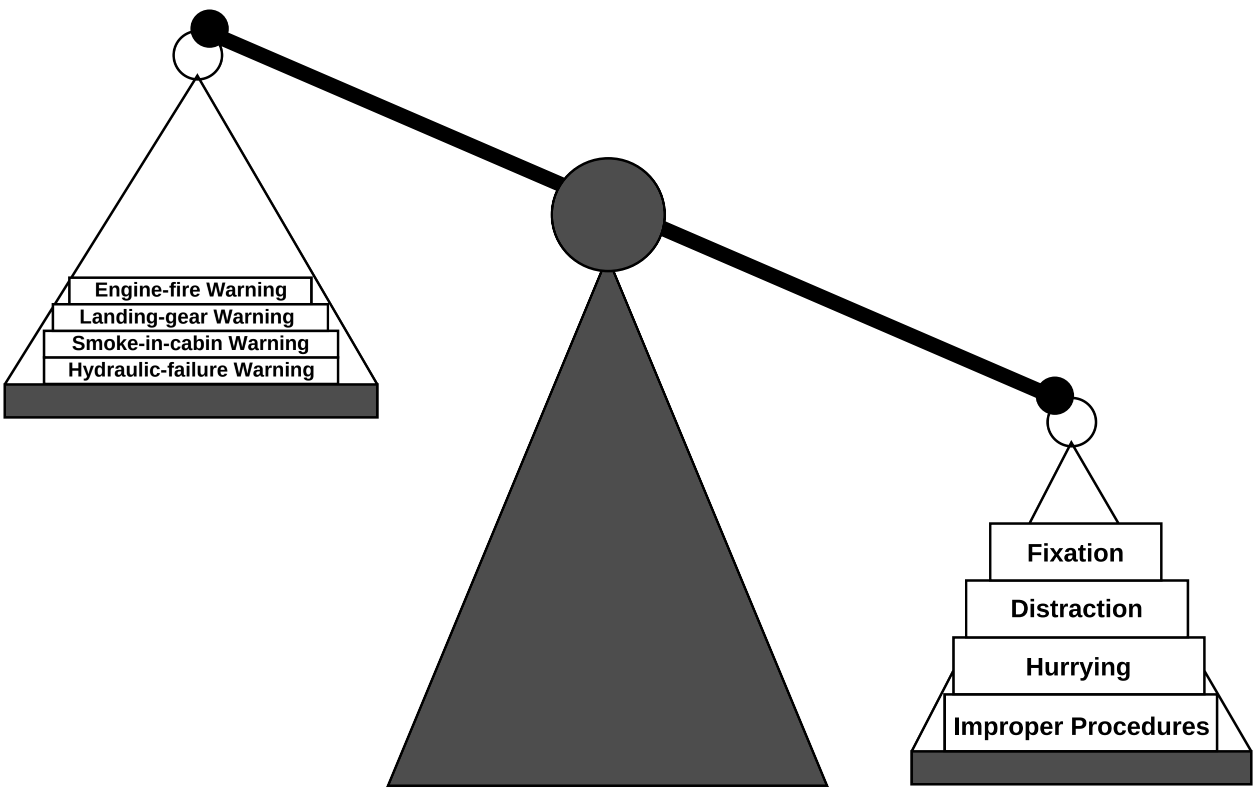
FLIGHT SAFETY FOUNDATION

OCTOBER 1995

FLIGHT SAFETY
DIGEST

ASRS Incident Data Reveal Details of Flight-crew Performance During Aircraft Malfunctions



Flight Safety Digest

Vol. 14 No. 10 **October 1995**

In This Issue

ASRS Incident Data Reveal Details of Flight-crew Performance During Aircraft Malfunctions

A study suggests that responses to less-serious malfunctions are associated with more error-chain symptoms and adverse safety consequences than are responses to serious malfunctions. The findings indicate that flight training must be modified to overcome these tendencies.

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Several accidents have been caused by the flight crew's exclusive attention to an aircraft malfunction, which resulted in their overall loss of situational awareness.[1] Examples include the December 1972 Eastern Air Lines Lockheed Martin L-1011 crash in the Florida (U.S.) Everglades and the December 1978 United Airlines McDonnell Douglas DC-8 accident in Portland, Oregon, U.S. Both of these accidents are well known, and are frequently cited in crew resource management (CRM) training.

[In the Everglades accident, the flight crew was preoccupied with a nose-gear problem and failed to heed the aircraft's loss of altitude. They resolved the nose-gear problem just before the L-1011 impacted terrain with a loss of 101 lives. Similarly, the DC-8 developed a landing-gear malfunction that, along with preparations for a landing emergency resulting from the malfunction, captured the attention of the crew for about one hour. The airplane crashed on approach to the airport. The U.S. National Transportation Safety Board (NTSB) determined that the probable cause of the accident was the captain's failure to monitor the aircraft's fuel state, resulting in fuel exhaustion before the landing could be completed.]

The study discussed in this article examined incident reports submitted to the U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS). There were two objectives: Develop a better understanding of factors — both positive and negative — that can affect crew performance when faced with in-flight aircraft malfunctions, and recommend ways to improve crew performance during these conditions.

The ASRS data base contains thousands of reports describing incidents that included aircraft malfunctions. [Reports are accepted from any aviation-related source — pilots, air traffic controllers, cabin crew, dispatchers or maintenance technicians — but approximately 80 percent are submitted by pilots. Of these, airline pilots contribute the majority, but submittals are received from corporate and other general aviation pilots, as well as military pilots. Reports may concern incidents anywhere in the world, although a large majority are about incidents in U.S. airspace.]

For inclusion in this study, the ASRS report must have involved a crew of at least two pilots and involved the actual or perceived in-flight malfunction of a major aircraft system or subsystem. The malfunction must have created a relatively prolonged period of demand on flight-crew communications, attention and procedures. This was to eliminate from consideration situations that were immediately resolved by flight crew "reflex action," such as a runaway stabilizer malfunction or an autopilot "hardover."[2]

The data set consisted of 230 reports that were submitted to ASRS between May 1986 and August 1994. ASRS data, including those in this study, may reflect reporting biases.

Table 1
Four Most Frequent Citations for Type A and Type B Aircraft Malfunctions

Type A Malfunctions (105 of 230 reports)	Citations
Engine fire and other serious engine problems requiring in-flight shutdown	72
Landing gear — inability to extend	18
Smoke or fumes in cockpit or cabin	15
Rapid depressurization	4
Type B Malfunctions (112 of 230 reports)	
Air-conditioning/pneumatic pressurization system	33
Flap and slat	23
Hydraulic	17
Landing gear — nonmajor (antiskid, brake pressure)	15

Source: Capt. Robert L. Sumwalt and Capt. Alan W. Watson, from U.S. National Aeronautics and Space Administration Aviation Safety Reporting System data

Chappell[3] noted that reporters' incident descriptions are influenced by their individual motivations for reporting, and that reports often give only one perspective of the event, which is not balanced by additional investigations or verification. Despite these caveats, Chappell wrote, "If large numbers of reports on a topic are available, it is reasonable to assume that consistently reported aspects are likely to be true. It is doubtful that a large number of reporters would exaggerate or report erroneous data in the same way."

Prior to initiating this research, the investigators turned to several sources to determine the type of information that should be gathered to evaluate crew performance. One helpful source was the U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 120-51A, *Crew Resource Management Training*, which notes that many successful CRM programs use three key areas to evaluate flight-crew performance: (1) communications processes and decision behavior, (2) team building and maintenance and (3) workload management and situational awareness.

Potential Malfunction List Developed

The next step developed an extensive list of potential aircraft malfunctions that might be found in a review of ASRS reports. Each of these potential aircraft malfunctions was then placed into one of two categories, depending on the severity of the malfunction. This allowed statistical comparison of crew performance when dealing with serious problems vs. less-serious problems.

