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Controlled Flight Into Terrain Takes Highest Toll in Business Jet Operations

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Controlled Flight Into Terrain Takes Highest Toll in Business Jet Operations

Loss of control was the second leading cause of fatal business jet accidents worldwide from 1991 through 2002. Inadequate crew coordination and monitoring were cited in the majority of business jet incidents.

— PATRICK R. VEILLETTE, PH.D.

A study of available data worldwide shows that from January 1991 through December 2002, business jets were involved in 251 accidents and 808 incidents (Table 1, page 2). The accidents included 67 fatal accidents (26.7 percent of the total).

Of the 1,138 people aboard the accident aircraft, 320 (28.1 percent) were killed, 36 (3.2 percent) received serious injuries and 48 (4.2 percent) received minor injuries (Table 2, page 3).

Seventy-four aircraft (29.5 percent) were destroyed, 169 aircraft (67.3 percent) were substantially damaged, and eight aircraft (3.2 percent) received minor damage or no damage in the accidents.

Business aircraft are defined as "tools used by companies and individuals in the conduct of their business."[1] In the United States, business-aircraft operators have access to 5,300 public-use airports, compared with 558 airports accessible to air carrier aircraft operators. Business aircraft often are operated at airports that lack the safety equipment common to airports that serve scheduled commercial aircraft. Flights often are conducted to and from airports that have various air traffic control (ATC) services, approach facilities and runway conditions.

To identify trends in the safety of business jet operations, the author conducted a study of accident reports (see "Business Jet Accidents, 1991–2002," page 22) by Airclaims, Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch and U.S. National Transportation Safety Board (NTSB), incident reports by the U.S. Federal Aviation Administration (FAA) and reports submitted by business jet flight crews to the U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS).[2]

The following criteria were used to select reports for the study:

- Fatal accidents, nonfatal accidents and incidents, and ASRS reports between Jan. 1, 1991, and Dec. 31, 2002;
- Fixed-wing turbojet aircraft (commonly called business jets) flown in unscheduled air-taxi operations, corporate/executive operations (flown by professional pilots), business operations (flown by nonprofessional pilots), personal operations, training operations, maintenance operations and public-use operations; and,
- Single-pilot and dual-pilot operations.

Table 1
Business Jet Accidents and Incidents, 1991–2002

Year	Fatal Accidents	Nonfatal Accidents	Incidents
1991	7	7	79
1992	3	7	57
1993	5	6	54
1994	4	13	60
1995	6	15	60
1996	8	15	52
1997	6	22	54
1998	5	21	70
1999	6	25	79
2000	6	17	74
2001	8	18	82
2002	3	18	87
Total:	**67**	**184**	**808**

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

CFIT: Greatest Killer

Major findings of the study were the following:

- Controlled flight into terrain (CFIT) was the leading type of fatal accident.[3] Twenty-seven (40.3 percent) of the 67 fatal accidents involved CFIT. Twenty-two (81.5 percent) of the CFIT accidents occurred in mountainous terrain. All of the CFIT accidents involved human error;
- One hundred four (41.4 percent) of the 251 accidents occurred during the approach-and-landing phase of flight. Ten (9.6 percent) of the approach-and-landing accidents (ALAs) were fatal. Fifty-nine (56.7 percent) involved runway overruns, 14 (13.5 percent) involved runway undershoots (in which the aircraft touched down before reaching the runway), 11 (10.6 percent) involved loss of control, 10 involved hard landings, seven (6.7 percent) involved failure to extend the landing gear, and three (2.9 percent) involved collisions with objects;
- Mechanical failure was the primary cause of 51 (20.3 percent) of the 251 accidents and 414 (51.2 percent) of the 808 incidents. Of the 414 incidents involving mechanical failure, 186 (44.9 percent) involved engine failure;
- One hundred seventy-six (21.8 percent) of the incidents involved runway overruns during landing; and,
- Sixty-four (7.9 percent) of the incidents involved wildlife strikes.

Type of Operation

Sixty-three (25.1 percent) of the business jet accidents involved aircraft registered in countries other than the United States.

Forty accidents (15.9 percent) occurred during corporate/executive flights conducted under U.S. Federal Aviation Regulations (FARs) Part 91, the

general operating and flight rules. Corporate/executive transportation is defined by FAA as "any use of an aircraft by a corporation, company or other organization (not for compensation or hire) for the purposes of transporting its employees and/or property, and employing professional pilots for the operation of the aircraft."[4] Professional pilots receive a salary or compensation for their corporate/executive aviation services.

Thirty-one accidents (12.4 percent) occurred during business flights conducted under Part 91. Business transportation is defined by FAA as "any use of an aircraft (not for compensation or hire) by an individual for transportation required by the business in which the individual is engaged."[5] Business pilots commonly are referred to as nonprofessional pilots because they do not receive a salary or compensation for their business aviation services.

Other accidents that occurred during Part 91 operations included the following: 34 accidents (13.5 percent) during positioning flights; 15 accidents (6 percent) during training flights; 15 accidents during personal flights; eight accidents (3.2 percent) during fractional (shared) ownership flights; seven accidents (2.8 percent) during public-use flights (defined by NTSB as flights "for the purpose of fulfilling a government function")[6]; and four accidents (1.6 percent) during maintenance flights.

Table 2
Fatalities and Injuries in Business Jet Accidents, 1991–2002

Year	Total Occupants	Uninjured	Minor	Serious	Fatal
1991	77	33	—	—	44
1992	57	33	2	2	20
1993	53	22	5	—	26
1994	91	63	—	—	28
1995	111	74	6	—	31
1996	128	70	3	—	55
1997	78	52	5	1	20
1998	117	87	10	7	13
1999	153	110	7	12	24
2000	89	63	5	3	18
2001	112	68	4	7	33
2002	72	59	1	4	8
Total:	**1,138**	**734**	**48**	**36**	**320**

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

Approach Accidents

Eighty-four (33.5 percent) of the 251 accidents occurred during approach (Table 3, page 4). Sixty-six of the approach accidents involved human error; 15 involved mechanical failure; and three involved "other" factors (e.g., wildlife strikes, turbulence). Forty approach accidents involved fatalities; they accounted for 59.7 percent of the 67 fatal accidents.

Of the 808 incidents, 87 (10.8 percent) occurred during approach. Fifty incidents involved mechanical malfunctions; 19 involved human error; and 18 involved other factors.

Eighty-three accidents (33.1 percent), including two fatal accidents, occurred during the landing roll-out. Sixty-six of the roll-out accidents involved human error; 14 involved mechanical failures; and three involved other factors.

Two hundred seventy-three incidents (33.8 percent) occurred during the landing roll-out. Of these, 176 involved human error, 88 involved mechanical malfunctions, and nine involved other factors.

Forty-one accidents (16.3 percent) occurred during takeoff. Eight takeoff accidents were fatal. Thirty takeoff accidents involved human error; five involved mechanical failures; and six involved other factors.

Eighty-three incidents (10.3 percent) occurred during takeoff. Thirty-six incidents involved mechanical failures; 36 involved human error; and 11 involved other factors.

Twenty-eight accidents (11.2 percent) occurred during cruise flight. Ten of the cruise accidents were fatal. Thirteen cruise accidents were caused by mechanical failure; 13 were caused by human error; and two were caused by other factors.

Two hundred twelve incidents (26.2 percent) occurred during cruise flight. Two hundred five

Table 3
Phase of Flight in Business Jet Accidents and Incidents, 1991–2002

	Nonfatal Accidents	Fatal Accidents	Incidents
Ground	6	1	64
Takeoff	33	8	83
Climb	1	4	71
Cruise	18	10	212
Descent	0	0	18
Approach	44	40	87
Roll-out	81	2	273
Go-around	1	2	0
Total	**184**	**67**	**808**

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

cruise incidents were caused by mechanical failures, and seven were caused by human error.

Five accidents (2 percent), four of which were fatal, occurred during climb. Four climb accidents were caused by human error.

Seventy-one incidents (8.8 percent) occurred during climb. Twenty-eight incidents were caused by mechanical failure; 17 were caused by human error; and 26 involved other factors.

Seven accidents (2.8 percent) occurred during ground operations. One of the ground accidents involved a fatality. Five ground accidents were caused by human error; and two were caused by mechanical failure.

Sixty-four incidents (7.9 percent) occurred during ground operations; all were caused by human error.

