U.S. Report: Delays Still Plague Efforts to Harmonize Commercial Transport Airplane Standards

Despite 10 years of joint efforts to harmonize certification standards, the United States and European aviation authorities still have much to accomplish. A U.S. study says that a new joint strategy may speed the process.

—

Editorial Staff Report

Efforts by U.S. and European aviation regulatory authorities to harmonize commercial transport airplane standards have been fraught with delay during the past 10 years, according to a recently released U.S. report.

Despite initiating a joint effort in 1983 and formally placing a high priority on harmonizing certification standards and practices in 1989, the U.S. Federal Aviation Administration (FAA) and the [European] Joint Aviation Authorities (JAA) are still far apart, a report by the U.S. General Accounting Office (GAO) says.

"An FAA analysis in the early 1980s found 267 significant differences between the two standards. GAO found that at least 233, or 87 percent, of those differences still exist."

The GAO, an independent government monitoring agency, quoted an FAA official as saying that "no real progress has been achieved to eliminate unnecessary duplication on specific projects over the last nine years."

However, an official FAA response to the GAO report countered that many achievements had been ignored or played down in the report.

"While the [GAO] report presents extensive information regarding the remaining differences in standards and interpretations between the FAA and the JAA, the [FAA] maintains that recognizing the significant harmonization progress that has already occurred would provide a more balanced presentation.

"Considering all the activities required over the five-year period it typically takes to type certify transport category airplanes, the FAA and JAA standards are remarkably harmonized already. This does not diminish the need for further harmonization in the remaining areas; nevertheless, credit could be given for the high degree of harmonization that already exists and the work in progress."

The FAA rebuttal added: "The limited scope of the [GAO] report does not provide a full appreciation of the magnitude of harmonization efforts. The report addresses only 'design' requirements. The importance of 'production' requirements and their harmonization deserve emphasis to provide a complete understanding of their significant impact on airplane safety."

In compiling its report, the GAO said it evaluated data from the FAA, airplane manufacturers and trade associations, reviewed legislation, regulations, bilateral agreements and policies governing airplane certification and interviewed officials in the United States and Europe. "We obtained the views of officials from all five producers of transport category airplanes (Boeing, McDonnell Douglas, Airbus, British Aerospace and Fokker), as well as from the FAA, JAA, and the civil aviation authorities of the United Kingdom, France and The Netherlands."

According to the GAO, differences and duplication persist because they are rooted in statutory requirements and their elimination involves compromise and forfeiture of some independence. "Until recently, the FAA and JAA had not developed an effective strategy to focus their efforts. Instead, they implemented an ad hoc approach in which numerous working groups were created as differences arose."

However, the GAO said FAA and JAA officials began developing a strategic plan in 1992 when it became clear that a new approach was needed.

"Until recently, the FAA and JAA had not developed an effective strategy to focus their efforts."

The strategic plan, proposed by the FAA, sets priorities and establishes time frames for the harmonization effort. FAA officials say the plan addresses most of the GAO's concerns and that resolution of harmonization issues is gaining momentum.

The GAO said that while the strategic plan was a "good starting point for the eventual resolution of certification differences," the FAA should closely monitor progress to ensure that projected timetables are met and efficiency is improved. It also recommended that joint teams should be created to coordinate certification activities.

In addition to a failure to develop a joint strategy to focus joint efforts, the GAO said the harmonization process has been slowed because:

- The JAA concentrated primarily on eliminating national variants from its own regulations and coordinating its own certification activities; and,

- The FAA and JAA "have not developed specific procedures to coordinate certification, prevent duplication and eliminate interpretational differences late in the process."

Although the FAA said it agreed with the report's principal recommendations, it added:

"Throughout the report, GAO concludes that concerns regarding independence and the unwillingness to compromise are the major causes of regulatory differences and duplication in the airplane design certification process. This does not recognize the statutory, legislative and technical constraints on the system. The FAA and JAA are subject to statutory constraints that in many instances preclude compromise. Further, it also does not acknowledge that there may be valid technical reasons for the regulatory differences."

The FAA also noted that the GAO report did not clearly define differences in statutory

authority between the FAA and the JAA.

"The JAA is not a statutory regulatory authority — it is only a coordinating organization. As such, it has no authority to grant any type of certificates. That must be done separately by each of its member countries. It has no authority to directly charge for its services or to delegate certification responsibilities to organizations or private citizens," the FAA response said.

The GAO report acknowledged that the FAA and JAA faced a task that involved changes to "hundreds of technically complex rules" when harmonization efforts began in the early 1980s.

Manufacturers and regulators on all sides are in virtual agreement that the current certification system remains duplicitous, the report said.

Progress toward standardization has been hampered in part because the JAA did not have a consolidated standard until 1988, the GAO said.

"The current system of certifying designs for commercial transport airplanes lacks uniform standards, interpretations, and procedures, resulting in an increase in manufacturers' costs and inefficient use of resources. Regulatory differences have often arisen late in the certification process and have resulted in costly design changes," the GAO said.

Anthony J. Broderick, FAA associate administrator for regulation and certification, said during an address at the Flight Safety Foundation's 45th International Air Safety Seminar (IASS) in November 1992 that, in one sense, "JAA must decide what it wants to be."

"JAA is not a political body, but an informal group that has some standing within other European bodies. But what is JAA? How do we talk to JAA, and how do we formally deal with it? In its current form, you cannot easily do either. It has no set of appeal routes, and there does not appear to be a functioning legal mechanism to contest decisions it has made. The Executive Board strives mightily to achieve consensus, but that is not easily done among the six members of the board, let alone the 19 members of the [JAA] arrangement," Broderick said.

The GAO report acknowledged that the FAA and JAA faced a task that involved changes to "hundreds of technically complex rules" ... .

The GAO report cited several examples of regulation interpretations that cost manufacturers millions in design changes. In one instance, the GAO said, the JAA interpreted an identical regulation differently than the FAA, claiming that McDonnell Douglas had not minimized the risk of possible damage after an engine explosion. "Douglas officials stated that JAA's certification of the MD-11 had several such differences and cost the company $21 million." [Although the FAA certified the MD-11 in November 1990, the JAA wrote McDonnell Douglas a month later stating that the company had not adequately "minimized" the hazards that could occur after a rotor burst (engine explosion). The JAA required McDonnell Douglas to reroute the hydraulic lines for aircraft exported to Europe.] The FAA had already invested 33,600 staff hours to certify the aircraft, the GAO said.