Type A malfunctions were those that were judged as being quite serious and posing the real or perceived threat of loss of life or equipment (e.g., engine fire or failure, inability to extend landing gear and major flight control problems that grossly affect the ability to control the aircraft). Type B malfunctions were those that were judged as being less serious (e.g., flap problems, air-conditioning malfunctions and minor hydraulic system malfunctions). We further distinguished Type A and Type B malfunctions by noting that malfunctions placed in the Type A category are the sort resolved by many air carriers through use of Emergency Checklists, while those placed into the Type B category are the sort resolved by Abnormal Checklists.

By use of a six-page questionnaire, bits of relevant information were extracted from each ASRS report in the data set. The reports were analyzed as to which type of malfunction occurred and what crew factors — various aspects of flight-crew performance — were present. A comparison of crew factors across malfunction types was then performed.

Ninety-five percent of ASRS reports in this study involved air-carrier operations; 92 percent involved passenger-carrying operations. Two-thirds of these reports had a crew size of two pilots, while one-third involved three crew members.

In the ASRS reports in this study, the four most frequently found citations of Type A malfunctions and of Type B malfunctions are shown in Table 1.[4]

Of the 230 reports in the data set, 199 cited single malfunctions and 31 cited multiple malfunctions. One report referenced five aircraft malfunctions, one cited four malfunctions, five reports referenced three malfunctions and 24 reports described two malfunctions.

By design, the study aimed to evaluate approximately the same number of Type A and Type B reports of malfunctions. Type A malfunctions were noted in 105 of the 230 reports (46 percent), and Type B malfunctions were noted in 112 of the 230 reports

Table 2
Crew Procedural Usage According to Malfunction Type

	A	B	C	Totals
Crew followed prescribed procedures	90	54	5	149
Crew did not follow procedures	4	14	2	20
No information available	11	44	6	61
Total	105	112	13	230

Source: Capt. Robert L. Sumwalt and Capt. Alan W. Watson, from U.S. National Aeronautics and Space Administration Aviation Safety Reporting System data

(48 percent). A combination of Type A and Type B malfunctions were found in 13 of the 230 reports (6 percent), which are referred to as Type C reports.

The study also focused on whether the crews followed prescribed procedures to deal with these malfunctions. Of the 230 reports in the data set, 169 provided this information. Table 2 compares the number of reports where crews followed prescribed procedures vs. those reports where crews did not. Examples of improper procedural actions included failing to complete a checklist because of haste, using the wrong checklist and turning off the operative generator after a generator malfunction was discovered.

Chi-square analysis [a mathematical technique measuring the probability that numerical differences are a statistically independent population, rather than the result of chance variations] revealed a significant difference between Type A and Type B malfunctions regarding crews following (and not following) prescribed procedures.[5]

Emergency Not Always Declared

Eighty-eight of the 230 reports provided information concerning whether or not following discovery of the mechanical malfunction an emergency was declared. In those 88 reports, 71 of the reporters wrote that they declared an emergency, while 17 wrote that they did not declare an emergency. Of those where an emergency was declared, 40 reporters indicated that an emergency was declared immediately or very soon after the problem was detected.

Nine reports noted that an emergency was declared after a delay. In one report, after discovering that the landing gear would not extend, a crew delayed declaring an emergency for 2.5 hours while the aircraft circled to burn excess fuel. In two reports, the crews did not declare emergencies until on short final approaches, and only then because air traffic control (ATC) positioned aircraft onto the runway just ahead of them. One reporter wrote, "Declaring an emergency may have allowed us priority handling, and hence, less traffic disturbance." Another wrote, "It would have been much safer to inform ATC of our suspected problem early on."

Previous NASA research has shown that the type and quality of crew communications are predictors of crew performance.[6,7] Because of this previous research, and because the importance of crew communications is widely emphasized in CRM programs, the study distilled crew-communications information from these ASRS reports. Only 89 of the 230 reports had information pertaining to crew communications. Reports citing instances of crews using "positive" communications techniques outnumbered the reports of "negative" communications techniques by five to one. Table 3 describes some of the findings about crew communications.

Table 3
Citations Concerning Crew Communications*

Positive Communications (75 of 230 reports)	
Captain's open solicitation of input	(38 of 75 reports)
Briefing concerning planned actions, solutions or crew coordination issues	(26 of 75 reports)
Crew members providing input and/or voicing safety concerns	(20 of 75 reports)
Active participation encouraged in decision-making process	(9 of 75 reports)
Negative Communications (14 of 230 reports)	
Captain not receptive to crew member input	(7 of 14 reports)
Strain or difficulty with crew communications	(5 of 14 reports)
Captain failure to keep others informed of intentions	(2 of 14 reports)

* Information supplied in 89 of 230 reports.

Source: Capt. Robert L. Sumwalt and Capt. Alan W. Watson, from U.S. National Aeronautics and Space Administration Aviation Safety Reporting System data

Regarding the captain's open solicitation of input ("positive communications," Table 3), many reports indicated that solicitation of input was not limited to cockpit crew members. Eight reports cited input from company maintenance facilities via radio, and seven reported radio calls to the company dispatcher for input. Flight attendant input was sought in seven reports where information was needed about passenger status or problems visible in or from the passenger cabin.

Reporters exemplified positive communications and decision-making behaviors with statements such as "decision making in a collective environment, and coordination between us (and the cabin team) went extremely well." An example of a "negative communications" citation came from the report of an incident where the first officer informed the captain that he (the first officer) was not comfortable with the situation, but the captain continued the flight despite the input.

Error-chain Clues Signal Loss of Awareness

Schwartz[8] identified 10 items that can be symptoms of loss of flight crew situational awareness, referring to these as "error-chain clues." The components of this list, slightly modified, were used to seek evidence of crew member loss of situational awareness. At least one error-chain element was identified in 73 of the 230 reports. Figure 1 (page 4) depicts the error-chain clues, along with the number of their citations according to Type A, Type B and Type C malfunction.[9]