Three accidents (1.2 percent), of which two were fatal, occurred during go-arounds. All were caused by human error.

CFIT Death Toll

There were survivors in only one of the 27 CFIT accidents. The copilot and four passengers aboard a Learjet 24 received serious injuries when the jet struck terrain while being flown on a DME (distance-measuring equipment) arc at Tampico, Mexico, Jan. 2, 1998; the captain and two passengers were killed.

All 171 occupants aboard the other 26 CFIT accident aircraft were killed.

All 27 CFIT accident aircraft were destroyed. Destruction of aircraft involved in CFIT accidents is typical; studies of large transport category aircraft CFIT accidents found that 97 percent of the aircraft were destroyed and that 91 percent of the occupants were killed.[7] This illustrates the high level of kinetic energy associated with CFIT accidents.

Eighteen CFIT accident reports said that the aircraft were not equipped with ground-proximity warning systems (GPWSs); one accident report said that the aircraft was equipped with a GPWS that issued a "sink rate" warning prior to impact. The other eight accident reports did not specify whether the aircraft was equipped with GPWS.

Significant terrain was present in 22 (81.5 percent) of the CFIT accidents. Significant terrain includes terrain or obstacles more than 2,000 feet above airport-reference-point (ARP) elevation within six nautical miles (11 kilometers) of the ARP or 6,000 feet above ARP elevation with 25 nautical miles (46 kilometers) of the ARP.

Inadequate airport facilities and inadequate ATC service were factors in many of the CFIT accidents and ALAs (Table 4, page 5). For example, only 15.3 percent of the airports at which business jets were involved in CFIT accidents and 26.6 percent of the airports at which business jets were involved in ALAs were served by ATC terminal approach radar facilities.

At the airports where CFIT accidents occurred, 3.8 percent had full-time ATC towers, 7.4 percent had two or more precision instrument approaches, 30.7 percent had approach-light systems; 23.1 percent had either visual approach slope indicator (VASI) systems or precision approach path indicator (PAPI) systems; and 3.7 percent had full-time weather observers.

At the airports where ALAs occurred, 29.3 percent had full-time ATC towers, 24.6 percent had two or more precision instrument approaches,

65.8 percent had approach-light systems; 79.7 percent had either VASI systems or PAPI systems; and 12.9 percent had full-time weather observers.

Nonprecision Approaches

Thirteen (48.1 percent) of the 27 CFIT accidents occurred when the flight crews were conducting nonprecision approaches (Table 5).

Seven CFIT accidents occurred during VOR (very-high-frequency omnidirectional radio)/DME approaches; three occurred during NDB (nondirectional beacon) approaches; two occurred during localizer/DME approaches; and one occurred during a GPS (global positioning system) approach.

Flight crews were conducting visual approaches when four CFIT accidents occurred. Six accident reports did not specify the type of approach being conducted.

Precision approaches often are unavailable at business jet destinations. Among the CFIT accidents for which data were available, 7.4 percent of the airports had two or more operating precision approaches, 44.4 percent had one precision approach, 44.4 percent had only nonprecision approaches, and 3.8 percent had no instrument approaches.

Of the airports at which the 104 ALAs occurred, 24.6 percent had two or more operating precision approaches, 28.9 percent had one precision approach, 32.3 percent had only nonprecision approaches, and 14.2 percent had no instrument approaches.

CFIT Environmental Conditions

Thirteen CFIT accidents (48.1 percent) occurred in daytime instrument meteorological conditions (IMC), and six (22.2 percent) occurred in nighttime IMC (Table 6, page 6). Five CFIT accidents (18.5 percent) occurred in nighttime visual meteorological conditions (VMC), and one (3.7 percent) occurred in daytime VMC. Data were not available for two accidents.

Table 4
Availability of Airport Facilities and ATC Services in Business Jet CFIT Accidents and ALAs, 1991–2002

Service	CFIT (%)	ALAs (%)
Terminal approach radar	15.3	26.6
Full-time ATC tower	3.8	29.3
Part-time ATC tower	48.1	30.0
No ATC tower	48.1	40.7
Precision instrument approach (two or more)	7.4	24.6
Precision instrument approach (one)	44.4	28.9
Nonprecision instrument approach (only)	44.4	32.3
VFR only	3.8	14.2
Approach light system	30.7	65.8
Runway lights	88.0	93.7
VASI/PAPI	23.1	79.7
On-field weather reporting and forecasts		
Full-time weather observers	3.7	12.9
Part-time weather observers	59.3	67.8
RVR	11.1	13.3
ATIS/VOLMET	27.0	59.5
AWOS/ASOS	44.4	64.3
None available	0.0	19.3

ALAs = Approach-and-landing accidents
ASOS = Automatic surface observation service
ATC = Air traffic control
ATIS = Automatic terminal information service
AWOS = Automatic weather observing service
CFIT = Controlled flight into terrain
PAPI = Precision approach path indicator
RVR = Runway visual range
VASI = Visual approach slope indicator
VFR = Visual flight rules
VOLMET = Routine broadcast of meteorological information for aircraft in flight

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

Table 5
Type of Approach Flown in 27 Business Jet CFIT Accidents, 1991–2002

Type of Approach	Number of Accidents
Nonprecision	13
Precision	4
Visual	4
Unknown	6

CFIT = Controlled flight into terrain

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

Table 6
Lighting, Weather Conditions in Business Jet CFIT Accidents, 1991–2002

	VMC	IMC	Total
Day	1	13	14
Night	5	6	11
Unknown	—	—	2
Total	**6**	**19**	**27**

CFIT = Controlled flight into terrain
IMC = Instrument meteorological conditions
VMC = Visual meteorological conditions

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

Accurate weather reports often are unavailable to business jet operators. Full-time weather-reporting service was available at only one of the CFIT accident airports, and 16 (59.3 percent) of the airports had part-time weather-reporting service. An automated weather-observing system (AWOS) or an automated surface-observing system (ASOS) was present at 12 (44.4 percent) of the airports.

Among airports where ALAs occurred, 14 (13.5 percent) had full-time weather-reporting service, 70 (67.3 percent) had part-time weather-reporting service, 67 (64.4) percent had AWOS or ASOS systems, and 20 (19.2 percent) had no weather-reporting service or facilities.

In the United States, business jet pilots operating under Part 91 are not prohibited from conducting instrument approaches in IMC at airports without weather-reporting service, and they are not prohibited from conducting instrument approaches when weather conditions are reported to be below published approach minimums. Such prohibitions do apply to pilots operating business jets under Part 135, the regulations governing commuter and on-demand operations.

CFIT Phase of Flight

Twenty-five (92.6 percent) of the 27 CFIT accidents occurred during approach and landing. Fourteen CFIT accidents occurred during approach; 10 accidents occurred during landing; and one accident occurred during a missed approach. The other two CFIT accidents occurred during departure.

Although the business jet operating environment is similar in some ways to the air carrier aircraft operating environment, it also differs in significant ways. For example, a departure from an uncontrolled airport without a published instrument flight rules (IFR) departure procedure and with no provision for the flight crew to obtain an IFR clearance before takeoff is one of the higher-risk activities commonly faced in the business jet operating environment.

Situational Awareness

One hundred fifty-eight (62.9 percent) of the 251 business jet accident reports and 1,547 (48.5) percent of the 3,190 ASRS reports filed by business jet pilots indicated that the flight crew did not maintain situational awareness.

Situational awareness is the accurate perception of the factors and conditions that affect an aircraft and the flight crew, an accurate awareness of past relevant events, and a reasonable anticipation of how changes in pertinent factors could affect the flight.

Loss of situational awareness was cited in 13 (48.1 percent) of the 27 CFIT accident reports.

The CFIT accident reports also cited the following factors: procedural errors (44.4 percent); inadequate monitoring (40.7 percent); communication errors (33 percent); decision-making errors (22.2 percent); and operational errors (14.8 percent).

Procedural errors cited in 12 CFIT accident reports included: failure to make required callouts; inaccurate callouts; failure to conduct checklists or briefings; failure to complete checklists or briefings; failure to adhere to prescribed checklist procedures; and failure to consult charts or obtain critical information.

Flight crew monitoring errors were cited in 11 CFIT accident reports. Monitoring errors included: failure to monitor and/or challenge improper action or inaction by other crewmembers; and failure to challenge improper continued descent below

minimum altitudes during instrument approaches.

