includes bibliographical references.

Keywords
1. Aviation Mechanics (Persons) — Psychology.
2. Airplanes — Maintenance and Repair.
3. Aeronautics — Human Factors.

Summary: This interim report on human factors research in aviation maintenance includes four studies, each dedicated to factors associated with the aviation maintenance technician and other personnel supporting the maintenance system goals. Chapter two presents a study of the maintenance organization. Its intent is to identify how communication is accomplished within the maintenance organization. Chapter three offers a study of the maintenance technician in inspection. Its approach is to determine typical human/system mismatches to guide both future research and short-term human factors implementation by system participants. Chapter four documents a study of advanced technology for maintenance training. This study reports the status of a project to support the application of advanced technology systems for aircraft maintenance training. The final study, chapter five, presents research on job performance aids. This research was designed to provide information for government and industry managers in their efforts to access the utility and implementation of job-aiding technology. An executive summary, chapter one, is also provided and includes summaries of subsequent phase plans for each study, information on other research activity in human factors and references.[Modified executive summary]

Aviation Safety: Progress on FAA Safety Indicators Program Slow and Challenges Remain: Report to the Chair, Subcommittee on Government Activities and Transportation, Committee on Government Operations, House of Representatives General Accounting Office. Washington, D.C. General Accounting Office, [1992]. Report No. GAO/IMTEC-92-57. 40 p.: ill. Includes bibliographical references.

Keywords
1. Aeronautics — United States — Safety Measures.
2. Air Traffic Control — United States.

Summary: This report gives the background and an assessment of the FAA's Safety Indicators Program. Two components of the program are described: development of safety indicators, or categories of safety measurements for the aviation system; and development of a decision support system, or computer analysis tool, to obtain information from numerous stand-alone databases for sophisticated analysis and presentation. While the program's goal was to develop a consistent set of safety measures and computer analysis capability to present quickly and vividly the state of aviation safety, ineffective user involvement and unclear management commitment have contributed to the agency's inability to complete the program. Because a wide difference of opinion as to what constitutes acceptable measures of air traffic safety resulted between those developing the indicators and many of those who were targeted to use them, progress in developing the key safety indicators has been slow.

According to the report, clear top-level FAA management backing of the program, through statements on the participants responsibilities and authority, is essential in fostering the cooperation needed to complete the development of the safety indicators. The report further states that although the National Aviation Safety Data Center (NASDC) has made some progress in the development of the automated decision support system intended to import, validate and integrate data imported from the FAA's diverse collection of existing safety-related databases, development of the capability to import data from outside of NASDC's own division has yet to begin. According to the report, this capability is critical to the success of the decision support system since NASDC estimates that information will be extracted from as many as 70 aviation data sources. The unreliability of many of FAA's safety-related databases is also a significant challenge. According to the report, many of these databases are inaccurate, inconsistent and often incompatible. In light of this testimony and previous recommendations, no further recommendations were offered. However, the report said success in the development of the safety indicators program and decision support system depend heavily on the FAA's effectively addressing the issues of source data reliability, refinement of safety indicators and user involvement in and management commitment to the development of both the safety indicators and the decision support system.[modified results in brief and conclusions]

New Reference Materials

Advisory Circular 21-32, 10/14/92, Control of Parts Shipped prior to Type Certificate Issuance. Washington, D.C. U. S. Federal Aviation Administration (FAA), 1992. 3p.

Summary: This advisory circular provides information and guidance concerning the control of parts to be shipped by manufacturers with an approved production inspection system (APIS) or production certificates (PC) in advance of type certification of a new aircraft, aircraft engine or propeller (product).♦

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National Technical Information Service (NTIS)
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**U.S. General Accounting Office (GAO)
Post Office Box 6012
Gaithersburg, MD 20877 U.S.
Telephone: (202) 275-6241

Updated Reference Materials (Advisory Circulars, U.S. FAA)

Numbers	Month/Year	Subject
21.17-1A	September 1992	*Type Certification — Airships* (Cancels AC 21.17-1, dated 9/20/87).
91-62	October 1992	*Use of Child Seats in Aircraft* (Cancels AC 91-62, dated 2/26/85).
21.303-2H	October 1992	*Parts Manufacturer Approvals 1992* (Microfiche listing of parts manufacturer approvals valid through August 1992; cancels AC 21.303-2G, dated 10/21/88).