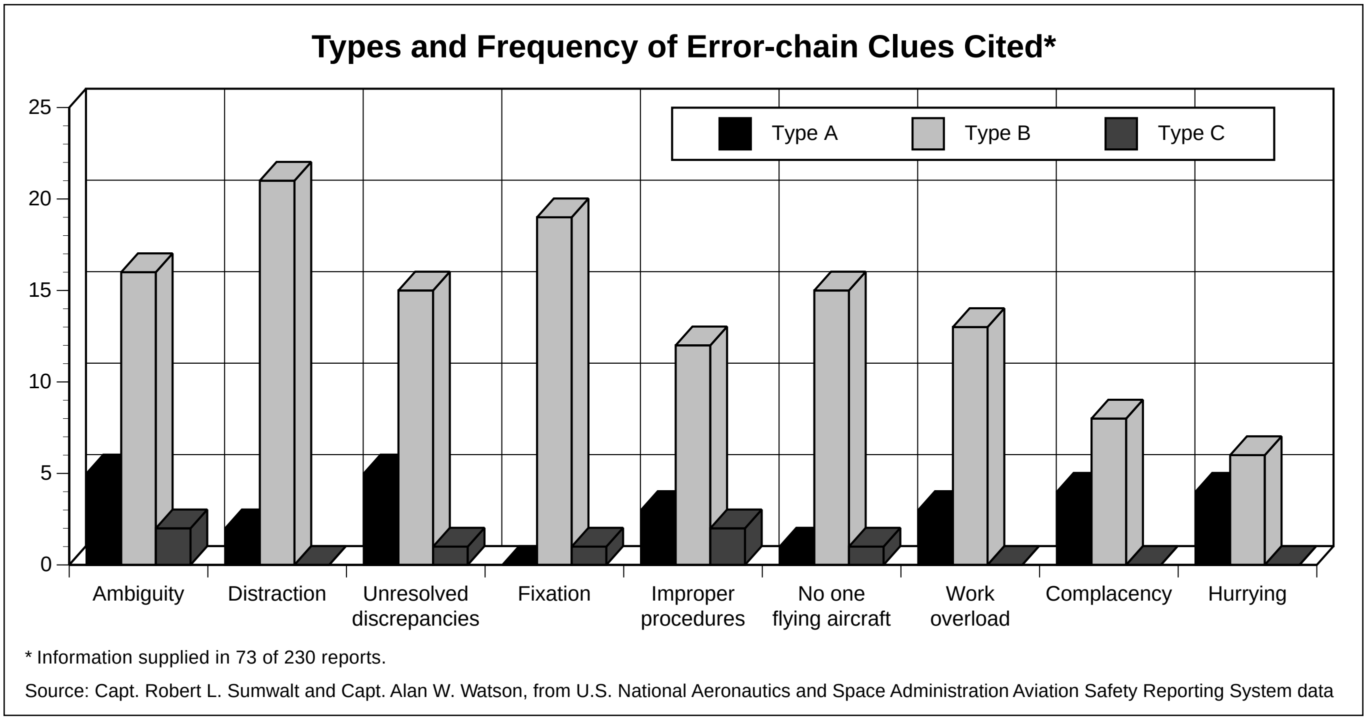

Figure 1

It was theorized that having a number of simultaneous error-chain clues could have a cumulative effect on decreasing crew performance during the resolution of malfunctions. Table 4 shows the number of these simultaneous error-chain clues, according to malfunction type. To determine if the number of simultaneous error-chain clues depended on malfunction type, a chi-square test was performed. This test showed a significant difference between the numbers of error-chain clues in Type A and in Type B malfunctions.

Reports were examined to determine if the attention demands on the flight crews during resolution of the aircraft malfunctions caused any adverse safety consequences. Of the 230 reports, 192 (83 percent) provided no evidence of any further consequences or safety problems. The remaining 38 (17 percent) led to various problems, and Table 5 shows their distribution. Two categories of adverse safety consequences — altitude deviations and course/track/heading deviations — were statistically compared for significant differences between Type A and Type B malfunction types. Chi-square tests show a significant difference between Type A and Type B malfunctions for both of these adverse safety consequences.

Table 4
Number of Simultaneous Error-chain Clues Present According to Malfunction Type

	A	B	C	Total
One clue	13	16	3	32
Two clues	4	10	2	16
Three clues	1	12	0	13
Four clues	0	10	0	10
Five clues	1	3	0	4
Six clues	0	1	0	1
Totals	19	52	5	76

Source: Capt. Robert L. Sumwalt and Capt. Alan W. Watson, from U.S. National Aeronautics and Space Administration Aviation Safety Reporting System data

Table 5
Number of Adverse Safety Consequences According to Malfunction Type

Adverse Safety Consequence	A	B	C	Total
Altitude deviations	0	14	2	16
Nonadherence to ATC clearance	0	11	2	13
Course/track/heading deviations	0	9	2	11
Noncompliance with FARs/SOPs	0	7	1	8
Other	3	5	0	8
Totals	3	46	7	56

Source: Capt. Robert L. Sumwalt and Capt. Alan W. Watson, from U.S. National Aeronautics and Space Administration Aviation Safety Reporting System data

Type B malfunctions were associated with 14 altitude deviations and 9 course/track/heading deviations, but no adverse safety consequences were associated with Type A malfunctions.

Of those reports where information could be extracted about crew procedural issues, 88 percent revealed that crews followed prescribed procedures when faced with in-flight aircraft malfunctions. Nevertheless, unlike some businesses where 80 percent may be considered “a passing score,” aviation demands that safety margins be held to the highest values. In early 1995, the U.S. Secretary of Transportation held an industry-wide safety conference where he challenged the industry to set a goal of “zero accidents.”[10] There is certainly room for improvement in crew performance during aircraft malfunctions.

Malfunction Type Affects Crew Adherence to Procedures

Chi-square analysis revealed a highly significant difference between Type A and Type B malfunction categories in crew procedural issues, simultaneous error-chain clues and adverse safety consequences (altitude and course/track/heading deviations). It appears that crew adherence to procedures is affected by the type of malfunction (as well as other factors).

A much less sophisticated look at raw numbers also points to other observations. Merely totaling the number of error-chain clue citations (Figure 1) shows that there were 25 citations for the 105 Type A malfunction reports, but 125 citations for the 112 Type B reports. Totaling the number of citations for adverse safety consequences shows similar results (Table 5). For the 105 Type A reports there were three citations of adverse safety consequences, while the 112 Type B reports had 46 adverse safety consequence citations.

The wide differences between adverse safety consequences for Type A and Type B malfunctions may be caused by crew perception of the malfunction, and training. When faced with major malfunctions such as engine fires or complete loss of major aircraft systems, crews typically resorted to highly practiced rules-based procedures, CRM principles and some degrees of heightened awareness. Analysis suggests that the way a crew perceives a mechanical malfunction, to some extent, determines the way a crew will deal with the problem; i.e., serious problems demand a high degree of procedural usage and crew coordination, whereas less serious problems pose little threat so they can be handled less formally.

Skill-rule-knowledge Classification Offers Explanation

Rasmussen’s skill-rule-knowledge (SRK) classification of human performance can further explain differences in crew performance.[11] Skill-based actions are those actions that can be accomplished with little effort once the basic skill is mastered (such as driving a car). Rules-based actions are those that have well-prescribed procedures, i.e., if X happens, accomplish Y. Knowledge-based actions usually result from ambiguous situations, or those that do not have clearly prescribed procedures. Because of uncertainty, knowledge-based actions can require considerable time and thought to deal with the task.

Clearly, the majority of this study’s Type A malfunctions could have been resolved by rules-based behavior, e.g., at the indication of an engine fire, crew should accomplish the following by immediate recall: thrust lever — close, start lever — cut off, engine fire handle — pull, engine fire bottle — discharge. But many of this study’s Type B malfunctions had resolution procedures that were less defined, and therefore may have required crews to revert to knowledge-based behavior, requiring more time and effort to properly assess and resolve the situation. This refocusing of tasks likely resulted in reduced levels of procedural accomplishment, communications and situational awareness.

This study, therefore, indicates a paradox: less-serious malfunctions appear more likely than serious malfunctions to induce flight crew behavior leading to dangerous situations! The explanation is presumably that critical malfunctions tend to trigger crew actions performed “by the book,” which have been studied and practiced until they are virtually reflexes and which call into play all of the teamwork and resource management skills taught in CRM. The situation is often resolved quickly — in many cases, it *must* be resolved quickly — leaving less time for distraction from situational awareness and other standard practices. In addition, the crew faced with a serious malfunction is likely to be in a state of all-around heightened awareness, making it less likely to add to the error chain.

Conversely, the minor anomalies called Type B malfunctions in this study often have no immediate or obvious solution. Resolving them may require time-consuming thought, discussion and trial-and-error procedures. The danger is that in such a situation, too much of the crew’s time and attention can be diverted from the normal duties involved in safe piloting, as in the Everglades and Portland accidents.

This finding has important implications for flight training.

Simulating Less-serious Malfunctions Is Equally Important

Apart from line-oriented flight training (LOFT) simulations, training and check flights usually involve handling of major malfunctions, but have much less involvement with less-serious malfunctions. This study therefore supports enhancing flight crews’ understanding that procedural issues and CRM principles must be employed when dealing with less-serious malfunctions, just as they must be used when dealing with serious problems. Further, simulator-training program developers should recognize the importance of simulating both serious and less-serious malfunctions.