Inadequate monitoring is illustrated by the following ASRS report by a corporate pilot:

> *The Aspen Approach controller cleared us for the VOR/DME [approach] to the Aspen-Pitken County/Sardy Field airport. The controller vectored us to the Red Table VOR and cleared us for the approach. (Prior to being cleared for the approach, we were cleared to 14,000 feet.) After being cleared for the approach, we were handed off to Aspen Tower, and then we began our descent at Red Table VOR to 12,700 feet. At 3 DME, we continued to 12,200 feet as published. Aspen Tower called opposite-direction traffic. I [looked] for the traffic [but did not see the traffic]. When I looked back inside, the pilot flying was at 10,800 feet at 5 DME [where the minimum altitude was 12,200 feet]. I challenged him to climb. He leveled, however, and said, "Don't worry about it. I know what I'm doing." At the same time, Aspen Tower advised [that] they had an altitude-alert warning and had us verify [that] we were at 10,800 feet. I verified it. At 6 DME, we continued to descend to 10,400 feet, at which time we gained visual contact with the airport. We were then cleared for the visual approach after stating such. The weather at the time was 4,000 scattered and 10 miles [16 kilometers visibility] with light rain, which was one factor. Traffic being announced and looked for was another. We are, however, working on our CRM [crew resource management] skills to communicate, which broke down during the approach.*[8]

'Hostile Cockpit'

Inadequate CRM was cited as a factor in 12 CFIT accidents.

The following ASRS report, by a designated trip captain during a flight in which the chief pilot was serving as second-in-command (SIC) and as the pilot flying, illustrates problems that can arise when both flight crewmembers do not adhere to CRM principles:

> *The primary cause of this event was human factors — specifically, the hostile cockpit environment created by the chief pilot. His unprofessional behavior began during taxi-out and pervaded the remainder of that leg. … As his verbal and nonverbal communications continued to be terse and agitated, I felt compelled to ask him to verify that he was working with me as a team. … Though he completed all tasks and checklists at appropriate times, the cockpit remained a tense calm. Approximately one hour five minutes after departure, ATC gave us a clearance "direct to WANES [an initial approach fix], maintain 3,000 feet until WANES, cleared VOR/DME-A at Teterboro [New Jersey, U.S.]." Pilot flying used VNAV [vertical navigation] for descent [to 3,000 feet]. Pilot flying requested 2,000 feet in altitude alerter (our SOP [standard operating procedure] once level is to put in next altitude). At 12 DME from Teterboro, ATC questioned our altitude, at which time I looked back inside and saw we were below 3,000 feet. … The chief pilot made a gross error, and my vigilance for traffic kept me from a thorough cockpit scan. He did return to 3,000 feet. … Our department needs to revise our policy on setting the altitude alerter when VNAV is/was in use. More importantly, my chief pilot (and others like him) need to recognize — and correct — their unwillingness to accept the capabilities of those different from them. In the past year I've attended both CRM and corporate air safety seminars, as well as CFIT awareness training; my chief pilot did not, stating [that] he did not need to, as he already knew all that.*[9]

Flight crew navigational errors were cited in 10 CFIT accident reports. Navigational errors include selecting an incorrect frequency for the required radio navigation station, selecting an incorrect radial or heading, misreading charts, and misinterpreting the aircraft's navigation instruments.

The following ASRS report was submitted by a first officer who set the incorrect course in both horizontal situation indicators (HSIs) during departure from an airport in mountainous terrain:

> *This was my first trip [to the airport]. Weather was excellent, with no ceiling and unrestricted visibility. … After an uneventful takeoff, we flew the departure procedure: heading 340 degrees; at 8,700 feet, left turn to 270 degrees to intercept [the] localizer back course outbound. I had set up both pilots' [HSIs] with the "reverse" of the published course [i.e., 120 degrees, rather than 300 degrees]. When we turned to 270 degrees, it appeared that we'd already flown through the course. This confused both pilots, and the [distraction] could have been disastrous if we lost an engine or were in IMC. Luckily, weather was ideal and we could look outside to avoid the "cumulogranite." My inexperience at [the airport] was a factor, but the captain (who has [operated at the airport] several times) was confused also.*[10]

The following ASRS report by an air traffic controller describes several events in which turbine-aircraft flight crews misinterpreted a departure procedure when climbing out from an airport in mountainous terrain:

> *We have an unsafe IFR departure procedure [assigned by Eagle (Colorado, U.S.) Tower] to all IFR Runway 25 departures released by*

Denver Center. The Runway 25 IFR departure is confusing and complicated by not having a visual picture of the procedure. It is frequently not flown correctly by pilots, which puts them in unsafe proximity to terrain and Aspen approach airspace. … I've personally seen four pilots misfly and get into Aspen airspace. … [Recently, a] pilot was confused [and] misflew the procedure, heading south instead of north, putting himself in unsafe proximity to terrain and another flight inbound to Aspen.

Callback conversation with the reporter revealed the following information: The reporter stated that [the navigational errors that he witnesses occurred when the pilots flew] the radial as the heading, rather than using the reciprocal of the VOR radial as intended.[11]

Communication Errors

Communication errors were cited in nine CFIT accident reports.

Examples of communication errors included incorrect readback of ATC instructions, incorrect "hear-back" by controllers and failure to provide accurate information.

The following ASRS report illustrates problems that can occur when only one flight crewmember is monitoring ATC radio transmissions:

We had briefed the GPS Runway 13 approach with a circle to land [on] Runway 31. After contacting Salt Lake [Utah, U.S.] Approach Control, we were advised that the GPS Runway 13 approach was not available due to restricted airspace being active. It was agreed to accept the ILS for Runway 13 and circle to land Runway 31. After crossing the [initial approach fix], we were assigned a heading of 010 degrees and instructed to descend to 11,000 feet. I began to tune and identify the radios for the ILS when ATC advised that the vector was going to take us through the localizer. When I acknowledged ATC, I did not understand that the instructions included: "Expect a left turn after crossing the localizer." My attention was divided between setting and tuning radios and communicating with ATC. Although the workload for the pilot not flying was acceptable, the mindset was expecting a [right] turn back toward the airport to intercept the localizer. The approach checklist had been completed and the radios were set for the approach [when] I advised the pilot flying that I was going to get a wind check at the airport. While I was listening to the ASOS weather, ATC gave instructions to turn to a heading of 160 degrees and to descend to 8,000 feet. The pilot flying acknowledged a heading of 060 degrees. The 060-degree heading was a logical heading for vectors back to the localizer. However, after a short time, ATC realized [that] we were not on their assigned heading of 160 degrees and advised an immediate left turn and an immediate climb to 11,000 feet. We initiated the left turn and a climb when ATC then advised [us] to make an immediate right turn and to increase our angle of bank. A right climbing turn was initiated with a bank angle of 35 degrees. After approaching 11,000 feet, ATC then instructed a left turn for vectors to the Runway 13 ILS. The remainder of the approach and landing was uneventful.[12]

Faulty Decisions and System Operation

Inadequate flight crew decision making was cited in six CFIT accident reports.

Factors included: failure to revise action in response to indications that the action should be revised; failure to heed warnings or alerts; and descending below decision height (DH) or minimum descent altitude (MDA) prior to sighting the runway environment.

Improper system operation was cited in four CFIT accident reports. Two accidents involved failures to correctly reset altimeters.

Flight crew distraction with an aircraft system anomaly during an approach was cited in the following ASRS report:

Crew was involved in troubleshooting, diagnosing [and] investigating an asymmetric thrust control problem. Monterey [California, U.S.] Tower called and advised us to check our altitude due to low-altitude alert they were receiving; simultaneously, our GPWS sounded an alert. We stopped our descent and checked our altitude to be 3,800 feet, which was approximately 400 feet below the published crossing altitude … for the area of the approach we were on. … This occurrence points out that flight crews must not neglect their primary duty to "fly the aircraft." Regardless of anything else going on with the aircraft, they must continue to fly the aircraft.[13]

In 13 CFIT accidents, flight crews descended to altitudes that were lower than the minimum altitudes prescribed for the segments of the approaches they were flying.

Fatigue was cited in two CFIT accident reports and in 11 ASRS reports.

Runway Overruns, Undershoots

The following analysis of the 104 business jet ALAs does not include information about the 25 CFIT accidents that occurred during approach and landing.

Ten (9.6 percent) of the 104 ALAs were fatal.

Fifty-nine ALAs (56.7 percent), all of which were nonfatal, involved runway overruns (Table 7).