Boeing Commercial Airplane Group had similar complaints, the report said. According to Boeing officials, "late interpretation differences unnecessarily increased total production costs between $60 million and $90 million for Boeing's 747-400 fleet."

["FAA regulations state that for derivative aircraft, new design requirements cannot be imposed unless an aircraft area ... was changed significantly or service experience was unsatisfactory. Because the 747-400 was a derivative of the 747-300 and had an identical floor in the upper deck, the FAA did not require the 747-400 to meet a new rule that required the

upper deck floor to be designed to withstand the effects of depressurization resulting from a 20-square-foot opening in the fuselage. The JAA disagreed with the FAA and required that the 747-400 meet the new regulation even though the FAA had already certified the aircraft. Boeing agreed to redesign the aircraft and retrofit those already exported to Europe."]

Costly duplication of certification activities is widespread, the GAO said.

"Airbus officials stated, and the FAA's aircraft certification service director acknowledged, that the FAA unnecessarily duplicated many of the JAA's tests and analyses for the A320 aircraft, which cost Airbus $3.5 million. In addition, Boeing spent approximately $500,000 to conduct an 11-hour flight test of the 747-400 aircraft for the JAA even though the FAA had conducted similar tests and certified the aircraft."

Other examples of differing interpretations the GAO said resulted in costly changes included:

- The FAA and JAA differed in their interpretation of the regulation governing the segregation of electrical wiring for the Boeing 747-400. Although the regulations are identically worded, the JAA applied a more conservative interpretation of the word "segregation." Because this difference surfaced late in the certification process, Boeing had to redesign the wiring of the aircraft to meet the JAA requirement. Two 747-400 designs now exist as a result of the different interpretations — one based on FAA standards and one based on JAA requirements.

- Airbus officials say disagreement about one regulation late in the design stage increased production costs by more than $20 million for the entire fleet. ["In February 1991 the FAA informed Airbus that the A340 design, scheduled for certification in February 1993, did not sufficiently minimize the risk of damage to the fuel tanks after a rotor burst or ensure that a significant proportion of fuel remains on board after a rotor burst. According to the FAA's A340 project manager, the FAA applies the rule assuming that an explosion will happen and defines the angles of trajectory after the explosion. The JAA interprets the identical rule to assume that the explosion could happen and does not specifically define the angle of trajectory."]

- Fokker officials say they were forced to spend million of dollars to duplicate tests and analyses for the FAA and other authorities during the certification of its Fokker 100. "Although the authority in The Netherlands has spent approximately 10,000 staff hours certifying the aircraft, the FAA spent approximately 7,100 staff hours to conduct its own certification activities," the GAO report said.

"According to the FAA's international airworthiness officer for certification, every major transport airplane designed since 1980 has experienced significant duplication of certification tests and analyses," the GAO said.

Costly duplication of certification activities is widespread, the GAO said.

Since 1982, the FAA has certified 12 different Boeing airplane designs, the report said. In order to export these aircraft, Boeing conducted more than 90 foreign certification projects that duplicated earlier testing. Based on these experiences, Boeing has budgeted about $30 million for JAA certification of its new 777 aircraft after the FAA completes its certification in 1995. McDonnell Douglas has been forced to budget similar outlays, the GAO said.

The GAO said the common standards and practices would eliminate many unnecessary costs and actually increase overall aviation safety.

According to figures provided by the Aerospace Industries Association (AIA), elimination of current duplications and differences in the certification process would save U.S. aircraft manufacturers alone between $800 million and $1 billion during the next 10 years. [The FAA contends that this figure is too high, but has used this estimate in official documents calling for harmonization at a quicker pace.]

The GAO report said that resources saved could be channeled to address other safety issues (including human factors-caused accidents, operational safety and continued airworthiness) and that common standards would speed the exchange of information when new or improved standards are required.

In addition to the strategic plan, the FAA has proposed a new certification approach for major transport airplane designs to eliminate duplication of FAA and JAA efforts.

"The FAA has proposed a new 'concurrent and cooperative' approach in which specialists from the FAA and JAA would work together during the certification process. For example, JAA specialists would be integrated as part of the FAA team certifying a new Boeing aircraft design. Likewise, FAA specialists would be integrated as part of a JAA certification team for new Airbus aircraft."

The FAA has proposed a new certification approach for major transport airplane designs to eliminate duplication ... .

The report said that three projects currently in progress — Boeing's 777 and the Airbus A340 and A330 — are too far along to incorporate the joint team approach, but that the approach could still be used during some remaining stages of the programs. "The fully developed approach could then be used on the next certification project started by the FAA and JAA," the report said.

Several manufacturers, however, had doubts about the new program, the report said. "Although endorsing the approach, officials from several manufacturers expressed concern in light of their previous experience that the FAA and JAA will never fully develop and implement such a system," the GAO said. "These officials emphasized that the FAA and JAA made similar commitments in 1989 and 1990 with no subsequent progress."

Other obstacles to harmonization, the GAO said, are the different ways each agency works with manufacturers.

Several European authorities charge aircraft manufacturers for activities conducted through the JAA, while the FAA does not have such user fees, the report said. "The United Kingdom, for example, charged McDonnell Douglas $1.2 million for British Civil Aviation Authority labor, lodging and travel associated with JAA's certification of the MD-11 aircraft."

In addition, the FAA's 288-member transport certification staff relies on designated representatives employed by domestic manufacturers — 447 at Boeing and 243 at McDonnell Douglas — to conduct certification analyses and tests. The JAA does not employ such a designee system. Finally, the JAA collaborates from the beginning with manufacturers and implements regulations much faster than the FAA."

[The FAA has formed the Aviation Rulemaking Advisory Committee (ARAC) to improve its process.]

The GAO report said that Boeing officials had called for a system of "mutual recognition" to speed the certification process. "Under this system, authorities from importing countries would automatically accept the certification of the exporting authority without additional tests, analyses and requirements."

But the report said: "FAA officials stated that such a system would be unrealistic, given each authority's requirement under its own law to determine compliance with national safety

regulations."

The report said that Airbus offered a different proposal calling for a step-by-step process to create an integrated certification system. Airbus listed several prerequisites it said were needed to help the process, including:

- Developing the JAA to the equivalent of the FAA in stature;
- Eliminating differences in regulation wording and interpretation;
- Securing FAA/JAA commitment for joint development of new regulations; and,
- Creating an international arbitration board to settle any disputes between the FAA, JAA and aircraft manufacturers.