Error-chain clues can denote reductions in, or loss of, situational awareness. We identified at least one error-chain clue in 73 of the 230 reports. Fixation, distraction, no one flying the aircraft and work overload were found in a number of these reports, and are of particular concern because they have been identified in many fatal aircraft accidents. In reports in this study, there was a frequent tendency of crew members to become absorbed with resolving the malfunction, often at the expense of proper aircraft control. Wrote one reporter, "No doubt flying the aircraft is the most important thing. We paid too much attention to a problem and forgot the most important thing — fly the airplane ... . One [person] should fly the airplane at all times, while the other crew member solves the problem." To minimize the possibility of such occurrences, crews should practice controlling their FATE (see shaded box).

FATE:

Fly the aircraft.
Assess the situation.
Take appropriate action.
Evaluate the results.

Moreover, flight-crew training should emphasize that an aircraft malfunction can serve as an immediate "red flag" to crew members, warning them to be alert against the loss of situational awareness.

Many air carriers use LOFT scenarios to allow crews to practice and critique their CRM skills, often during simulations of aircraft-malfunction resolution. Several of the ASRS reports reviewed in this study provided a wealth of information about problems encountered by crews dealing with malfunctions. Such reports are readily available to developers of LOFT scenarios, which could help incorporate real scenarios that have caused real problems for real crews.

One in 10 of the 230 reports provided evidence of crews using improper actions, such as not completing a checklist because of haste, using the wrong checklist and activating the wrong system-control switches. Such situations can be prevented by insisting that all crew members verify intended actions before initiation. Although crew coordination and verification are topics usually emphasized in training, furnishing crews with these findings may supply the insight that in a crisis crews may react in a manner contrary to training. If awareness is the first step toward behavioral change, then arming crews with this knowledge may better prepare them to avoid making these same mistakes.

Of the 88 reports that indicated whether crews declared an emergency, nine indicated that the emergency was declared after a delay. In two reports, the crews were forced to make this declaration at an inopportune time, because ATC did not fully appreciate or understand the problems. It is commonly accepted that there exists a widespread reluctance within the pilot community to declare an emergency. Often-cited reasons for failure to declare an emergency are not wanting to fill out paperwork, and not wanting to receive attention from regulatory authorities or company management. It should be stressed with crews that the mere act of declaring an emergency does not, in itself, generate the automatic requirement to complete paperwork.♦

Editorial note: This article was adapted from "What ASRS Incident Data Tell About Flight Crew Performance During Aircraft Malfunctions," a paper presented at the Eighth International Symposium on Aviation Psychology, Ohio State University, Columbus, Ohio, U.S.

References

1. Wiegers, F.A.; Rosman, E.I. "Safety Information System — A Safety Profile of Wide-body Commercial Aircraft." In *Proceedings of the 39th annual International Air Safety Seminar*. Arlington, Virginia, U.S.: Flight Safety Foundation, 1986.

2. The initial search of the ASRS data base yielded a large number of reports that did not meet the rigid inclusion criteria. To reduce this number of irrelevant reports, a second ASRS data base search excluded certain types of reports (e.g., those that mentioned rejected takeoffs, stuck microphones or autoflight automation anomalies). By the same token, the search criteria were refined to look for certain malfunction key phrases (e.g., engine fire, landing-gear malfunctions and flap/slat problems). Because of these search strategies, the types and percentages of malfunctions cited in this study are not a representative sampling of the total number of aircraft malfunctions in the ASRS data base. Further, as with all ASRS data, no inference can be drawn as to how these numbers relate to the total numbers of aircraft malfunctions, reported to ASRS or not.

3. Chappell, S.L. "Using Voluntary Incident Reports for Human Factors Evaluation." In *Aviation Psychology in Practice* (N. Johnson et al., eds.). Aldershot, England: Ashgate, 1994.

4. A single ASRS report may cite more than one situation or problem. (For example, one ASRS report cited a hydraulic failure that resulted in the failure to properly extend the landing gear.) Therefore, the total citations may exceed the total number of reports.

5. Each chi-square test computed these comparisons two ways. One comparison used Type A, Type B and Type C

categories. Another comparison first combined Type A and Type C categories, and then compared that group against the Type B category. The comparison was significant in both cases. The rationale for combining Type A and Type C categories was that, by definition, Type C malfunctions combined Type A and Type B malfunctions. It was hypothesized that a crew who experienced both a serious and a less-serious malfunction would prioritize tasks and deal with the serious (Type A) malfunction first and most aggressively, then with the less-serious (Type B) malfunction. In some cases, dealing with the more-serious malfunction pre-empted resolving the less-serious malfunction. Therefore, it was felt that combining Type A and Type C for these comparisons was logical.

6. Foushee, H.C.; Manos, K.L. "Information Transfer Within the Cockpit: Problems in Intracockpit Communications." In *Information Transfer Problems in the Aviation System* (C.E. Billings; E.S. Cheaney, eds.). U.S. National Aeronautics and Space Administration (NASA) Technical Paper 1875. Moffett Field, California, U.S.: NASA. 1981.

7. Foushee, H.C., Lauber, J.K. et al. "Crew Factors in Flight Operations: III. The Operational Significance of Exposure to Short-haul Air Transport Operations." NASA Technical Memorandum 88322. Moffett Field, California, U.S.: NASA. 1986.

8. Schwartz, D.C. "CRM Training for FAR Parts 91 and 135 Operators." In *Cockpit Resource Management Training* (H.W. Orlady and H.C. Foushee, eds.). Proceedings of the NASA/MAC Workshop (NASA Conference Publication 2455). Moffett Field, California, U.S.: NASA. 1986.

9. Error-chain clues were not mutually exclusive, and some were closely related (e.g., "distraction" and "no one flying the aircraft"). During analysis care was taken to avoid double entry of related error-chain clues, thereby artificially increasing their count.

10. U.S. Department of Transportation (DOT). "Zero Accidents ... A Shared Responsibility." Washington, D.C., U.S.: DOT/U.S. Federal Aviation Administration (FAA). 1995.

11. Rasmussen, J. "Deciding and Doing: Decision Making in Natural Contexts." In *Decision Making in Action: Models and Methods* (G.A. Klein et al., eds.). Norwood, New Jersey, U.S.: Ablex, 1993.

About the Authors

Capt. Robert L. Sumwalt has been a research consultant for NASA ASRS since 1992. He is an active captain for a major U.S. air carrier, and has published more than 50 articles and papers on aviation safety issues, including presentations at the Sixth, Seventh and Eighth International Symposiums on Aviation Psychology at Ohio State University, Columbus, Ohio, U.S.

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Publications Received at FSF
Jerry Lederer Aviation Safety Library

FAA Aviation Safety Conference Proceedings Published

U.S. Department of Transportation Secretary Federico Peña challenged U.S. air carriers to achieve goal of "zero accidents."

Editorial Staff

Advisory Circulars (ACs)

Announcement of Availability FAA-S-8081-10A, Aircraft Dispatcher Practical Test Standards. U.S. Federal Aviation Administration (FAA). Advisory Circular (AC) no. 61-121. May 1995. 2 p. Available through U.S. Government Printing Office (GPO).***

This AC announces the availability of FAA standards for the certification of aircraft dispatchers. These standards are to be used by FAA inspectors and designated examiners in conducting practical tests for aircraft dispatcher certification; the standards may also aid applicants preparing for certification. Price and ordering information are included.