One hundred seventy-six (21.8 percent) of the 808 incidents occurred during the approach-and-landing phase of flight; all 176 approach-and-landing incidents involved runway overruns.

Fourteen ALAs (13.5 percent) involved runway undershoots.

All 10 fatal ALAs and one nonfatal ALA involved loss of control.

Ten ALAs (9.6 percent) involved hard landings.

Ten ALAs involved other types of accidents, including seven in which the crew failed to extend the landing gear and three in which the aircraft struck objects.

Flight crews were conducting precision instrument approaches (i.e., ILS approaches) when 36 (34.6 percent) of the ALAs and 69 (39.2 percent) of the approach-and-landing incidents occurred (Table 8). Nonprecision approaches were being conducted when 18 (17.3 percent) of the ALAs and 43 (24.4 percent) of the approach-and-landing incidents occurred. Visual approaches were involved in 42 (40.4 percent) of the ALAs and 46 (26.1 percent) of the approach-and-landing incidents. The reports on eight (7.7 percent) of the ALAs and on 18 (10.2 percent) of the approach-and-landing incidents did not specify the type of approach that was conducted.

The pilot-in-command (PIC; captain) was the pilot flying in 64 (61.5 percent) of the ALAs and 111 (63.1 percent) of the 176 approach-and-landing incidents (Table 9, page 10). The SIC (first officer) was the pilot flying in six ALAs (5.8 percent) — three runway overruns and three hard landings — and in 18 approach-and-landing incidents (10.2 percent). Insufficient information was available in the reports to determine the pilot flying in the remaining 23 ALAs and 26 approach-and-landing incidents. Eleven ALAs (10.6 percent) and 21 approach-and-landing incidents (11.9 percent) involved single-pilot operations.

Sixty-three (60.6 percent) of the ALAs occurred during daytime, including 19 ALAs in IMC and 44 ALAs in VMC (Table 10, page 10). Nineteen ALAs (18.3 percent) occurred during nighttime, including 12 in IMC and seven in VMC. Eleven of the nighttime ALAs occurred in mountainous terrain.

Six ALAs occurred during twilight, including one in IMC and five in VMC. Lighting conditions were not specified in 16 ALA reports.

IMC prevailed when 64 ALAs (61.5 percent), including eight fatal ALAs, occurred. Thirty-seven ALAs (35.6 percent) occurred in VMC.

ALA Environmental Conditions

Seventy-one ALAs (68.3 percent) occurred in precipitation (Table 11, page 11). Of these, 33

Table 7
Business Jet Approach-and-landing Accidents and Incidents, 1991–2002

Type	Fatal Accidents	Nonfatal Accidents	Incidents
Runway overrun	0	59	176
Runway undershoot	0	14	0
Loss of control	10	1	0
Hard landing	0	10	0
Other	0	10	0
Total	**10**	**94**	**176**

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

Table 8
Approach Procedure Being Conducted During Business Jet ALAs and Approach-and-landing Incidents, 1991–2002

Approach	Accidents (%)	Incidents (%)
ILS	34.6	39.2
Nonprecision	17.3	24.4
Visual	40.4	26.1
Unknown	7.7	10.2

ALAs = Approach-and-landing accidents ILS = Instrument landing system

Note: Incidents do not total 100 percent because of rounding.

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

Table 9
Pilot Flying in Business Jet ALAs and Approach-and-landing Incidents, 1991–2002

	PIC	SIC	Single Pilot	Unknown	Total
Accidents	64	6	11	23	104
Incidents	111	18	21	26	176

ALAs = Approach-and-landing accidents PIC = Pilot-in-command (captain) SIC = Second-in-command (first officer)

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

ALAs occurred in rain, 23 in snow and 15 in mixed rain and snow.

Low visibility — 1.0 statute mile (1.6 kilometers) or lower — was cited in 64 (61.5 percent) of the ALA reports, including eight reports on fatal ALAs.

Low ceilings — within 100 feet of the DH/MDA for the approach — were cited in 44 (42.3 percent) of the ALA reports.

Adverse wind conditions were present in 44 ALAs (42.3 percent). Eighteen ALAs involved wind shear and/or turbulence. Strong crosswinds — exceeding a 15-knot crosswind component — were present in 13 ALAs. Tail winds in excess of 10 knots were present in 13 ALAs.

In-flight icing conditions were present in 14 ALAs.

Contaminated Runways

Contaminated runways were a factor in 42 (71.2 percent) of the 59 ALAs that involved runway overruns and 123 (69.9 percent) of the 176 incidents that involved runway overruns (Table 12, page 11).

Table 10
Lighting, Weather Conditions in Business Jet ALAs, 1991–2002

Light Condition	VMC	IMC	Unknown	Total
Day	19	44	—	63
Night	7	12	—	19
Twilight	1	5	—	6
Unknown	10	3	3	16
Total	37	64	3	104

ALAs = Approach-and-landing accidents IMC = Instrument meteorological conditions
VMC = Visual meteorological conditions

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

The runway contaminants included the following:

- Rain — 19 ALAs, 56 incidents;
- Snow — 12 ALAs, 36 incidents;
- Slush — six ALAs, 17 incidents; and,
- Ice — five ALAs, 14 incidents.

Nine ALA reports cited inadequate snow-removal from runways, including snow piled on the sides of runways (reducing available runway width) and partial snow removal from runways.

The following information, from the *Cessna Citation Operating Manual*, is typical of guidance provided by business jet manufacturers for operations conducted on contaminated runways:

> *All flight manual field-length data assumes a dry, hard-surface runway, except where otherwise noted. Precipitation-covered-runway conditions will degrade braking effectiveness and will require significantly greater actual takeoff abort [lengths] and landing field lengths.*
>
> *Considerations for landing on a precipitation-covered runway are similar to those for short-field operations where velocity and speed are minimized and maximum roll-out distance is made available. Runway composition, condition and construction, the amount of precipitation and the depth of main landing gear tire tread remaining affect the magnitude of braking degradation, so it is impossible to*

Table 11
Environmental Conditions in Business Jet ALAs, 1991–2002

	Number	Percent
Precipitation	71	68.3
Low visibility	64	61.5
Low ceiling	44	42.3
Wind shear/turbulence	18	17.3
Icing	14	13.5
Crosswind	13	12.5
Tail wind	13	12.5

ALAs = Approach-and-landing accidents

Note: Percentages do not total 100 because many of the ALA reports cited multiple environmental conditions.

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

apply a fixed factor to cover all conditions. … Again, maximizing roll-out runway available and touching down at minimum safe speed will provide the greatest possible margin.

With precipitation cover on the runway, braking should be very judicious. If runway length permits, delay braking slightly until some aerodynamic deceleration has taken place. Under normal braking conditions, the optional anti-skid [braking] system is very effective in preventing skids and producing minimum stopping distances; however, on a precipitation-covered runway, the phenomenon of hydroplaning may greatly reduce the anti-skid effectiveness, due to the possibility of the airplane wheels not rotating up to a speed equal to the airplane's groundspeed. Airplanes equipped with the optional skid-warning system instead of the anti-skid system will experience the same reduced effectiveness. With 100 psi [pounds per square inch] main tires, the Citation's minimum dynamic hydroplaning initiating groundspeed may occur at speeds above approximately 70 knots. Since groundspeed is the critical factor, landing on precipitation-covered runways with any tail wind component should be avoided. Good tread depth tends to relieve hydrodynamic pressure under the tire on wet runways, and inflation is important because a low tire pressure lowers the minimum hydroplaning speed. Anticipated operation on precipitation-covered runways dictates close monitoring of tire condition and pressure.

The Citation manual recommends that published landing performance data be corrected when operations are conducted on wet runways. The recommended corrections are to multiply the published dry-runway landing distances by 1.45 when the runway is contaminated by less than 0.01 inch (0.25 millimeter) of water and 2.20 when the runway is contaminated by 0.01 inch to 0.50 inch (12.70 millimeters) of water.

Airport Conditions

Twenty-two percent (702) of the 3,190 ASRS reports were about operations conducted at major airline-hub airports, which typically have round-the-clock ATC services, precision instrument approach equipment and long and well-lighted runways.

Thirty-three percent (1,052) of the ASRS reports were about operations conducted at "satellite" airports, many of which have part-time ATC service, nonprecision approaches and shorter runways.

Twenty-eight percent (893) of the ASRS reports were about operations conducted at uncontrolled airports.