"FAA and JAA officials agreed with Boeing's and Airbus' position that international certification standards, interpretations and procedures are urgently needed to reduce unnecessary costs and increase safety," the GAO said. "However, they stated that the strategic plan and new certification approach proposed by the FAA are more likely to produce the desired results."

But the report noted that officials from the FAA and JAA, along with U.S. and non-U.S. manufacturers, stated that "the time it takes the FAA to issue a regulation could have a negative impact on the harmonization process."

"Through its collaborative effort, the JAA is able to develop and finalize new regulations much faster than the FAA, according to JAA and FAA officials," the report said. This can result in perpetuation of differences, the GAO said. [Unlike the JAA, which involves industry throughout the process, FAA teams charged with developing new regulations "consist solely of FAA officials."]

The FAA's Broderick, in his address at the IASS, said it would become increasingly important to include operating rules in the harmonization process. He said great cost savings could be won by harmonizing operations and maintenance rules.

"Better trans-oceanic routings, reduced separation standards, better weather and winds aloft information to eliminate fuel tankering, streamlined flight simulator certification and training rules, common flight and rest time requirements, common repair station requirements and harmonized maintenance requirements ... hold treasure chests of potential savings."

Broderick noted that "experience to date has demonstrated that if harmonization is to work, it takes time and a substantial ... commitment by all parties to fashion a viable process."

Harmonization also requires consideration of the technological, political and legal aspects involved in each negotiation stage, Broderick said.

But he added: "Every day that we shrink from this responsibility hundreds of thousands of dollars are wasted in the name, but not the achievement, of aviation safety and diverted from addressing other vital safety issues."

Despite its criticisms, the GAO also concluded:

"The FAA and JAA ... now appear poised to develop and implement a strategy that will lead to real progress. If the strategic plan is used as a management tool to measure the effectiveness of their efforts and the concept of joint certification teams is fully developed, the FAA and JAA will produce a more efficient certification system that will benefit authorities, manufacturers and the flying public." ♦

1992 Statistics Released on Accidents, Fatalities and Accident Rates for U.S. Aviation

Even though the number of accidents dropped, more people were killed in general aviation accidents last year than in 1991, according to new statistics released by the U.S. National Transportation Safety Board (NTSB).

Preliminary statistics for 1992 also show that fewer people were killed in commuter aviation accidents, and the number of persons killed in accidents involving large scheduled commercial carriers dropped to its lowest level since 1986.

The NTSB reports a total of 951 people died in 2,105 aviation accidents either in the U.S. or involving U.S.-registered civil aircraft last year. The vast majority of fatalities occurred in general aviation with 408 fatal accidents resulting in 812 deaths. In 1991, there were 414 fatal general aviation accidents and 746 deaths. There was a total of 1,956 general aviation accidents last year, the lowest number since the NTSB began compiling aviation records in 1967.

Last year there were seven fatal commuter aviation accidents, compared with eight in 1991. The number of fatalities aboard commuter airplanes dropped to 21 in 1992 from 77 a year earlier. Large commercial scheduled carriers registered four fatal accidents and 33 fatalities in 1992, compared with the same number of accidents and 49 deaths the year before. The 33 fatalities represent the lowest number of deaths in that category since 1986, when five persons died.

There were 74 accidents and 66 fatalities involving U.S. air taxis in 1992, compared with 88 accidents and 73 fatalities the year before, the NTSB reports. The 74 accidents are the fewest involving air taxis since the NTSB began compiling air taxi records in 1975.

According to figures supplied to the NTSB by the U.S. Federal Aviation Administration (FAA), U.S. air carriers flew a record 4.74 billion scheduled miles last year, an increase of more than 173 million miles from 1991. The FAA reports

that there were approximately 7.6 million scheduled departures by the air carriers in 1992, about 1 percent more than 1991 departures, and a record of 11.6 million hours flown.

Commuter air carriers flew an estimated 408 million miles and had approximately 2.9 million departures in 1992, up from 381 million miles flown and a little more than 2.7 million departures in 1991.

The NTSB said that aircraft flying in the U.S. logged approximately 43.8 million hours in 1992, according to the FAA-supplied figures.

Each category of aviation, showing statistics and accident rates for each year since 1982, are presented in the following tables. ♦

Table 1

Accidents, Fatalities and Accident Rates
Air Carriers and General Aviation
1992 (Preliminary Data)

	Accidents		Fatalities				Accident Rates			
							Per 100,000 Aircraft Hours		Per 100,000 Departures	
	Total	Fatal	Total	Aboard	Aircraft Hours Flown#	Aircraft Departures#	Total	Fatal	Total	Fatal
Air Carriers Operating Under U.S. Federal Aviation Regulations (FAR) Part 121										
Scheduled	17	4	33	31	11,600,000	7,630,000	0.147	0.034	0.223	0.052
Nonscheduled	2	0	0	0	630,000	360,000	0.317	0	0.556	0
Air Carriers Operating Under U.S. Federal Aviation Regulations (FAR) Part 135										
Scheduled	23	7	21	21	2,180,000	2,880,000	1.055	0.321	0.799	0.243
Nonscheduled	74	24	66	66	2,230,000	n/a	3.32	1.08	n/a	n/a
General Aviation+	1,956	408	812	810	27,190,000	n/a	7.19	1.50	n/a	n/a
U.S. Civil Aviation*	2,070	443	932	928						
Non U.S.-registered Aircraft Accidents in the U.S.	18	6	9	8						
Unregistered Aircraft Accidents in the U.S.	17	7	10	10						

\# Exposure data estimate source: U.S. Federal Aviation Administration (FAA).
\+ Accidents involving U.S. registered civil aircraft not operated under U.S. Federal Aviation Regulations (FAR) Part 121 or Part 135.
* Accidents and fatalities in the categories do not necessarily sum to the figures in U.S. civil aviation. Differences are due to collisions involving aircraft in different categories.
n/a Data not available.