Government Aircraft Operations. U.S. Federal Aviation Administration (FAA). Advisory Circular (AC) no. 00-1.1. April 1995. 25 p. Available through GPO.***

This AC is intended to aid aircraft operators who may have lost public aircraft status under the new statutory definition of "public aircraft." Chapter 1 contains the history of the new law as well as the U.S. Federal Aviation Administration's (FAA's) intended application of key terms in the new definition of "public aircraft"; Chapter 1 also provides guidance on whether particular government aircraft operations are now public or civil aircraft operations under the new definitions. For operations that have lost public aircraft status, Chapter 2 provides information on bringing such operations into compliance with FAA regulations for civil aircraft. Information on applying for exemptions is provided in Chapter 3.

Reports

Aviation Safety Conference Proceedings. U.S. Federal Aviation Administration (FAA). Proceedings of a conference held in Washington D.C., Jan. 9–10, 1995. 107 p. Appendix. Available through NTIS.*

The Aviation Safety Conference was convened to improve safety standards and performance after four fatal air carrier accidents occurred in the United States in 1994. Concerned about the public perception of air safety, conference attendees focused primarily on finding the means to achieve a goal of "zero accidents." More than 1,000 participants from government agencies, the U.S. airline industry and aviation unions attended. U.S. Secretary of Transportation Federico Peña delivered the opening address.

The main part of the conference consisted of workshops led by aviation industry professionals from such organizations as the U.S. Air Line Pilots Association (ALPA), the Air Transport Association (ATA), the U.S. Federal Aviation Administration (FAA), the International Association of Machinists (IAM) and the Regional Air Association (RAA). The topics discussed were Crew Training; Air Traffic Control and Weather Issues; Safety Data Collection and Use; Applications of Emerging Technologies; Aircraft Maintenance Procedures and Inspections; and Development of Flight Operating Procedures. More than 900 participants contributed to these six workshops to generate a total of 540 ideas for ways that aviation safety might be improved.

The appendix to the proceedings contains information on on-line services where documents related to this conference are available. These on-line sources are National Technical Information Service (NTIS) FedWorld, the FAA Flight Standards bulletin board and CompuServe.

International Aviation: DOT Needs Better Data for Monitoring and Decisionmaking. Mead, Kenneth M. Testimony before the Committee on Commerce, Science and Transportation, U.S. Senate. U.S. General Accounting Office (GAO). Report no. GAO/T-RCED-95-240. July 11, 1995. 11 p. Appendix. Available through GAO.**

Kenneth Mead, director, Transportation and Telecommunications Issues, Resources, Community, and Economic Development Department, U.S. General Accounting Office (GAO), testified before the U.S. Senate on the U.S. Department of Transportation's (DOT's) efforts to increase U.S. airline access to foreign markets. Mead repeated the key points of his previous statements on DOT efforts: The DOT has not collected sufficient information to conduct a satisfactory economic analysis of proposed deals, or to remain apprised of changes in the international marketplace. This information is necessary for effective negotiations. Mead testified that DOT's "open skies" goal policy, which aims for a deregulated international environment, has achieved only a limited success in key aviation markets due to competitive concerns. Because greater U.S. airline access may only be achieved in exchange for increased opportunities for foreign airlines in the U.S. market, DOT will continue to negotiate bilateral agreements for reciprocal access rights. Mead also said that DOT has responded to GAO recommendations for improving information gathering and analysis with a set of initiatives. DOT recently released a policy statement that emphasized its commitment to economic analysis and has created a new office to conduct such analyses. According to Mead, DOT has begun to collect information on airlines' business problems; a data base has been designed to monitor these problems and facilitate their resolution. Mead added that DOT must provide continued support and resources to the new economic analysis office to enable it to fulfill its purpose. He also expressed concern that the data limitations described in GAO's recent code-sharing report (GAO/RCED-95-99) have not yet been addressed. Appendix A lists all code-sharing alliances between U.S. and foreign airlines approved by DOT prior to June 30, 1995.

A Study of Aircraft Passenger Brace Positions for Impact. U.K. Civil Aviation Authority (CAA). Paper no. 95004. May 1995. 44 p. Tables, figures, references, appendix.

This report reveals the results of a study conducted for the U.K. Civil Aviation Authority (CAA) on passenger brace positions for commercial aircraft. The study investigates whether the "legs-back" braced position, which apparently offers the least risk of injury, could actually increase the chance of spinal damage. To determine the true risk of spinal injury, a series of dummy crash tests and computer occupant simulations were conducted. Analytical models, including a representation of the human spine, were correlated with the test results. The baseline, legs-back crash position was tested with variations in arm position, seat pitch, floor friction and lower-leg angle. In all tests, attention was focused on spinal loading. Other factors examined included the effectiveness of a three-point belt restraint and the use of aft-facing seats.

The report concludes that the legs-back braced position may minimize injuries for passengers in forward-facing seats in an impact. The upper body should be bent forward as far as possible and arms should shield the head. No increased risk to the spine was observed in this position. The report also suggests that three-point seatbelts provided greater restraint than two-point lap belts. In addition, high-friction carpeting beneath the seats reduces foot slide and lower-leg flail. Passengers seated in aft-facing seats are less likely to receive traumatic injury (excluding injuries sustained from flying debris). The appendix contains tables and diagrams of investigation procedure and data.

Federal Aviation Administration: Issues Related to FAA Reform. Mead, Kenneth M. Testimony before the Committee on Commerce, Science and Transportation, U.S. Senate. U.S. General Accounting Office (GAO). Report no. GAO/T-RCED-95-247. Aug. 2, 1995. 13 p. Tables, appendices. Available through GAO.**

Kenneth Mead, director, Transportation and Telecommunications Issues, Resources, Community, and Economic Development Department, U.S. General Accounting Office, testified before the U.S. Senate on the merits of several reform proposals for the U.S. Federal Aviation Administration (FAA). The proposed reforms include increased authority for the FAA, a new organizational structure for federal aviation functions, the creation of an independent agency outside the Department of Transportation (DOT) and the establishment of a public or private air traffic control corporation. Mead noted that all of these proposals would exempt FAA from federal procurement and personnel rules.

Mead's testimony focused on three key issues: the modernization of the air traffic control system; sufficient and reliable funding for aviation programs; and the reorganization of the agency. Although delays in the air traffic control modernization program are commonly attributed to cumbersome federal procurement rules, Mead said that many cost and scheduling problems are due to other factors. Delays have occurred when the technical complexity of the modernized systems was underestimated, particularly when software development was involved. Inadequate supervision of contractors and frequent turnover of FAA's top managers were also cited as contributing to the FAA's difficulties. Mead contended that exempting the FAA from procurement rules may expedite the acquisition process, but this will not be an immediate or dramatic change. On the subject of FAA funding, Mead noted that the proposal to create an air traffic control corporation and one of the independent-FAA proposals would enable the new corporation or agency to seek exemption from the Budget Enforcement Act. He added, however, that it is unlikely that either plan would solve the funding problem. Mead also discussed the importance of a clear division of responsibilities between the proposed air traffic control corporation and the FAA should the two organizations become separate entities. The testimony concluded with a review of the issues raised by the possibility of a private air traffic control corporation.

Appendix I provides information on schedule and cost data for air traffic control systems. Appendix II lists GAO reports and testimony relevant to Mead's present testimony.