Accident/Incident Briefs

Liquor Bottles Cripple Aircraft

by
Editorial Staff

This information is intended to provide an awareness of problem areas through which such occurrences may be prevented in the future. Accident/incident briefs are based on preliminary information from government agencies, aviation organizations, press information and other sources. This information may not be entirely accurate.

Air Carrier

Strong Gusts Add To Go-around Woes

Airbus A310. Substantial damage. No injuries.

The Airbus was on final approach to an island off the coast of Greece when tower controllers issued a gust warning.

Winds at the time were reported to be 090 degrees through 140 degrees, with 20-knot winds gusting to 32 knots. Approach plates for the airport cautioned pilots about landing with winds from the south to southeast at wind speeds above 15 knots.

The first officer, who was flying the aircraft, continued the approach. Wind conditions required a firm touchdown without excessive flare. Because of a higher than normal approach speed, the aircraft entered the flare about eight feet off the runway. The captain called for a go-around and took the controls.

After the go-around was initiated, the A310 was caught by a violent wind gust and its right wing struck the ground. The impact damaged the wingtip, slats, flap fairings and the wing underside.

The crew recovered from the gust and continued the go-around. The climbout and subsequent landing were uneventful.

After the aircraft landed, the airport was closed because of excessive wind conditions. It took five days to repair the aircraft.

Water Leak Causes Emergency Landing

Boeing 737. Minor damage. No injuries.

Shortly after takeoff, the cabin crew reported water streaming out of the forward toilet.

A few moments later, several aircraft systems failed, including autopilots A and B, altimeters, mach trim, transponder and automatic pressurization. Warning flags appeared on the captain's instrument panel and on the first officer's as well.

The aircraft returned safely to its departure airport, but it took several minutes to open the cabin doors because of a faulty pressurization system. It was determined that electrical system damage was caused by a cracked water fountain in the forward toilet.

Stashed Liquor Cripples Controls, Cancels Flight

McDonnell Douglas MD-80. No damage. No injuries.

The MD-80 with 77 passengers on board was preparing to depart from a European airport when the controls jammed.

Mechanics summoned to the aircraft found three bags of bottled whiskey and vodka hidden under a hatch. It was determined that the bottles were smuggled aboard by the pilot, who was subsequently grounded for 10 months. The bags had prevented the controls from moving freely. The flight was canceled and the passengers were transported to their destination by other operators.

Air Taxi Commuter

Icing Forces Aborted Takeoff

Cessna 402. Substantial damage. No injuries.

The takeoff was begun following deicing, taxiing and runup procedures. Acceleration and engine indications were normal.

Rotation at 95 knots, however, resulted in a stall warning. The pilot determined that the twin-engine aircraft would not remain airborne and aborted the takeoff. The crew was unable to stop the aircraft before it reached the end of the runway, and it slid down a slope and across a ditch. The landing gear was sheared off, but passengers and crew were able to evacuate successfully.

It was determined that minor deposits of snow on the top side of the wings and water from melting snow refreezing on the lower sides disturbed the airflow. A contributing factor in the daylight incident was the crew's lack of precise information on the actual glycol/water mixture of the deicing fluid.

Takeoff Without Elevator Control Ends Abruptly

Mitsubishi Diamond. Substantial damage. No injuries.

The night takeoff was aborted after the twin-turbofan aircraft experienced elevator control problems. The pilot was not able to stop the aircraft on the runway and elected to turn right into a recently sown field. The nose gear collapsed, but the crew and two passengers were able to exit the aircraft safely.

It was determined that the crew had forgotten to remove the elevator gust lock during the preflight. Records indicated the crew had performed poorly together on earlier flights and during check rides. An investigation concluded that poor crew coordination and unsatisfactory training were contributing factors in the accident.

Unstabilized Approach Dooms Commuter

Antonov An-24. Aircraft destroyed. Forty-one fatalities.

About two kilometers from the runway, the twin-engine turboprop began to deviate to the right of its proper approach course. A tower controller queried the crew about the deviation but received no response.

At a distance of .93 miles (1.5 kilometers) from the runway threshold, the controller ordered the flight to go-around. A few moments later, the aircraft crashed about 2,640 feet (800 meters) from the runway, about 1,980 feet (600 meters) to the right of the center line.

The four-man crew and 37 passengers were killed in the evening crash. A post-crash investigation found a layer of ice up to .6 inch (15 mm) thick on the horizontal stabilizer.

Darkness, Fatigue Disorient Pilot

Beech 90 King Air. Aircraft destroyed. Five fatalities.