Source: U.S. National Transportation Safety Board

Table 2

Accidents, Fatalities and Accident Rates
U.S. Air Carriers Operating
Under U.S. Federal Aviation Regulations (FAR) Part 121
All Scheduled and Nonscheduled Service*
1982–1992

	Accidents		Fatalities					Accident Rates@					
								Per Million Aircraft Miles		Per 100,000 Aircraft Hours		Per 100,000 Departures	
Year	Total	Fatal	Total	Aboard	Aircraft Miles Flown#	Aircraft Hours Flown#	Aircraft Departures#	Total	Fatal	Total	Fatal	Total	Fatal
1982	20	5	235	223	2,938,513,000	7,040,325	5,351,133	0.0065	0.0014	0.270	0.057	0.355	0.075
1983	24	4	15	14	3,069,318,000	7,298,799	5,444,374	0.0078	0.0013	0.329	0.055	0.441	0.073
1984	17	1	4	4	3,428,063,000	8,165,124	5,898,852	0.0050	0.0003	0.208	0.012	0.288	0.017
1985	22	7	526	525	3,631,017,000	8,709,894	6,306,759	0.0061	0.0019	0.253	0.080	0.349	0.111
1986	24	3	8	7	4,017,626,000	9,976,104	7,202,027	0.0057	0.0005	0.231	0.020	0.319	0.028
1987	36	5	232	230	4,360,521,000	10,644,856	7,601,373	0.0080	0.0009	0.329	0.038	0.460	0.053
1988	29	3	285	274	4,503,426,000	11,139,519	7,716,061	0.0062	0.0004	0.251	0.018	0.363	0.026
1989	28	11	278	276	4,605,083,000	11,273,908	7,645,494	0.0061	0.0024	0.248	0.098	0.366	0.144
1990	26	6	39	12	4,954,328,000	12,149,487	8,127,133	0.0052	0.0012	0.214	0.049	0.320	0.074
1991	27	4	62+	49	4,825,268,000	11,893,917	7,858,872	0.0056	0.0008	0.227	0.034	0.344	0.051
1992P	19	4	33	31	4,987,000,000	12,230,000	7,990,000	0.0038	0.0008	0.155	0.033	0.238	0.050

P Preliminary data.
* Includes accidents involving deregulated all-cargo air carriers and commercial operators of large aircraft when those accidents occurred during U.S. Federal Aviation Regulations (FAR) Part 121 operations.
\# Source of estimate: U.S. Federal Aviation Administration (FAA).
\+ The fatality total includes the 12 persons killed aboard a Skywest commuter aircraft and the 22 persons killed aboard a USAir airliner when the two aircraft collided on a runway.
@ The following suicide/sabotage cases are included in “Accidents” and “Fatalities” but not in “Accident Rates”:

			Fatalities	
Date	Location	Operator	Total	Aboard
8/11/82	Honolulu, Hawaii	Pan American	1	1
4/02/86	Near Athens, Greece	Trans World Airlines	4	4
12/07/87	San Luis Obispo, California	Pacific Southwest	43	43
12/21/88	Lockerbie, Scotland	Pan American	270	259

Source: U.S. National Transportation Safety Board

Table 3

Accidents, Fatalities and Accident Rates
U.S. Air Carriers Operating
Under U.S. Federal Aviation Regulations (FAR) Part 121
All Scheduled Service*
1982–1992

	Accidents		Fatalities					Accident Rates@					
								Per Million Aircraft Miles		Per 100,000 Aircraft Hours		Per 100,000 Departures	
Year	Total	Fatal	Total	Aboard	Aircraft Miles Flown#	Aircraft Hours Flown#	Aircraft Departures#	Total	Fatal	Total	Fatal	Total	Fatal
1982	16	4	234	222	2,806,885,000	6,697,770	5,162,346	0.0053	0.0011	0.224	0.045	0.291	0.058
1983	22	4	15	14	2,920,909,000	6,914,969	5,235,262	0.0075	0.0014	0.318	0.058	0.420	0.076
1984	13	1	4	4	3,258,910,000	7,736,037	5,666,076	0.0040	0.0003	0.168	0.013	0.229	0.018
1985	17	4	197	196	3,452,753,000	8,265,332	6,068,893	0.0049	0.0012	0.206	0.048	0.280	0.066
1986	21	2	5	4	3,829,129,000	9,495,158	6,928,103	0.0052	0.0003	0.211	0.011	0.289	0.014
1987	32	4	231	229	4,125,874,000	10,115,653	7,293,025	0.0075	0.0007	0.306	0.030	0.425	0.041
1988	28	3	285	274	4,260,785,000	10,521,052	7,347,575	0.0063	0.0005	0.257	0.019	0.367	0.027
1989	24	8	131	130	4,338,031,000	10,597,922	7,269,094	0.0055	0.0018	0.226	0.075	0.330	0.110
1990	24	6	39	12	4,696,400,000	11,524,726	7,833,487	0.0051	0.0013	0.208	0.052	0.306	0.077
1991	26	4	62+	49	4,561,784,000	11,253,051	7,553,051	0.0057	0.0009	0.231	0.036	0.344	0.053
1992P	17	4	33	31	4,735,000,000	11,600,000	7,630,000	0.0036	0.0008	0.147	0.034	0.223	0.052

P Preliminary data.
* Includes accidents involving deregulated all-cargo air carriers and commercial operators of large aircraft when those accidents occurred during U.S. Federal Aviation Regulation (FAR) Part 121 operations.
\# Source of estimate: U.S. Federal Aviation Administration (FAA).
\+ The fatality total includes the 12 persons killed aboard a Skywest commuter aircraft and the 22 persons killed aboard a USAir airliner when the two aircraft collided on a runway.
@ The following suicide/sabotage cases are included in “Accidents” and “Fatalities” but not in “Accident Rates”:

			Fatalities	
Date	Location	Operator	Total	Aboard
8/11/82	Honolulu, Hawaii	Pan American	1	1
4/02/86	Near Athens, Greece	Trans World	4	4
12/07/87	San Luis Obispo, California	Pacific Southwest	43	43
12/21/88	Lockerbie, Scotland	Pan American	270	259

Source: U.S. National Transportation Safety Board

Table 4

Accidents, Fatalities and Accident Rates
U.S. Air Carriers Operating
Under U.S. Federal Aviation Regulations (FAR) Part 121
All Nonscheduled Service*
1982–1992