Two hundred eighty-seven ASRS reports cited inadequate airport conditions (Table 13, page 12). Of the 287 reports, 33 percent cited inadequate runway conditions and/or inadequate runway maintenance; 28 percent cited inadequate field

Table 12
Runway Conditions During Business Jet ALAs and Incidents Involving Runway Overruns, 1991–2002

	Dry	Rain	Snow	Slush	Ice	Total
Accidents	17	19	12	6	5	59
Incidents	53	56	36	17	14	176

ALAs = Approach-and-landing accidents

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

maintenance, including inoperative lights, inadequate surface conditions, worn paint and lack of adequate markings; 26 percent cited inadequate ramp conditions, including congested, narrow taxiways; 19 percent cited lack of weather-reporting services; 18 percent cited lack of adequate runway-condition reports; and 14 percent cited inadequate snow removal.

Unreported or inaccurately reported weather conditions and braking action were factors in the following ASRS report:

> *Flew ILS Runway 9R at OSU [Ohio State University Airport] in landing configuration in accordance with company procedures. ATIS [automatic terminal information service] reported 1,800 broken, visibility five miles in light drizzle. No braking action advisories or reports were given. We touched down approximately 1,500 feet [458 meters] down the runway after following the glideslope all the way down. Thrust reversers and spoilers were deployed, and max[imum] braking was applied. During landing roll-out, we found braking action to be nil. Max[imum] reverse thrust was maintained until we reached the end of the runway. At that time, both engines were secured and the aircraft came to rest about 75 feet [23 meters] off the end in hard grass on the [extended runway] centerline. There was no damage to the aircraft or airport property. About five minutes after the landing, the aircraft became covered with clear ice due to freezing rain. The emergency vehicles that arrived at the scene had a difficult time stopping due to the conditions. Had we been advised of these conditions, we would have not attempted a landing at OSU due to the high ref[erence] speeds used in this aircraft [Learjet 23] and the length of the runway (5,000 feet [1,525 meters]). … It was obvious that the freezing rain had been going on for some time … and I feel somebody should have said something.*[14]

Table 13
Airport Conditions Cited in NASA ASRS Reports, 1991–2002

	Percent
Inadequate runway condition/maintenance	33
Inadequate field maintenance	28
Inadequate ramp conditions	26
Lack of weather reporting	19
Lack of adequate runway condition reports	18
Lack of adequate snow removal	14

NASA ASRS = U.S. National Aeronautics and Space Administration Aviation Safety Reporting System

Note: Percentages do not total 100 because several reports cited more than one airport condition.

Source: Patrick R. Veillette, Ph.D., from U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS).

Slippery Runways

Business jets often are operated on runways with surfaces that are not constructed specifically to minimize the effects of runway contaminants, such as surfaces with a porous friction course overlay or with grooves.

Fifty-nine percent of the ALAs occurred on runways that lacked a porous friction course overlay or a grooved runway surface.

U.S. Air Force research and NASA research found that an ungrooved runway or a runway lacking a porous friction course overlay provides a two-to-one wet-to-dry stopping ratio — for example, an airplane requiring 3,500 feet [1,068 meters] to stop on a dry runway would need 7,000 feet [2,135 meters] to stop on a wet runway. Runways with little or no aggregate in the asphalt, with a concrete surface polished by years of wear or with a significant rubber buildup from landing traffic provide a wet-to-dry stopping ratio of six-to-one.[15]

The following ASRS report cites a runway-surface hazard:

> *The weather was IFR in fog. It had rained earlier. We were flying the NDB Runway 36 approach to Sullivan, Indiana. We broke out in time to make a normal descent and landing in the touchdown zone, [at landing reference] speed. … Speed brakes, full [reverse thrust] and anti-skid brakes were applied but did little good. The airplane did not decelerate on a normal schedule. Finally, we got slow enough to turn off at the end. I spoke to [a representative of] the Department of Aeronautics for Indiana, who did some research on that airport surface. He said that it had an FAA AIP [Airport Improvement Program] project*

completed three years ago [and that] it had a clear surface seal coat applied to it. I asked him if any other Indiana airports had a clear surface seal coat, and he didn't think so. Is such a sealant approved? Something on that runway made it at least as slippery when wet as glare ice. This is a hazard, and it should be [disseminated in a notice to airmen (NOTAM)] as such until the sealant can be removed. The airport manager said that jets very seldom use that airport. … If any other airports in the United States have such a seal coat applied, it should be removed. When wet, it was as slippery as a rock in a creek.[16]

Inadequate Field Maintenance

Inadequate field maintenance that affected the safety of flight was cited in 28 percent of the 287 ASRS reports on airport conditions. Inadequate markings, inadequate lighting or inadequate surface conditions typically were cited.

Inadequate field maintenance was a factor cited by the following ASRS report:

Place: Madison [Mississippi, U.S.] Airport/ Bruce Campbell Field (MBO). Unsafe conditions: At MBO, runway lighting is not working the full length of the runway, lights are out, broken along sides of runway, runway end identifier lights are out or broken, VASI light system is not working, trees extend upwards into the flight path of the aircraft on a normal approach. Runway markings are bad, taxiway identifier stripes are virtually nonexistent. No taxiway identifier markers at north or south ends, runway is in very deteriorated condition, south taxiway is in horrible condition, taxiway marking stripe lines are very hard to see at night. No taxiway lights or reflectors. … VOR receiver checkpoint has been paved over and the sign has been knocked down and taken away.

Callback conversation with the reporter revealed the following information: … The reporter is an FAA accident prevention counselor as well as [a pilot] participating in corporate flying in a Citation II. They do a lot of night flying at this airport and that is one of his concerns. He doesn't know if the field conditions preclude a legal night operation or not. He stated that an aircraft had hit trees at the end of one of the runways. Following that, a mechanic had taken the lights out of the nonstandard VASI system, as they found that aircraft were actually following those lights into the trees.[17]

Inadequate snow removal was cited in 14 percent of the 287 ASRS reports on airport conditions.

The following ASRS report illustrates the hazards created by inadequate snow removal:

Last weather received from tower [included] one-half inch [one and one-quarter centimeters of] loose snow on runway, plowed 30 feet [nine meters] either side of center. I was not informed of any irregularities in plowing of runway. Last braking action fair to poor by [the pilot of] a medium large transport minutes prior. … Runway available: 11,700 feet [3,569 meters], 150 feet [46 meters] wide. A normal ILS approach was executed and the runway was acquired at approximately 500 feet AGL [above ground level]. The runway centerline lights were obscured by snow. A normal touchdown was made at approximately 300 feet [92 meters] from threshold at V_{REF} *134 knots. … The right side had been plowed … 25 feet [eight meters] from the centerline. The right tires impacted the plow berm (eight inches to 11 inches [20 centimeters to 28 centimeters] high) and pulled the aircraft into the unplowed area of the right side of the runway. Brakes, rudder and differential reverse thrust were ineffective in controlling the aircraft, and it exited the right side of the runway and continued several hundred feet through snow, soft turf and mud. … Damage: two landing lights were cracked. Injuries: none.*[18]

Other factors contributed to runway overruns (Table 14, page 14). Thirty-two overrun accidents and 74 overrun incidents were caused in part by excessive aircraft speed. Sixteen overrun accidents and 55 overrun incidents were caused in part by landing beyond the touchdown zone. Thirteen overrun accidents and 29 overrun incidents were caused in part by tail winds in excess of 10 knots. Fourteen overrun accidents and 33 overrun incidents were caused by incorrect braking procedures.

Table 14
Contributing Factors in Business Jet Runway Overruns, 1991–2002

	Runway Conditions	Excess Speed	Long Landing	Adverse Tail Wind	Inadequate Visibility	Incorrect Braking Procedures
Accidents	42	32	16	13	43	14
Incidents	123	74	55	29	92	33

Note: Several accident reports and incident reports cited more than one contributing factor.

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

ALA Causal Factors

Flight crews failed to conduct stabilized approaches in 67 (64.4 percent) of the ALAs (Table 15, page 15).