Aircraft Evacuations Through Type-III Exits. I: Effects of Seat Placement at the Exit. McLean, G.A.; George, M.H.; Chittum, C.B.; Funkhouser, G.E. A special report prepared for the U.S. Federal Aviation Administration (FAA) Office of Aviation Medicine. Report no. DOT/FAA/AM-95/22. July 1995. 9 p. Figures, tables, references. Available through NTIS.*

<u>Keywords:</u>
1. Aircraft Evacuations
2. Egress
3. Passageways
4. Ergonomics

This report presents the results of a study of the effect of aircraft passageway width and seat encroachment on passenger emergency evacuation. Two subject groups, one consisting of persons between the ages of 18 and 40, the other of persons between 40 and 62, enacted a series of simulated emergency evacuations of an aircraft via Type III overwing exits. The variable factors considered in these simulations were the amount of space between rows of three seats on either side of the exit, and the seat encroachment distance (i.e., the extent to which the lower portion of the seat blocked the exit door). The study notes that slower rates of exit occurred at six-inch (15.24-cm) and 10-inch (25.4-cm) passageways than at the 13-inch (33.02-cm), 15-inch (38.1-cm) and 20-inch (50.8-cm) passageways. Evacuation times also rose steadily as seat encroachment distance increased. Older subjects had greater egress time than the younger subjects in all seat placement configurations.

The report concludes that the placement of the seats at a Type-III exit has a critical effect on the speed and ease of passenger egress. Narrow passageways and/or large seat encroachment delay aircraft evacuation significantly. The report suggests that a 13-inch passageway with a midpoint seat encroachment is the minimum width that will allow aircraft passengers a swift emergency exit.

Final Response to the Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario. Government of Canada, Transport Canada. July 1995. 165 p. Appendix.

In response to the March 10, 1989, crash of an Air Ontario Fokker F-28, the Government of Canada established a Commission of Inquiry to investigate the main cause of the accident as well as contributory factors. In 1992, 191 recommendations for improving aviation safety were released by the commission; the Dryden Commission Implementation Project was subsequently created to ensure that each of these recommendations was given serious consideration. This Final Response presents an analysis of the problems identified by the commission and explains the effectiveness of the measures implemented to counter these problems.

The Commission of Inquiry determined that ice on the wings of the aircraft was the primary cause of the Air Ontario accident. Contributing factors included the weather, heavy passenger traffic along the Thunder Bay/Winnipeg route, inaccuracies in the operational flight plan and an unserviceable auxiliary power unit at the Dryden airport. As a result of these conclusions, the commission's principal goal was to strengthen existing legislation concerning ice-contaminated aircraft. To achieve this goal, the commission proposed a combination of education, legislation, mandatory inspections and improved airport operations under icing conditions. Recommendations include guidelines for the education of flight crew and ground crew on the dangers of icing and on available deicing and anti-icing methods, a requirement for one member of the flight crew to personally inspect the wings and a requirement that a member of the flight crew check the wing condition if a member of the cabin crew expresses concern regarding possible ice contamination. The commission also made recommendations concerning cabin interior flammability standards, flight attendant seat standards, runway conditions and emergency response services.

In November 1990, Transport Canada amended the existing rule on contaminated aircraft and created section 540.2, which states unequivocally that "no person shall take off or attempt to take off in an aircraft that has frost, ice or snow adhering to any of its critical surfaces." At the time of this report's release, 130 of the commission's recommendations to enforce this new regulation had been implemented in the form of amendments to the Canadian Aviation Regulations and associated standards. The report predicts that most of the remaining 61 recommendations will also be implemented through changes to other regulations and standards.

The Relationship Among Eye Movements, Head Movements, and Manual Responses in a Simulated Air Traffic Control Task. Boyer, Donna Jean. U.S. Federal Aviation Administration (FAA) Office of Aviation Medicine. Report no. DOT/FAA/AM-95/23. August 1995. 16 p. Figures, references. Available through NTIS.*

<u>Keywords:</u>
1. Eye Movements
2. Head Movements

3. Human Performance
4. Vigilance
5. Visual Attention

The performance of aviation systems' operators, including air traffic controllers, is extremely dependent upon their ability to scan information sources visually, identify problems and to respond with the appropriate action. As part of a larger investigation conducted to identify how alterations in various gaze measures can serve as indices of changes in alertness, this study examined patterns in head and eye movements.

Ten subjects selected for their propensity to make head movements when shifting their gaze from the CRT [cathode-ray tube] display to the keypad were asked to perform a complex visual-information processing task. The task consisted of 44 infrequently occurring events that required manual responses via the keypad. Four types of events were used: Unidentified Aircraft, Loss of Altitude, Conflict (two aircraft flying toward each other at the same altitude) and No Conflict (two aircraft flying away from each other). The task was conducted in a two-hour session divided into three time blocks of approximately the same duration. Head and eye movement latencies were measured from the manual response. The report concluded that there were no significant eye-head movement differences among the event types and that the relationship between the initiation of eye movements and head movements appears to be a consistent characteristic of the individual.

Books

Aircraft Crashworthiness. Chandler, Richard F. (ed.). Warrendale, Pennsylvania, U.S.: Society of Automotive Engineers (SAE), 1995. SAE Order no. PT-50. 423 p. Figures.

This collection of thirty SAE technical papers covers some of the most significant studies in aircraft crashworthiness conducted during the past 40 years. These papers trace the development of crashworthiness technology from the first systematic investigation of aircraft crashes, Hugh DeHaven's Crash Injury Research Project at Cornell University Medical College in 1942; DeHaven's "Accident Survival — Airplane and Passenger Car," and "Protective Design in Forward and Rearward Facing Seats in Transport Aircraft" are among the papers presented in this collection. Other papers describe early research into technologies that have led to many of the standard safety features incorporated into aircraft design today. Featured among the papers in this collection are "Crash Protection to Air Transport Passengers," "A Review of Crashworthy Seat Design Principles," "Methods of Crashworthiness Testing for Aircraft Design," "Crash Impact Characteristics of Helicopter Composite Structures," "Controlled Impact Demonstration Review" and "Airplane Size Effects on Occupant Crash Loads." The development of breakaway accessories, digital simulation testing, antimisting fuels and inflammable seat-cushion materials are discussed in other reports.

The papers presented in *Aircraft Crashworthiness* were selected through an electronic data search of SAE technical papers, supplemented by a manual search of SAE's Cumulative Index of papers written since 1906. Other titles recovered in this literature search are listed in two bibliographies at the end of the book. "Recommended Readings" is an annotated list of titles that were not chosen for this collection but deal with specific areas of crashworthiness that may also be of interest to readers. "Related Readings" lists all other items retrieved during the literature search.

The Anatomy of the Aeroplane. Stinton, Darrol. Oxford, England: BSP Professional Books, 1994. 322 p. Figures, appendices, index.

According to the author's preface, this textbook developed from his annual lectures on aero-structures to student test pilots. The book begins with the premise that every external feature on an aircraft body is shaped to perform a specific set of functions. It is intended to give student pilots an understanding of the fundamental principles of aircraft design.

The book is also written to create an appreciation for the practical applications of flight dynamics, which must take environmental factors, size and flight speed, and safety requirements into consideration to make an aircraft aerodynamically sound. Various types of aircraft are described and discussed in these terms. Illustrated examples make clear why propellers and jet engines are placed where they are on particular craft. The reasons for low tails and no tails on supersonic jets are likewise explained. The bodies of seaplanes are contrasted with their landplane counterparts. Chapter titles include "The Atmosphere," "The Operational Environment," "Requirements and the Specification," "The Generation of Aerodynamic Forces," "The Control of Lift and Drag," "Engine-Airframe Matching," "The Structure" and "The Final Aeroplane."

Numerous diagrams and illustrations accompany the text. Appendices A–F describe the layouts of "Light Aeroplanes," "Utility Aeroplanes," "Subsonic Transports," "Supersonic Transports," "Strike and Reconnaissance Aeroplanes" and "Vertical and Short Take-Off and Landing (VSTOL) Aeroplanes" respectively. The author also provides a list of books for suggested further reading on the subject.

The Design of the Aeroplane. Stinton, Darrol. Oxford, England: BSP Professional Books, 1993. 642 p. Tables, figures, appendices, index.