	Accidents		Fatalities					Accident Rates: Per Million Aircraft Miles		Accident Rates: Per 100,000 Aircraft Hours		Accident Rates: Per 100,000 Departures	
Year	Total	Fatal	Total	Aboard	Aircraft Miles Flown#	Aircraft Hours Flown#	Aircraft Departures#	Total	Fatal	Total	Fatal	Total	Fatal
1982	4	1	1	1	131,628,000	342,555	188,787	0.0304	0.0076	1.168	0.292	2.119	0.530
1983	2	0	0	0	148,409,000	383,830	209,112	0.0135	0	0.521	0	0.956	0
1984	4	0	0	0	169,153,000	429,087	232,776	0.0236	0	0.932	0	1.718	0
1985	5	3	329	329	178,264,000	444,562	237,866	0.0280	0.0168	0.125	0.675	2.102	1.261
1986	3	1	3	3	188,497,000	480,946	273,924	0.0159	0.0053	0.624	0.028	1.095	0.365
1987	4	1	1	1	234,647,000	529,203	308,348	0.0170	0.0043	0.756	0.189	1.297	0.324
1988	1	0	0	0	242,641,000	618,467	368,486	0.0041	0	0.162	0	0.271	0
1989	4	3	147	146	267,052,000	675,986	376,400	0.0150	0.0112	0.592	0.444	1.063	0.797
1990	2	0	0	0	257,928,000	624,761	293,646	0.0078	0	0.320	0	0.681	0
1991	1	0	0	0	263,484,000	640,058	305,821	0.0038	0	0.156	0	0.327	0
1992P	2	0	0	0	252,000,000	630,000	360,000	0.0079	0	0.317	0	0.556	0

* Includes accidents involving deregulated all-cargo air carriers and commercial operators of large aircraft when those accidents occurred during U.S. Federal Aviation Regulations (FAR) Part 121 operations.
P Preliminary data.
Source of estimate: U.S. Federal Aviation Administration (FAA).

Source: U.S. National Transportation Safety Board

Table 5

Accidents, Fatalities and Accident Rates
U.S. Air Carriers Operating
Under U.S. Federal Aviation Regulations (FAR) Part 135
All Scheduled Service
(Commuter Air Carriers*)
1982–1992

	Accidents		Fatalities					Accident Rates@: Per Million Aircraft Miles		Accident Rates@: Per 100,000 Aircraft Hours		Accident Rates@: Per 100,000 Departures	
Year	Total	Fatal	Total	Aboard	Aircraft Miles Flown#	Aircraft Hours Flown#	Aircraft Departures#	Total	Fatal	Total	Fatal	Total	Fatal
1982	26	5	14	14	222,355,000	1,299,748	2,026,691	0.117	0.022	2.000	0.385	1.283	0.247
1983	17	2	11	10	253,572,000	1,510,908	2,328,430	0.067	0.008	1.125	0.132	0.730	0.086
1984	22	7	48	46	291,460,000	1,745,762	2,676,590	0.075	0.024	1.260	0.401	0.822	0.262
1985	21	7	37	36	300,817,000	1,737,106	2,561,463	0.070	0.023	1.209	0.403	0.820	0.273
1986	15	2	4	4	307,393,000	1,724,586	2,798,811	0.049	0.007	0.870	0.116	0.536	0.071
1987	32	10	59	57	350,879,000	1,946,349	2,809,918	0.091	0.028	1.644	0.514	1.139	0.356
1988	19	2	21	21	380,237,000	2,092,689	2,909,005	0.050	0.005	0.908	0.096	0.653	0.069
1989	18	5	31	31	393,619,000	2,240,555	2,818,520	0.046	0.013	0.803	0.223	0.639	0.177
1990	15	3	6	4	450,067,000	2,336,952	3,159,763	0.033	0.007	0.642	0.128	0.475	0.095
1991	22	8	99+	77	381,390,000	2,171,602	2,718,720	0.058	0.021	1.013	0.368	0.809	0.294
1992P	23	7	21	21	408,000,000	2,180,000	2,880,000	0.056	0.017	1.055	0.321	0.799	0.243

* Includes accidents involving all-cargo air carriers when those accidents occurred during scheduled U.S. Federal Aviation Regulation (FAR) Part 135 operations.
P Preliminary data.
Source of estimate: U.S. Federal Aviation Administration (FAA).
\+ The fatality total includes the 12 persons killed aboard a Skywest commuter aircraft and the 22 persons killed aboard a USAir airliner when the two aircraft collided on a runway.
@ Rates are based on all accidents.

Source: U.S. National Transportation Safety Board

Table 6

Accidents, Fatalities and Accident Rates
U.S. Air Carriers Operating
Under U.S. Federal Aviation Regulation (FAR) Part 135
Nonscheduled Operations
(On-demand Air Taxis)
1982–1992

	Accidents		Fatalities			Accident Rates Per 100,000 Aircraft Hours	
Year	Total	Fatal	Total	Aboard	Aircraft Hours Flown#	Total	Fatal
1982	132	31	72	72	3,008,000	4.39	1.03
1983	141	27	62	57	2,378,000	5.93	1.14
1984	146	23	52	52	2,843,000	5.14	0.81
1985	154	35	76	75	2,570,000	5.99	1.36
1986	117	31	65	61	2,690,000	4.35	1.15
1987	97	30	65	63	2,657,000	3.63	1.13
1988	101	28	59	55	2,632,000	3.81	1.06
1989	111	25	83	81	3,020,000	3.68	.083
1990	108	28	49	47	2,241,000	4.82	1.25
1991	88	26	73	69	2,241,076	3.93	1.16
1992P	74	24	66	66	2,230,000	3.32	1.08

P Preliminary data.
Source of estimate: U.S. Federal Aviation Administration (FAA). Hours flown for the years 1982 through 1991 have been revised to reflect the results of FAA's *General Aviation Activity and Avionics Non-respondent Survey.*

Source: U.S. National Transportation Safety Board

Table 7

Accidents, Fatalities and Accident Rates
U.S. General Aviation*
1982–1992

	Accidents		Fatalities			Accident Rates@ Per 100,000 Aircraft Hours	
Year	Total	Fatal	Total	Aboard	Aircraft Hours Flown#	Total	Fatal
1982	3233	591	1187	1170	29,640,000	10.90	1.99
1983	3077	556	1069	1062	28,673,000	10.73	1.94
1984	3016	545	1042	1021	29,099,000	10.35	1.87
1985	2738	498	955	944	28,322,000	9.65	1.75
1986	2582	474	967	878	27,073,000	9.54	1.75
1987	2494	447	838	823	26,972,000	9.24	1.65
1988	2386	460	800	792	27,446,000	8.69	1.68
1989	2233	432	768	765	27,920,000	7.98	1.53
1990	2218	445	763	758	28,510,000	7.78	1.56
1991	2143	414	746	740	27,226,000	7.78	1.52
1992P	1956	408	812	810	27,190,000	7.19	1.50