Slow or delayed flight crew action was a causal factor in 51.9 percent of the ALAs. Flight-handling difficulties were involved in 51 percent of the ALAs. Inadequate CRM (e.g., failure to cross-check and/or coordinate actions) was involved in 44.2 percent of the ALAs. Omission of action or inappropriate action was involved in 43.3 percent of the ALAs. Failure to adequately evaluate the conditions contributed to 42.3 percent of the ALAs. Inadequate judgment was involved in 41.3 percent of the ALAs. Inadequate qualification, training and/or experience was involved in 33.7 percent of the ALAs. Inadequate positional awareness was present in 33.7 percent of the ALAs. "Press-on-itis" — characterized by a flight crew's determination to continue toward the destination or to continue an approach despite a lack of readiness of the aircraft or the flight crew — was involved in 25 percent of the ALAs, and disorientation was involved in 15.4 percent of the ALAs.

Eighty-one percent of the unstabilized ALAs involved rushed approaches (Table 16, page 16). Other factors contributing to the unstabilized approaches were: inadequate crew coordination (72 percent); attempts by flight crews to comply with demanding ATC clearances (66 percent); inadequate automation management (62 percent); inadequate energy management (60 percent); handling difficulties because of in-flight icing conditions (30 percent); and adverse wind conditions — turbulence, wind shear, gusts — (26 percent).

The following ASRS report illustrates the influences of a demanding ATC clearance on an unstabilized approach:

> *Requested many times a lower altitude. … ATC kept us high even on localizer with full fly-down glideslope [indication]. Finally, ATC asked if we could get down OK. Captain hesitated and replied, "Yes." Trying to frantically fly down to glideslope at 260 knots, I advised captain I should ask for one turn in hold on localizer at FAP [final approach point] at 4.5 DME. … Captain did not reply. ATC again asked if we could make it, and I told captain, "I'll tell him we need one turn," to which the captain replied, "OK." As I informed ATC, captain reached over and threw out landing gear at 220 knots (max[imum] gear speed is 190 knots). I stopped transmitting to observe and challenge captain when he responded, "Give me slats, now." I advised him that ATC had issued a turn, as ATC was now informing us something about "a small aircraft on low downwind, are we turning?" I asked captain what he was doing, as we were now at approximately 3,400 feet at about 3.7 miles [6.9 kilometers] (glideslope intercept altitude is 1,620 feet at 4.5 DME for ILS DME 5). We were now about 195–200 knots, gear down, 20 degrees flaps (captain selected), 6,000 fpm [feet per minute] descent. GPWS was yelling "sink rate, pull up" and "terrain, terrain, pull up." To add to the chaos, I told ATC [that] we were continuing and told captain to go around, as I monitored altitude, radio altitude and vertical speed. We suddenly broke out, high, close-in [and] the captain continued to land while I did checklists to touchdown.*

We touched down at about 140 knots with a V_{REF} of about 117 knots. Landing was without further incident until approach called. I responded. ATC said contact tower. We had landed without ever talking to the tower. I attempted to discuss this with the captain, but he seemed unconcerned. I expressed my displeasure with continuing a nonstable approach inside the glideslope intercept point, to which he replied it was OK.[19]

An unstabilized approach and consequent go-around were the result of inadequate cockpit coordination procedures and lack of standard callouts in the following ASRS report:

In the in-range phase of the flight, as the pilot flying briefed the approach, the pilot not flying was facing aft in an attempt to set up the jump seat so a seven-year-old [child] could ride in the cockpit and observe the landing. The jump seat was never successfully locked in position, but the child was permitted to sit on a shelf aft of the copilot's seat until directed to take a seat in the cabin for landing. While the child was basically well-behaved, there were occasional questions and comments that may have interrupted the normal cockpit communications. The radios and instruments were all correctly set for the approach. The clearance was to fly an assigned heading until localizer intercept and to maintain 2,500 feet until established. Unnoticed by either pilot, the aircraft flew through the localizer. When Approach asked, "Are you receiving the localizer OK?" the pilot not flying announced to the pilot flying, "You went through the localizer." The pilot flying made a heading change to capture the localizer. Shortly thereafter, the pilot not flying said, "Better get it down, we're high on the glideslope." The pilot flying argued that since the aircraft was not yet established on the localizer, descent below 2,500 feet was not authorized. During the debate, the aircraft flew through the localizer again, and [this] was not detected by either pilot until full needle deflection. The pilot flying made another correction back to the localizer. The resultant approach was sloppy at best — a well-established, stabilized approach was never achieved. The pilot not flying failed to make most of the standard callouts on the approach. There were no callouts made for localizer intercept, glideslope intercept, passing the marker, 100 feet to minimums, or at minimums. The next cockpit communication was the pilot not flying saying, "We're below minimums, go around." The pilot flying executed a go-around and leveled off at the assigned altitude. As the pilots discussed plans to make another approach to a different runway, the pilot flying allowed the aircraft to climb to an altitude significantly above the assigned altitude. This error, too, went unnoticed by both pilots until it was called out by approach control. The altitude correction was made by the pilot flying, and a stabilized approach and landing followed. In postflight discussion, the pilots determined that a misset, misinterpreted or malfunctioning flight director probably contributed to the altitude bust during the missed approach. The pilot flying admitted to a sloppy approach but at the same time questioned the lack of standard callouts by the pilot not flying. The pilot not flying speculated that fixation on the errors and corrections being made by the pilot flying contributed to the failure to make the standard callouts.[20]

Table 15
Most Frequently Cited Causal Factors in Business Jet ALAs, 1991–2002

Causal Factor	Number	Percent
Failure to conduct stabilized approach	67	64.4
Slow/delayed crew action	54	51.9
Flight-handling difficulties	53	51.0
Inadequate CRM (cross-check/coordinate)	46	44.2
Omission of action/inappropriate action	45	43.3
Failure to adequately evaluate conditions	44	42.3
Inadequate judgment	43	41.3
Inadequate qualification/training/experience	35	33.7
Lack of position awareness	35	33.7
"Press-on-itis"	26	25.0
Disorientation	16	15.4

ALAs = Approach-and-landing accidents CRM = Crew resource management

Note: Percentages do not equal 100 because many of the 104 ALA reports cited more than one contributing factor.

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

Table 16
Contributing Factors in Business Jet Unstabilized Approaches, 1991–2002

Factor	Percent
Rushed approach	81
Inadequate crew coordination	72
Demanding ATC clearance	66
Inadequate energy management	66
Inadequate automation management	62
In-flight icing	30
Wind shear/turbulence/gusts	26

ATC = Air traffic control

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

Slow/Delayed Actions

Slow crew action or delayed crew action was a causal factor in 54 (52 percent) of the ALAs. In several occurrences, crew recognition of the seriousness of the situation was not timely. For example, the decision to go-around was delayed in 23 accidents; of these, 19 were initiated within 1,000 feet (305 meters) of the departure end of the runway.

In 47 of the 59 runway-overrun ALAs, flight crews said that they did not become aware of the impending overrun until the final 500 feet (153 meters) of the runway, where conducting a go-around was impractical.

Delayed application of wheel brakes contributed to 14 ALAs.

Flight-handling Difficulties

Flight-handling difficulty was a causal factor in 53 ALAs (51 percent), of which 10 were fatal. This factor involves the inability of the crew to maintain control the aircraft to the desired parameters (e.g., speed, altitude, rate of descent).

Flight-handling difficulties resulted in 11 loss-of-control (LOC) accidents, 32 runway overruns and 10 hard landings.

In nine ALAs, LOC occurred below 500 feet AGL. Eight of these were fatal. Two fatal ALAs involved LOC between 1,001 feet AGL and 2,500 feet AGL.

Nine of the 11 LOC ALAs were caused by the crews' failure to maintain adequate airspeed (Table 17). Nine of the LOC ALAs were preceded by an unstabilized approach. Eight of the LOC ALAs occurred in low visibility. Six LOC ALAs involved in-flight icing conditions — five of these accidents involved a circling maneuver following a nonprecision approach, and all six icing-related accidents involved failure to maintain adequate airspeed. Three LOC ALAs occurred during precision approaches when flight crews allowed airspeed to decrease during the landing flare, resulting in impact of a wing structure with the runway. Two LOC ALAs, both of which were fatal, involved the flying pilot's inability to recover from a wind shear-induced bank angle in excess of 30 degrees.

Three LOC ALAs occurred during precision approaches; two were fatal. Two LOC ALAs occurred during visual approaches; one was fatal.

Captains were flying the aircraft in six of the LOC ALAs. First officers were flying the aircraft in two of the LOC ALAs. Single-pilot operations were involved in two LOC ALAs.