Keywords:
1. Airplanes — Design and Construction

This textbook on the fundamental principles of aeronautical engineering is also a practical, step-by-step guide for those who wish to design and build their own airplanes. The emphasis is on one-pilot, small aircraft; the book covers design for aircraft from the ultralight up to 12,500 pounds (5,670 kilograms). Airworthiness standards are also considered. The author focuses on the requirements for British certification, but the differences between the U.K. British Civil Airworthiness Requirements (BCARs) and U.S. Federal Aviation Regulations (FARs) are compared as well.

Chapter headings include "Airworthiness the Object," "Vocabulary of Design," "Nature of Air," "Drag, Flap and Wakes," and "Power for Flight." Engines, fuselages, landing gear and stability are discussed in other sections. The final chapter, "Layout," presents 40 practical examples of project designs. Diagrams and photographs illustrate these examples as well as aerodynamic principles throughout the text.

The book begins with a brief list of Anglo-English aviation terms matched with their American-English counterparts for easy translation. Appendix A lists data sheets for light- and general-aviation aerodynamics; Appendix B lists light- and general-aviation performance data sheets.

[Both *The Anatomy of the Aeroplane* and *The Design of the Aeroplane* have been reprinted in the United States by the American Institute of Aeronautics and Astronautics (AIAA). They can be ordered by calling 1-(800)-682-2422 in the United States.]

Flight Management Systems: The Evolution of Avionics and Navigation Technology. Fishbein, Samuel B. Westport, Connecticut, U.S.: Praeger, 1995. 237 p. Figures, glossary, index.

Keywords:
1. Avionics
2. Navigation (Aeronautics) — History

Written by a museum specialist at the Smithsonian Institution's National Air and Space Museum, Washington, D.C., U.S., and prepared under the auspices of the Smithsonian, this technical guide covers the history of avionics and navigation instruments from the distant past and looks to the foreseeable future. The development of air navigation systems is traced from the early days of flight through the 1930s and World War II and into the postwar period. Ancient celestial navigation tools such as the astrolabe and the sextant appear in relation to radio communications and Doppler navigation. This book also discusses space-based technologies such as NAVSTAR/Global Positioning System (GPS), and briefly examines such future possibilities as the use of artificial intelligence and "fuzzy logic" to help guide aircraft in flight. "Smart sensors" and "smart skins" (sensors implanted in the airframe) are also discussed briefly.

Chapter titles include "Historical Perspective," "Aircraft and Support Instruments," "Ground and Space Systems," "The Digital Revolution," "A Look at the Future" and "The Winds of Change." Each chapter is divided into clearly titled sections and subsections to permit quick reference to specific information. The book concludes with an extensive annotated bibliography and a glossary of abbreviations, acronyms and definitions.

[*Flight Management Systems* can be ordered by credit card in the United States by calling 1-(800)-225-5800.]

Helicopter Notes Two: The Helicopter Pilot's Complete Resource Guide. Third edition. Miller, Jerome. Montoursville, Pennsylvania, U.S.: JMCO Publishing, 1995. 157 p. Index, appendices.

The revised edition of *Helicopter Notes Two* has been expanded to include nearly 100 pages of updated information for helicopter pilots. This manual is designed to serve as a reference source as well as a safety guide. In addition to existing section topics such as "Mountain Flying," "Cold Weather Operations" and "Turbulence," new topics in the third edition include "Filing a VFR Flight Plan," "Night Flying Fog Hazard," "Radio Usage," "Search and Rescue Checklist," "Thunderstorms" and "Weather Briefing, Receiving and Requesting." This manual also addresses general safety precautions, boarding and unboarding passengers and postflight inspection procedures. Quick reference items such as the "Alpha, Bravo, Charlie" phonetic alphabet, transponder codes and a Fahrenheit-to-Celsius temperature conversion table are also provided.

The index appears at the beginning of the manual and serves as a table of contents. Appendix A is a glossary of abbreviated terms. Subsequent appendices direct the reader toward helicopter-related resources. Appendix B is an annotated list of helicopter-oriented books. Appendix C lists aviation book dealers and publishers. Appendix D lists aviation directories and appendix E is a list of helicopter-oriented videos. Appendix F provides a list of helicopter-oriented magazines. Appendix H lists aviation organizations.♦

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*** Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402 U.S.

U.S. Federal Aviation Administration (FAA) Regulations and Reference Materials

Part	Date	Subject
Part 1	7/10/95	*Definitions and Abbreviations* (incorporates Amendment 1-40, "Revision of Certain Flight Airworthiness Standards to Harmonize with European Airworthiness Standards for Transport Category Airplanes," adopted 6/2/95).
Part 25	7/10/95	*Airworthiness Standards: Transport Category Airplanes* (incorporates Amendment 25-84, "Revision of Certain Flight Airworthiness Standards to Harmonize with European Airworthiness Standards for Transport Category Airplanes," adopted 6/2/95).
Part 91	5/10/95, 5/31/95	*General Operating and Flight Rules* (incorporates Special Federal Aviation Regulation (SFAR) 67, "Prohibition Against Certain Flights Within the Territory and Airspace of Afghanistan," adopted 5/10/95).
Part 91	6/15/95	*General Operating and Flying Rules* (incorporates SFAR 50-2, "Special Flight Rules in the Vicinity of the Grand Canyon National Park," adopted 6/9/95).
Part 121	5/10/95, 6/1/95	*Certification and Operations: Domestic, Flag, and Supplemental Air Carriers and Commercial Operators of Large Aircraft* (incorporates Amendment 121–149, "Suspension of Pre-Employment Alcohol Testing Requirement," adopted 5/3/95 and SFAR 38-11, "Certification and Operating Requirements," adopted 5/31/95).
Part 125	6/1/95	*Certification and Operations: Airplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload Capacity of 6,000 Pounds or More* (incorporates SFAR 38-9, "Certification and Operating Requirements," 38-10, "Public Aircraft Definition and Exemption Authority," and 38-11, "Certification and Operating Requirements," adopted 5/31/95).
Part 127	4/23/95, 6/1/95	*Certification and Operations of Scheduled Air Carriers with Helicopters* (incorporates SFAR 38-10, "Public Aircraft Definition and Exemption Authority," adopted 1/6/95 and SFAR 38-11, "Certification and Operating Requirements," adopted 5/31/95).

Advisory Circulars (ACs)

AC No.	Date	Title
25–7	6/6/95	*Flight Test Guide for Certification of Transport Category Airplanes* (provides updated guidance to ensure consistent application of certain airworthiness requirements recently adopted by Amendment 25-84).
65–26A	4/20/95	*Charles Taylor "Master Mechanic" Award* (cancels AC 65-26, *Charles Taylor "Master Mechanic" Award*, dated 4/23/93).
135–13C	6/26/95	*List of Air Carriers Certificated by FAR Part 135* (cancels *List of Air Carriers Certificated by FAR Part 135*, dated 10/29/93).
150/5000-8A	7/3/95	*Office of Airport Safety and Standards Electronic Bulletin Board* (cancels *Office of Airport Safety and Standards Electronic Bulletin Board*, dated 7/27/92).
150/5345-53A	5/15/95	*Airport Lighting Equipment Certification Program* (cancels 150/5345-53, *Airport Lighting Equipment Certification Program*, dated 7/15/94).

Accident/Incident Briefs

Boeing 737 Narrowly Avoids Stall After Airspeed Decays

The aircraft had descended 800 feet (244 meters) below its assigned altitude.

Editorial Staff

The following information provides an awareness of problems 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

Tail Strike Cuts Flight Short

Boeing 737-300. Substantial damage. No injuries.

The Boeing 737 with 85 people on board had departed a European airport when the flight crew were alerted to decompression in the baggage hold and determined that the fuselage had been damaged.