P Preliminary data.
Source of estimate: U.S. Federal Aviation Administration (FAA). Hours flown for the years 1982 through 1991 have been revised to reflect the results of FAA's *General Aviation Activity and Avionics Non-respondent Survey.*
* U.S.-registered civil aircraft not operated under U.S. Federal Aviation Regulation (FAR) Part 121 or Part 135.
@ Suicide and sabotage accidents excluded from rates as follows:
Total – 1982 (3), 1983 (1), 1984 (3), 1985 (3), 1987 (1), 1988 (1), 1989 (5)
Fatal – 1984 (2), 1985 (2), 1987 (1), 1989 (4)

Source: U.S. National Transportation Safety Board

Table 8

Fatal Accidents and Fatalities
U.S. Air Carriers Operating
Under U.S. Federal Aviation Regulation (FAR) Part 121
All Scheduled Service
(Airlines)
1992 (Preliminary Data)

					Fatalities					
Date	Location	Operator	Service	Aircraft	Psgr	Crew	Other	Total	Total Aboard	Reported Type of Accident
2/15	Swanton, Ohio	Air Transport International	Cargo	DC-8-63	1	3	0	4	4	Crashed during a missed approach.
3/22	Flushing, New York	USAir	Psgr	Fokker F-28	25	2	0	27	51	Crashed during takeoff in wet snow.
4/8	Dayton. Ohio	Trans World	Psgr	DC-9-32	0	0	1	1	28	Mechanic killed by exploding wheel rim.
12/8	Flushing, New York	USAir	Psgr	B-737-300LS	0	0	1	1	60	Ground crewman struck by tug during pushback.

Source: U.S. National Transportation Safety Board

Table 9

Fatal Accidents and Fatalities
U.S. Air Carriers Operating Under 14 CFR 135
All Scheduled Service
(Commuter Air Carriers)
1992 (Preliminary Data)

					Fatalities					
Date	Location	Operator	Service	Aircraft	Psgr	Crew	Other	Total	Total Aboard	Reported Type of Accident
1/3	Gabriels, New York	USAir Express	Psgr	Beechcraft BE-1900C	1	1	0	2	4	Crashed five miles from destination.
1/23	Clewiston, Florida	Air Sunshine	Psgr	Cessna 402C	1	1	0	2	2	Crashed during descent.
6/7	Mayaquez, Puerto Rico	American Eagle	Psgr	Casa 212	3	2	0	5	5	Crashed during approach.
6/8	Ft. McClellan, Alabama	GP Express	Psgr Airline	Beechcraft C-99	2	1	0	3	6	Crashed during approach.
10/26	Saipan, Mariana Islands	Pacific Island Aviation	Psgr	Cessna 310R	2	1	0	3	3	Crashed during initial climb.
10/31	Grand Junction, Colorado	Alpine Air	Psgr	Piper PA-42	2	1	0	3	3	Crashed during descent.
11/8	Kiana, Arkansas	Baker Aviation	Psgr	Cessna 402C	2	1	0	3	3	Crashed into mountain while en route.

Source: U.S. National Transportation Safety Board

Publications Received at FSF Jerry Lederer Aviation Safety Library

By
Editorial Staff

New Reference Materials

Advisory Circular 120-59, 10/26/92, *Air Carrier Internal Evaluation Programs*. Washington, D.C. U.S. Federal Aviation Administration, 1992. 19p.

Purpose: The purpose of this advisory circular (AC) is to provide information and guidance material that may be used by air carrier certificate holders operating under U.S. Federal Aviation Regulations (FAR) Parts 121 and 135 to design or develop an internal evaluation program. The procedures and practices outlined in this AC can be applied to maintenance, flight operations and security aspects of an air carrier's organization. Internal evaluation guidance for certificate holders other than those operating under FAR Parts 121 and 135 may be issued separately in the future.

Reports

FAA Statistical Handbook of Aviation, Calendar Year 1991. Washington, D.C. U.S. Dept. of Transportation, Federal Aviation Administration: Available from the National Technical Information Service; Springfield, Va.: National Technical Information Service*, 1992. xvi, 182 pages; tables.

Keywords
1. Aeronautics — United States — Statistics.
2. Aeronautics — Accidents — Statistics — United States.
3. Aeronautics — Yearbooks.

Summary: This report presents 1991 calendar year statistical information pertaining to the U.S. Federal Aviation Administration (FAA), the National Airspace System, airports, airport activity, U.S. civil air carrier fleet, U.S. civil air carrier operating data, airmen, general aviation aircraft, aircraft accidents, aeronautical production and imports/exports. This report consists of tables that highlight the FAA's fiscal operating budget and number of employees; air traffic activity by aviation category; airport activity by type of ownership, region and state; aircraft departures, enplaned revenue passengers and enplaned tons of cargo and mail; top 100 airports by total passengers enplaned; types of aircraft reported in operation; operating expenses and revenue of domestic and international air traffic; estimated number of pilots by operator type, age, gender, region; and aircraft accidents, fatalities and accident rates by aircraft operator type. A glossary is included to acquaint users with FAA terminology used in the report. [Contents summarized]

Aviation Safety: New Regulations for Deicing Aircraft Could Be Strengthened. Report to the ranking minority member, Subcommittee on Transportation and Related Agencies, Committee on Appropriations, U.S. Senate/U.S. General Accounting Office. Washington, D.C. General Accounting Office**, 1992. 17 p.

Keywords
1. Airplanes — Ice Prevention.
2. Aeronautics — Safety Regulations — United States.
3. Aeronautics — United States — Safety Measures.
4. Airplanes — Cold Weather Operation.

Summary: This report gives the background and assessment of the U.S. Federal Aviation Administration's (FAA) efforts to implement new regulations governing airlines' ground operations during icing conditions. The report states that within six months of the USAir Flight 405 accident, the FAA issued regulations that more strictly govern airlines' ground operations in icing conditions effective November 1, 1992; further, this was a significant accomplishment since the rule-making process can take as long as seven years. The FAA will accept comments on the new regulations through April 15, 1993 and use this information to make changes as needed.