Table 17
Contributing Factors in Business Jet Loss-of-control ALAs, 1991–2002

	Number
Failure to maintain adequate airspeed	9
Unstabilized approach	9
Restricted visibility	8
Icing conditions	6
Circle-to-land maneuvers	5
Decrease in airspeed during landing flare	3
Wake turbulence	2

ALAs = Approach-and-landing accidents

Note: Several of the 11 loss-of-control ALAs involved more than one factor.

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

Excessive Airspeed, Height

Thirty-two ALAs occurred because of excessive airspeed (more than 10 knots above the appropriate airspeed) on approach; all 32 accidents involved runway overruns.

Each knot of excess approach speed carried onto the runway will increase the minimum stopping distance by 20 feet to 30 feet (six meters to nine meters) on a dry runway and 40 feet to 50 feet (12 meters to 15 meters) on a wet runway. Additionally, the excess speed often increases the risk of a prolonged flare, which will increase the distance to touchdown by approximately 200 feet (61 meters) for each extra knot of speed.[21]

Excessive height over the runway threshold was a contributing factor in 10 runway overruns. Excessive height over the threshold will most likely result in a touchdown beyond the normal aiming point. If the approach is stabilized two dots high (as indicated by the glideslope indicator) at the middle marker, the landing will use 1,100 feet (336 meters) more runway than if the airplane had been on the glideslope.[22]

Hard Landings

Hard landings substantially damaged 10 business jets. Seven of the hard landings occurred after visual approaches, and three occurred after ILS approaches.

High sink rates on short final approach resulted in eight hard landings. Sudden loss of airspeed in the flare was involved in six hard landings. Inadequate power management in the flare caused four of the hard landings.

The landing gear collapsed after seven hard landings; the pilots were not able to maintain directional control, and the aircraft departed from the runways.

Inadequate maintenance of a stabilized approach throughout the landing flare was involved in the following ASRS report:

> *I was copilot on a Gulfstream en route VFR [to] Carson City, Nevada. … The captain made an appropriate 45-degree right downwind entry to Runway 9 at Carson City. However, I noticed he was drifting a bit below pattern altitude and I mentioned to him [that] he was getting low. He continued the approach, and on right base I called to him that he was "low and at V_{REF}." These calls were followed by my somewhat adamant calls of "[V_{REF}] minus five," then "airspeed minus 10, power, go around." At that point, we were at about 300 [feet] to 400 feet AGL. Simultaneously with the last call, the stick shaker activated. As I put my hand up to push forward the power levers, the captain finally started adding power for what I thought was a go-around. Instead, he [conducted a] 40-degree [banked] right turn as he overshot final and said (stick shaker still going), "These Gulfstreams will fly through anything." He then kept the power in, got back to a better airspeed. (Note: His [airspeed] bug was at 121 [knots], which was V_1 for takeoff out of Reno, even though twice on the "Before Landing" checklist I had confirmed V_{REF} was 139 [knots], and both times he acknowledged this and said, "Bug set." I can't see his airspeed bug very well from where I sit.) Once it was apparent [that] he was going to continue to fly the approach, I again confirmed V_{REF} at 139, and he again acknowledged this. Next, I noticed on final that he had kept the extra power in and was now getting high. I told him, "You're getting high, go around." I felt a go-around was needed since we were landing at maximum weight for the conditions to a 5,900-foot (1,800-meter) runway at 4,600 feet. The captain then, as we were nearly at the approach threshold fully 250 feet above ground, retarded the power levers to idle and said, "We can make it." The rate of descent was alarming, and I shouted "sink rate" followed by "flare!" The impact was impressive, and it's a testimonial to Grumman/Gulfstream that we didn't drive the main gear right through the wings.*[23]

Deviations From SOPs

Omission of action and/or inappropriate action was a factor in 45 (43 percent) of the business jet ALAs. This represents inadvertent or deliberate deviation from SOPs.

Examples of procedural deviations include:

- Omission of approach briefing or inadequate approach briefing;
- Omission of standard airspeed callouts and altitude callouts;
- Failure to check the radio altimeter;
- Failure to call out "runway in sight" or "no contact" at DH;
- Failure to request updated weather information;
- Omission of checklist items;
- Improper landing configuration;
- Failure to verbalize/confirm inputs to systems such as the flight management system (FMS), autopilot and navigation radios; and,
- Deliberate deviation from a published instrument approach procedure.

Failure of the flight crew to configure the aircraft properly for the landing (landing gear and/or flaps) was a factor in 13 business jet ALAs. Failure to extend the landing gear was involved in seven accidents, all of which occurred while crewmembers were undergoing flight training or check rides.

Inappropriate operation of the thrust reversers contributed to seven ALAs.

Evaluation of Runway/ Weather Conditions

Flight crews failed to adequately evaluate the aircraft's ability to land and stop within an adequate distance given the existing runway and meteorological conditions in 44 (42.3 percent) of the business jet ALAs.

Forty-two (71.2 percent) of the 59 runway-overrun accidents and 86 (70 percent) of the 123 overrun incidents occurred on contaminated runways.

Improper evaluation of the winds for the approach was a factor in 13 ALAs and 29 approach-and-landing incidents.

Of the 59 runway overruns, 44 (74.6 percent) involved operations under Part 91, 10 (17 percent) involved operations under Part 135, and five (8.4 percent) involved operations under the regulations of countries other than the U.S.

A significant difference exists in the runway landing requirements in Part 135 and Part 91. Part 135 requires that the aircraft be able to land within 60 percent of the effective length of the runway; Part 91 has no such requirement.

Eighty-one percent of the runway-overrun accidents and 79 percent of the runway-overrun incidents occurred on runways with lengths of 6,000 feet (1,830 meters) or less. Forty percent of the overrun accidents and 34 percent of the overrun incidents occurred on runways with lengths of 4,000 feet (1,220 meters) or less. Ten percent of the overrun accidents and 11 percent of the overrun incidents occurred on runways with lengths of 3,000 feet (915 meters) or less.

Inadequate Judgment

Forty-three (41.3 percent) of the 104 business jet ALAs involved inadequate judgment or airmanship. This factor typically involves inadequate decision making other than press-on-itis.

Thirty-two ALAs (30.8 percent) involved failure to conduct a go-around or a missed approach when the aircraft was not stabilized at an appropriate airspeed, and 16 ALAs (15.4 percent) involved failure to go around when the aircraft deviated significantly from the glideslope.

Seven ALAs (6.7 percent) occurred when pilots continued an instrument approach below DH or MDA in absence of adequate visual references.

Five ALAs (4.8 percent) occurred when flight crews continued an approach when the runway environment no longer could be positively identified.

Qualification, Experience, Training

Absence of adequate flight crew qualification, experience and/or training was a contributing factor in 35 ALAs (Table 18, page 19).

Inadequate knowledge of aircraft flight profiles, procedures and callouts contributed to 25 ALAs (24 percent).

Unfamiliarity with aircraft systems and system operating procedures was involved in 24 ALAs (23.1 percent).

Inadequate experience of the PIC was cited in 14 ALAs (13.5 percent).

Inadequate experience of the SIC was cited in 23 ALAs (22.1 percent).

Unfamiliarity with company procedures was cited in 23 ALAs.

Unfamiliarity with the FMS and inadequate automation management contributed to 21 ALAs (20.2 percent).

The flight crew's inadequate ability to accurately evaluate takeoff and landing performance planning criteria was cited in 20 ALAs (19.2 percent)

Flight crews exhibited inadequate knowledge of adverse-weather procedures in 20 ALAs.

Press-on-itis

Press-on-itis was involved in 26 ALAs (25 percent).

Examples of press-on-itis include:

- Continuing a flight to the destination (as opposed to diverting to an alternate) despite deteriorating weather conditions or conditions below minimums for a given approach;
- Accepting excessively demanding ATC clearances;
- Continuing an approach because of excessive management-induced commercial pressures; and,
- Continuing an approach when a missed approach or a go-around normally would be conducted.

Press-on-itis can be caused by pressure to complete a flight within the prescribed flight duty period and operational penalties incurred by diversions.

Table 18
Flight Crew Experience, Training and Qualification Factors in 35 Business Jet ALAs, 1991–2002

Factor	Number of ALAs
Inadequate knowledge of procedures and callouts	25
Unfamiliarity with aircraft systems and procedures	24
Inadequate experience of SIC	23
Unfamiliarity with company procedures	23
Unfamiliarity with FMS/automation management	21
Inadequate ability to evaluate aircraft performance	20
Inadequate knowledge of adverse weather procedures	20
Inadequate experience of PIC	14

ALAs = Approach-and-landing accidents FMS = Flight management system
PIC = Pilot-in-command SIC = Second-in-command

Note: Several ALAs involved more than one factor.