The aircraft returned to the departure airport and made an uneventful landing. An investigation determined that the aircraft's tail struck the tarmac when the aircraft rotated during takeoff. The passengers continued their journey on another aircraft. There were no injuries.

'Heads Down' Results in Altitude Deviation, Flight Attendant Injury

Boeing 737. No damage. One minor injury.

While descending in holding to 23,000 feet (7,015 meters) the pilot flying switched the autothrottles off. The captain and the first officer then began looking for approach plates.

The pilot not flying was the first to notice airspeed decaying through 180 knots. He pushed up the throttles and alerted the pilot flying. The pilot flying began hand flying the aircraft to recover airspeed and altitude. The aircraft had descended about 800 feet (244 meters) below its assigned altitude. During recovery, as the engines spooled up, the aircraft pitched up, triggering the stick shaker.

After leaving the hold, the first flight attendant informed the flight crew that a galley door had swung open and struck a flight attendant in the head during the incident.

Boeing 737 Makes Emergency Landing After Oil-pressure Loss

Boeing 737-200. No damage. No injuries.

During departure climb, at about 9,000 feet (2,745 meters), the captain noticed that the No. 1 engine oil-quantity gauge was just under two U.S. gallons, and the quantity continued to drop. The decrease was accompanied by loss of oil pressure and rise of temperature in the No. 1 engine.

The engine was shut down, and the flight crew informed departure control that the B-737 would be returning to the airport.

The crew declared an emergency and asked for crash, fire and rescue units to stand by. Flight attendants were briefed and passengers informed of the situation. A normal landing followed, after which maintenance made the necessary repairs and the aircraft was returned to service.

Air Taxi Commuter

Repaired Wheel Lost After Takeoff

Fokker F-50. Minor damage. No injuries.

The twin-turboprop aircraft was on a positioning flight after repairs conducted the night before. The repairs included removal and replacement of the right inner main wheel.

Shortly after takeoff, an object was observed dropping from the aircraft. It was subsequently determined that the object was the right inner main wheel. The aircraft landed without incident after flying to burn fuel.

An examination determined that the inner wheel bearing was still in place and was correctly fitted. After removing the bearing, however, it was found that the bearing and reinforced seal had been prevented from seating correctly by a reinforced seal that had not been removed when the wheel was replaced.

The aircraft maintenance manual showed the main wheel assembly and described the removal and replacement of the main wheel. The manual called for removal of the inner bearing after removal of the wheel. The manual did not indicate that the reinforced seal was a separate item.

Ground Agent Walks into Propeller During Departure Preparations

ATR-42. Minor damage. One fatality.

The aircraft was parked at night on the ramp with the right engine running. A nonrevenue company passenger was assisting the station agent in preparing the aircraft for departure.

Neither the flight crew nor the station agent were aware that the assisting employee had walked to the right side of the aircraft until they heard a “loud thump” and saw the employee lying under the propeller.

Corporate Executive

Twin Hits Trees After Engine Failure on Final

Beech 200 King Air. Aircraft destroyed. Four fatalities.

The aircraft was on final approach in daylight visual meteorological conditions when it suddenly lost airspeed and lost altitude. The gear was retracted and the aircraft rolled to the left and struck trees. The twin-turboprop was destroyed by impact and a postcrash fire. Two crew members and two passengers were killed.

An investigation determined that the left engine failed because of a fatigue failure of a compressor turbine blade. The right engine was found to be operating properly at impact, which was caused by a stall.

Icing Encounter Ends on Mountainside

Beech 50 Bonanza. Aircraft destroyed. Two fatalities.

The aircraft impacted a mountain at about 8,300 feet (2,532 meters) mean sea level (MSL) in a near-vertical attitude at high speed.

Weather at the time of the daylight accident was reported as instrument meteorological conditions with ceiling overcast at 2,700 feet (824 meters) above ground level (AGL) with tops from 17,000 feet (5,185 meters) to 19,000 feet (5,795 meters) MSL and severe mixed icing above the 9,500-foot (2,898-meter) MSL freezing level. The aircraft had no anti-ice equipment and the oxygen system was inoperative.

Other General Aviation

Twin Impacts Terrain on Night Approach

Beech 90 King Air. Substantial damage. No injuries.

The aircraft impacted the ground during a night circling approach to the airport. The King Air was cleared for a very high frequency omnidirectional radio range (VOR) approach to Runway 30, but because of unfavorable winds the pilot elected to circle to land on Runway 12.

While on right downwind, visual contact with the runway was lost. The aircraft struck terrain in a slight right turn.

Gusty Winds Cause Fatal Control Loss

Cessna 310. Aircraft destroyed. Three fatalities. Two minor ground injuries.

During the twin-engine Cessna's takeoff roll, gusty winds shifted to a direct right crosswind and directional control became difficult.

After liftoff, the aircraft banked left and continued to fly in a nose-high, steep left bank, then collided with terrain. A line of thunderstorms was reported in the area at the time of the crash. The pilot and two passengers were killed. The aircraft was destroyed by impact and a postcrash fire.

Rotorcraft

Bird Strike Smashes Windshield, Injures Pilot

Bell 206. Substantial damage. One serious injury.

The helicopter was on a law enforcement operational flight at night at an altitude of 1,200 feet (366 meters) over a Canadian city when a large bird came through the right side of the windshield, striking a door post and then the pilot's face.

The pilot was wearing a helmet with the visor lowered, which lessened the extent of his injuries. Nevertheless, the pilot suffered severe face cuts and was almost knocked unconscious by the impact. The pilot told investigators: "Had I not been wearing my helmet with the visor down, I certainly would have been incapacitated, with most likely a fatal result. At the very least I would have lost my right eye."

Power Lines Surprise Pilot During Aerial Application

Hughes 269B. Aircraft destroyed. One minor injury.

The helicopter was conducting an aerial application when it struck power lines and collided with terrain.

A witness reported that the helicopter was rolling out of a descending turn in preparation for an application run when the main rotor blades struck the wires. The aircraft impacted the ground about 150 feet (46 meters) from the wires. Weather at the time of the accident was reported as daylight visual meteorological conditions with clear skies and 10 miles (16 kilometers) visibility.

Tail Rotor Strikes Ground During Landing Attempt on River-bank Slope

Robinson R-22. Substantial damage. No injuries.

The R-22 pilot was attempting to land on a five- to seven-degree river-bank slope when the helicopter lost tail-rotor control. Witnesses reported seeing the tail strike the ground before the aircraft crashed.

The pilot was uninjured but the helicopter sustained substantial damage, with both tail-rotor blades bent and separated from their yokes.

Weather was reported as daylight visual meteorological conditions with clear skies and 15 miles (24.1 kilometers) visibility.

AStar Encounters Power Line

Aerospatiale AS-350 AStar and Bell 206. Substantial damage. No injuries.

The AS-350 AStar was landing under a power line when its main blades struck two wires. The AS-350's main rotor blades were damaged. One tail-rotor blade and the tail-rotor drive shaft cover of a Bell 206, parked nearby, were also damaged.

FLIGHT SAFETY DIGEST
 ISSN 1057-5588

Staff: Roger Rozelle, director of publications; Girard Steichen, assistant director of publications; Rick Darby, senior editor; Karen K. Bostick, production coordinator; and Kathryn Ramage, librarian, Jerry Lederer Aviation Safety Library.

Subscriptions: US$95 (U.S.-Canada-Mexico), US$100 Air Mail (all other countries), twelve issues yearly. • Include old and new addresses when requesting address change. • Flight Safety Foundation, 2200 Wilson Boulevard, Suite 500, Arlington, VA 22201-3306 U.S. • Telephone: (703) 522-8300 • Fax: (703) 525-6047