These regulations require more thorough procedures for inspecting aircraft and removing ice before takeoff. Moreover, new guidelines were incorporated for deicing and anti-icing fluid holdover periods, i.e., the length of time that these fluids are effective in keeping the aircraft free of ice.

According to the report, these added precautions need improvement. With regard to aircraft inspection for ice, the report states that the potential for misjudgment exists since the regulation allows pilots to check for ice from inside the aircraft. The report states that obstructed views, distance and poor lighting can make it difficult to detect ice from inside the aircraft. The report concludes that the safest approach would be for interim final regulations to require that all aircraft be closely inspected from the outside or deiced after the holdover period has expired.

The report also states concern that the new regulations do not apply to commuter airlines. According to the report, safety would be improved by making commuter airlines subject to more stringent regulations governing ground operations during icing conditions. The report expressed concern over the receipt, understanding and implementation of the new interim regulations. The report states that in the past, information the FAA distributed on the hazards of ice did not reach all pilots. The report recommends the development of a method to determine whether airline pilots and ground personnel have received and understood the initial training material explaining their responsibilities and to develop more specific guidelines for monitoring the implementation of the regulations this winter. An appendix of tables showing the FAA's approved holdover times is also included. [modified results in brief and conclusions]

Aviation Safety: Increased Oversight of Foreign Carriers Needed. Report to the Chairman, Subcommittee on Investigations and Oversight, Committee on Public Works and Transportation, United States House of Representatives / United States General Accounting Office. Washington, D.C. General Accounting Office**, 1992. 19 p.

Keywords

1. Airlines — Inspection — Government Policy — United States.
2. Airlines — Safety Regulations.
3. United States — Federal Aviation Administration — Auditing.
4. United States — Department of Transportation — Auditing.

Summary: This report gives the background to the FAA's effort to determine whether other countries meet international safety standards. FAA uses new carrier applicants as a basis for visiting foreign governments and assessing their oversight capabilities of home air carriers. According to the report, the FAA found that six of the 15 countries visited thus far met or exceeded international standards and nine did not provide oversight to ensure that their air carriers meet international standards.

According to the report, although the FAA has taken steps to fill this void in safety oversight by performing increased inspections of some carriers, its inspections are not as comprehensive as they could be.

The report recommends that the secretary of transportation direct the FAA to require field offices to perform comprehensive inspections of foreign air carriers that fly into the United States when the FAA finds that their home governments do not comply with international standards and / or when the FAA becomes aware that the carrier has serious safety problems.

The FAA should continue these inspections until it determines that the home government meets international safety standards and that the carrier is operating safely. The report also recommends that priority be given to assessing the oversight capabilities of those countries that have one or more carriers with serious safety problems and that the FAA work with countries to ensure that their oversight capabilities are sound. The report recommends that the FAA promptly notify all relevant field offices of serious safety concerns about foreign carriers. [modified results in brief and conclusion]

Books

Why Airplanes Crash: Aviation Safety in a Changing World. Clinton V. Oster Jr., John S. Strong, C. Kurt Zorn. New York: Oxford University Press, 1992. xv, 200 p. ill.; 25 cm. Includes bibliographical references and index.

Keywords
1. Aeronautics — Accidents.
2. Aeronautics — United States — Accidents.
3. Aeronautics — Canada — Accidents.

Summary: This book presents a comprehensive overview of issues affecting aviation safety and airplane accident causes. Its contents include an introductory chapter on risk in air travel; a chapter on the U.S. airline safety record in the post-deregulation era examining the performance of the jet carrier and commuter carrier segments of the industry in both the pre- and post-regulation periods; a chapter on charter service and general aviation dedicated to the rest of the U.S. aviation industry including jet charter operators, air taxi operators, cargo carriers and general aviation. Another chapter compares aviation safety in Canada and the United States. The book also compares the North American safety record with the international safety record. Chapters on the margin of safety, aging aircraft and aviation security are also included. The book's scope goes beyond the safety records of U.S. airlines to address broader issues such as the effect of deregulation on the safety of the U.S. airline industry, the effect on airline maintenance under deregulation's competitive pressures and the resulting increase in equipment failure, the effect on safety in the air traffic control system in light of the greater demands upon this system, and the effect of increased use of commuter airlines on safety. Appendices on safety measures, definitions and rules for assigning causes to accidents are provided. A glossary of terms and an index are also included.

*U.S. Department of Commerce
National Technical Information Service (NTIS)
Springfield, VA 22161 U.S.
Telephone: (703) 487-4780

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

Low Speaker Volume on Cockpit Radios Causes Near-miss

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.

Failure To Monitor Radio Leads To Near-miss

McDonnell Douglas DC-10. No damage. No injuries.

Near the end of an uneventful trans-Atlantic flight from London to Atlanta, Georgia, the captain turned down the speaker volume on his communications radio on the flight deck, while he made an announcement on the public address system.

A short time later, the copilot donned his headset and turned down the speaker volume on his communications radio while he obtained destination weather. Both pilots subsequently forgot to reset the volume controls to normal and failed to maintain radio monitoring. No contact was made with air traffic control (ATC) until shortly before descent into Atlanta about an hour later.

After landing, ATC informed the captain that his flight had been involved in an near-miss while out of communication.

An inquiry determined that the flight crew had failed to comply with flight crew regulations that require them to maintain a radio listening watch in the airspace in which they are operating.

Fuel Starvation Causes Engine Flameout

McDonnell Douglas DC-10. No damage. No injuries.

After the DC-10 reached cruise altitude, fuel pressure for the No. 2 engine went to zero.

The engine continued to run after the crew diverted fuel from the No. 3 tank. However, a fuel imbalance quickly developed between the No. 2 and the No. 3 fuel tanks. The No. 3 tank quantity was rapidly decreasing and the No. 2 rapidly increasing. The crew then elected to switch back to the No. 2 configuration. The No. 2 engine then flamed out because of fuel starvation. The aircraft diverted to a nearby airport and the landing was uneventful.

A subsequent maintenance investigation indicated a failure in the fuel manifold of No. 2 tank.

Runway Excursion Follows Unstabilized Approach

Airbus A-310. Substantial damage. No injuries.

The approach was being flown in the manual mode by the captain. The aircraft was executing a VOR/DME (very high frequency omni range/distance measuring equipment) approach because the instrument landing system (ILS) for the runway was out of service.

The runway became visible on the right as minima were reached. The captain determined that the aircraft was a little high and increased the sink rate, aiming for the touchdown point in a left-hand curved final approach.