Shortly after the night takeoff, the twin-turboprop aircraft collided with a line of trees located about 1980 feet (600 meters) from the end of the runway and slightly left of the center line. The King Air struck the trees in a wings-level attitude in a very shallow descent.

After colliding with the trees, the aircraft impacted the ground and caught fire. The pilot and four passengers were killed.

A post-crash inquiry determined that the night was very dark with no moon and no visible horizon. Evidence suggested that the pilot may have been suffering from fatigue due to a heavy work schedule. The pilot had received no formal human factors instruction during his instrument training, and there was evidence that the pilot may have experienced visual illusions and vertigo after takeoff. All aircraft systems were functioning normally at the time of the crash.

Hard Landing Follows Two Missed Approaches

Cessna 340. Substantial damage. No injuries.

The twin-engine Cessna 340 was attempting to land under instrument meteorological conditions at night with a 7/8 cloudbase at 200 feet (60 meters).

The airport was not equipped with instrument approach facilities, only low-intensity runway lights. The pilot made a hard landing after two missed approaches. The aircraft was covered by clear ice and after landing, cracks were found in the main beam of the left wing and other structural parts of both wings.

Missed Approach Spells Tragedy

Cessna 421. Aircraft destroyed. Five fatalities.

The twin-engine Cessna was on a daylight instrument approach in meteorological conditions below minimums.

Following a missed approach, the aircraft struck the ground in a left spiral and in a 80-degree nose-down attitude. The pilot and four passengers were killed in the crash, which was attributed to pilot spatial disorientation during the go-around.

Turbulence Knocks Jodel Down

Jodel D120A. Substantial damage. Two injuries.

The pilot of the single-engine Jodel was practicing touch-and-go maneuvers.

During the takeoff phase, violent turbulence generated by wind and trees at the end of the runway caused the aircraft to stall. A wing touched the ground and the aircraft cartwheeled onto its nose. The front of the cockpit sustained severe damage, and the wings were torn from the fuselage. The pilot and passenger suffered serious injuries. The private pilot had logged a total of 265 flying hours.

Cessna Loses Contest with Strong Crosswind

Cessna 172. Substantial damage. Two serious injuries.

The pilot of the single-engine Cessna had been forced to execute two missed daylight approaches because of high winds.

On the third attempt, an increased power setting was used to counter wind effect. As the aircraft turned on final approach, it stalled at an altitude of 300 feet (90 meters). There was insufficient altitude for recovery, and the aircraft impacted the ground in a wings-level, nose-down attitude. The nose cowling, right wing, wheels and elevators were severely damaged. The pilot and a passenger were seriously injured.

A post-crash investigation concluded that the accident was attributed to the pilot attempting to land in a crosswind greater than acceptable for the aircraft type. The pattern flown also contributed to the accident by increasing the ground speed on the base leg/final approach turn, which required an increased bank angle to execute the turn. The private pilot had logged 650 flying hours.

Wind Shift Adds Drama to Short Field Landing

Cessna 182. Aircraft destroyed. Three injuries.

The single-engine Cessna encountered a sudden wind shift while landing at a short rural airfield.

The aircraft failed to reduce speed sufficiently and overran the runway, coming to rest in a pheasant coop. The aircraft was destroyed beyond economic repair. The pilot and two passengers suffered serious injuries. The private pilot had logged 444 hours flying time.

Rotorcraft

Oil Loss Leads to Crash Landing

Bell 47J2. Aircraft destroyed. Four fatalities.

The pilot of the Bell 47J had begun executing an emergency landing following loss of engine power.

Witnesses observed the helicopter flying at 500 feet (150 meters) above ground level when the engine appeared to backfire and begin sputtering. The aircraft descended rapidly in a left turn and struck trees before impacting the ground. The helicopter then rolled down a hill. The pilot and three passengers were killed.

A post-crash investigation revealed that the engine oil dip stick was not secure. A streak of engine oil extended from the filler neck to the tail boom. Two quarts of oil were drained from the engine oil system.

Disassembly of the engine revealed damage indicative of oil starvation on all bearing surfaces, but the engine had not seized. The accident occurred in daylight visual meteorological conditions. There was no fire.

Earthly Ties Too Strong for Schweizer

Schweizer 269C. Substantial damage. No injuries.

The helicopter was attempting to take off from a platform on a fishing vessel in the Pacific Ocean for a routine fish-spotting mission.

After the takeoff was initiated, the aircraft suddenly rolled over on the deck.

It was determined that the pilot had attempted to take off with one of the skids tied to the ship's deck. The pilot escaped injury. ♦