When the actual touchdown point was in sight, the aircraft was low and attitude was increased to a maximum of 16 degrees. The indicated airspeed (IAS) dropped 23 knots below the target speed because engine power was not increased.

The first officer made no warning callouts concerning the pitch attitude or speed drop. The aircraft touched down at a 16-degree pitch attitude with a 12-degree bank.

The left main gear touched down on the right shoulder of the runway. About 165 feet (50 meters) farther, the right main gear hit soft ground off the side of the runway. The aircraft was steered back onto the runway 825 feet (250 meters) farther.

The left wing tip, outer flap, flap fairing, main landing gears and the left tip of the stabilizer were substantially damaged.

Icing Cuts Short Training Flight

Fokker F27 Friendship. Aircraft destroyed. Three serious injuries.

The crew was practicing daylight instrument approaches in and out of a stratus cloud base of 1,000 feet, with tops at 3,500 feet. The freezing level was at the surface, with moderate to severe icing conditions reported.

When the aircraft was at 400 feet with the left engine throttled back, it was observed to bank steeply first to one side and then the other before descending to the ground. The twin-turboprop F27 impacted the ground with 18 degrees of left bank and considerable right yaw. A subsequent investigation found about one inch of horn-shaped glaze ice on the leading edges of all surfaces.

A review of the cockpit voice recorder revealed that the pilot under training had initiated a go-around using one engine and that the training captain had taken control of the aircraft nine seconds before impact.

Poor Landing Judgment Puts Falcon into Skid

Dassault-Breguet Falcon 20. Aircraft destroyed. One fatality. Ten serious injuries.

Despite poor weather and an unstabilized approach, the pilot of the Falcon 20 elected to continue the daylight landing.

The aircraft touched down at about the

mid-point of the 4,620-foot (1,400-meter) runway, which was slick from ongoing heavy rain. After touching down, the aircraft began to aquaplane down the remaining runway before overrunning the end and crashing into trees.

An inquiry determined that the glide path flown was too high, that decision-height procedures were misinterpreted and that the pilot exhibited poor judgment by not initiating a go-around. One passenger was killed in the accident.

Thunderstorms Send Cessna Plunging

Cessna 320. Aircraft destroyed. Four fatalities.

The Cessna 320 with a pilot and three passengers on board was in cruise when it encountered severe thunderstorms.

The pilot was advised of rain showers with thunderstorms along a frontal boundary in the flight's path. Radar data indicated a sudden descent rate of 12,000 feet per minute after the aircraft entered an area of violent thunderstorm activity. The aircraft impacted the ground inverted. An investigation found evidence of lightning strikes to the cockpit and wing, and a cabin fire. Wreckage was strewn over a one-mile area.

Management Pressure Ends in Tragedy

Beech 18. Aircraft destroyed. Two fatalities.

The Beech was in cruise at night when the pilot reported moderate to severe icing and a stuck right aileron. A short time later, the pilot reported that he could not maintain altitude. The aircraft crashed and was destroyed in a post-impact fire.

Records indicated the pilot had received a weather briefing before departure. An inquiry determined that before departure the pilot had declined ice removal from the wings. About 45 minutes after departure, the pilot reported that a deice boot had blown. There were no maintenance records for the deice boots in the previous 10 years. It was reported that the pilot had been pressured previously to fly aircraft with discrepancies.

Loose Gas Cap Leads to Fatal Stall

Beech 60 Duke. Aircraft destroyed. Two fatalities.

Just after take-off rotation, the pilot saw fuel spraying from the right wing outboard of the engine.

The aircraft remained in a tight pattern and an immediate emergency landing was attempted. On the turn to final approach, the aircraft descended in a nose-low attitude, with at least a 45-degree left bank, and crashed on the runway. The aircraft was destroyed by a post-crash fire. An investigation revealed that the wing tank was full and that the tank cap was resting unsecured on the filler neck. The inquiry concluded that the probable cause of the daylight accident was an inadvertent stall at an altitude insufficient for recovery.

Instrument Failure, Turbulence Bring Piper Down

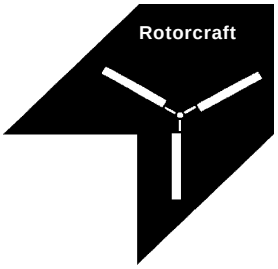
Piper PA-28. Aircraft destroyed. One fatality.

The aircraft was in cruise flight at 15,000 feet

when the pilot radioed requesting assistance from ATC because of a vacuum system malfunction.

The Piper was cleared to descend to 8,000 feet and vectored to a nearby airport. The pilot reported he only had use of the compass and was encountering turbulence. The aircraft disappeared from radar a short time later.

An investigation concluded that the accident was caused by the disintegration of the Piper's airframe in flight when the pilot lost control of the aircraft while descending into adverse weather conditions (severe turbulence and icing) following failure of the vacuum system.



Bell Crashes in Snowstorm

Bell 206B. Aircraft destroyed. One fatality. Three serious injuries.

The aircraft was engaged in a low-level surveillance mission. While flying at about 1,000 feet above ground level, the aircraft became engulfed in a snowstorm, forcing the pilot to descend to about 200 feet to retain visual contact with the ground. The pilot then attempted to find a suitable emergency landing site, but the engine failed and the Bell struck a building and fell to the ground.

An inquiry determined that the likely cause of the engine failure was blockage of the air intake path by snow. The aircraft was not equipped to fly in snow and had not been fitted with a deflector kit.

Power Wires Snare Bell on Liftoff

Bell 206B. Substantial damage. No injuries.

The pilot was attempting to take off from a forestry pad on the first flight of the day. The tail rotor was directly under electrical power lines. The pilot was aware of the location of the power lines.

After startup, the pilot realized that the skids were frozen to the ground and he decided to use power to break the skids free. When the skids broke free, the helicopter rose rapidly and the tail rotor struck the power lines. The aircraft sustained substantial damage but the pilot was not injured.

Fog Disorients Aeromedical Pilot

Aerospatiale AS350B. Substantial damage. Three serious injuries.

While en route to pick up a patient, the aeromedical flight encountered dense fog.

The pilot stated that he attempted to execute a 180-degree turn, but that the helicopter struck the ground during the turn and crashed in instrument meteorological conditions. The commercial pilot and both passengers were seriously injured in the crash. ♦