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

Visual Illusions

Disorientation and/or visual illusions were causal factors in 16 ALAs (15.4 percent). The effect of a visual illusion is generally a false perception of altitude and/or attitude, resulting in landing short or loss of control.

Visual illusions typically involved in business jet accidents and incidents result from runway slope effects. Sloping runways were contributing factors in six accidents that occurred in mountainous terrain.

Runway slopes are pronounced at many mountain airports. For example, Runway 09-27 at the airport in Telluride, Colorado (elevation 9,078 feet), has a 1.9 percent positive grade from the midpoint to both ends of the runway. Runway 15 at the Aspen–Pitkin County (Colorado) airport has a 2 percent positive grade.

A pilot conducting an approach to a runway with a positive (upward) grade might perceive that the airplane is higher than its actual height above the touchdown zone and fly a lower approach.

Visual illusions also are created by the "black-hole effect" and by whiteout conditions.

The black-hole effect typically occurs during a visual approach conducted on a moonless or overcast night, over water or over dark, featureless terrain where the only visual stimuli are lights on and/or near the airport. The absence of visual references in the pilot's near vision affect depth perception and cause the illusion that the airport is closer than it actually is and, thus, that the aircraft is too high. The pilot may respond to this illusion by conducting an approach below the correct flight path (i.e., a low approach).

Whiteout is a visibility-restricting phenomenon that occurs when a layer of cloudiness of uniform thickness overlies a snow-covered or ice-covered surface. Parallel rays of the sun are broken up and diffused when passing through the cloud layer so that they strike the snow surface from many angles. The diffused light then reflects back and forth countless times between the snow and the cloud, eliminating all shadows. The result is a loss of depth perception.

A visual illusion caused by rain on the windshield was a factor in at least one of the business jet accidents. Rain on the windshield can create an illusion that the aircraft is higher than it actually is and result in the flight crew conducting a lower approach.

Runway Undershoots

Fourteen business jet ALAs (13.5 percent) involved runway undershoots. Low visibility

was a factor in 11 undershoot accidents. Twelve of the undershoot accidents occurred during the transition from an instrument approach to the visual portion of the landing.

Flight crews were conducting nonprecision approaches when seven undershoot accidents occurred and ILS approaches when four undershoot accidents occurred. Visual approaches were involved in two undershoot accidents. One undershoot-accident report did not specify the type of approach that was conducted.

Nine undershoot accidents occurred during daytime, and five occurred during nighttime. Seven of the accidents occurred during approaches to runways equipped with VASI systems or PAPI systems. Adverse winds, including low-altitude wind shear, were factors in eight undershoot accidents.

Summary

Overall, operators of corporate/executive aircraft and business aircraft have excellent safety records. Data presented at the Flight Safety Foundation Corporate Aviation Safety Seminar in April 2004 showed that in 2003, corporate/executive aircraft were involved in 0.028 accidents per 100,000 flight hours (a record low) and that business aircraft were involved in 0.938 accidents per 100,000 flight hours.[24]

These accident rates compare with the following rates per 100,000 flight hours for other types of aircraft in 2003: 0.313 for air carrier aircraft; 0.722 for commuter aircraft; 2.500 for air-taxi aircraft; and 7.182 for general aviation aircraft.

The findings of this study indicate that reductions in the accident rates for business jets flown in corporate/executive, business and other general aviation operations, and in air-taxi operations will result from a focus on preventing CFIT accidents, ALAs and loss of control. ■

Notes

1. National Business Aviation Association. *Fact Book 2004*. <www.nbaa.org>.

2. The National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS) is a confidential incident-reporting system. The ASRS Program Overview said, "Pilots, air traffic controllers, flight attendants, mechanics, ground personnel and others involved in aviation operations submit reports to the ASRS when they are involved in, or observe, an incident or situation in which aviation safety was compromised. … ASRS de-identifies reports before entering them into the incident database. All personal and organizational names are removed. Dates, times and related information, which could be used to infer an identity, are either generalized or eliminated."

   ASRS acknowledges that its data have certain limitations. ASRS *Directline* (December 1998) said, "Reporters to ASRS may introduce biases that result from a greater tendency to report serious events than minor ones; from organizational and geographic influences; and from many other factors. All of these potential influences reduce the confidence that can be attached to statistical findings based on ASRS data. However, the proportions of consistently reported incidents to ASRS, such as altitude deviations, have been remarkably stable over many years. Therefore, users of ASRS may presume that incident reports drawn from a time period of several or more years will reflect patterns that are broadly representative of the total universe of aviation-safety incidents of that type."

3. Controlled flight into terrain (CFIT) occurs when an airworthy aircraft under the control of the flight crew is flown unintentionally into terrain, obstacles or water, usually with no prior awareness by the crew. This type of accident can occur during most phases of flight, but CFIT is more common during the approach-and-landing phase, which begins when an airworthy aircraft under the control of the flight crew descends below 5,000 feet above ground level (AGL) with the intention to conduct an approach and ends when the landing is complete or the flight crew flies the aircraft above 5,000 feet AGL en route to another airport.

4. NBAA.

5. Ibid.

6. U.S. National Transportation Safety Board (NTSB). *Public Aircraft Safety*. Safety Study NTSB/SS-01-01, Oct. 23, 2001.

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9. NASA ASRS report no. 402856. May 1998.

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22. Ibid.

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Capt. Randy Phillips (United Air Lines, retired), Capt. Robert Sumwalt (US Airways; chairman, Air Line Pilots Association, International Human Factors Committee) and Lt. Col. Stephen E. Wood (U.S. Air Force Reserve) contributed to the research for this report.

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Appendix
Business Jet Accidents, 1991–2002

Date	Location	Airplane Type	Airplane Damage	Injuries
Feb. 13, 1991	Aspen, Colorado, U.S.	Learjet 35A	destroyed	3 fatal
During a VOR/DME (very-high-frequency omnidirectional radio/distance-measuring equipment) approach to Runway 15, the airplane was observed in a steep turn below clouds west of the airport. The airplane struck terrain about one nautical mile (two kilometers) north of the airport. The accident occurred at sunset (1744 local time) during completion of a flight from Las Vegas, Nevada. Weather was reported as visibility seven statute miles (11 kilometers) in moderate snow showers with an overcast 1,000 feet above ground level (AGL).				
Feb. 14, 1991	Cleveland, Ohio, U.S.	Gulfstream II	substantial	3 none
The pilot conducted an ILS (instrument landing system) approach to Burke Lakefront Airport's Runway 24R. Braking action on the snow-covered runway was reported as poor, and the wind was from 350 degrees at 18 knots. On touchdown, the pilot used reverse thrust and full wheel braking, but the airplane did not decelerate sufficiently. The pilot saw the end of the runway nearing, steered off the left side of the runway and intentionally ground-looped the airplane. The main landing gear collapsed.				
Feb. 18, 1991	Eagle, Colorado, U.S.	Dassault Falcon 900	substantial	7 none
The airplane was being flown through 11,500 feet during climb when the flight crew heard an explosion. The cockpit instruments indicated that the left engine had failed. The crew secured the engine, returned to Eagle County Airport and landed without further incident. An engine examination revealed that assembly of the inner transition liner to the high-pressure turbine nozzle had been performed improperly during the last major inspection.				
March 16, 1991	San Diego, California, U.S.	Hawker Siddeley HS-125-1A	destroyed	10 fatal
The crew did not have the chart of the airport's departure procedure and asked a flight service specialist to read the procedure over the telephone. The pilot planned to depart under visual flight rules (VFR) and obtain an instrument flight rules (IFR) clearance from air traffic control (ATC). The Hawker departed after midnight and was flown northeast, toward rising terrain, while the crew attempted to obtain an IFR clearance. The airplane struck rising terrain about eight nautical miles (15 kilometers) northeast of the airport at an elevation of about 3,300 feet.				
May 1, 1991	Oxford, Connecticut, U.S.	Israel Aircraft Industries 1124A	substantial	9 none
The crew completed an instrument approach and landed hard, first on the left-main landing gear and then on the right-main landing gear. The tires burst, and the lower fuselage struck the runway. After the nose landing gear touched down, the right-main landing collapsed, and a loss of airplane control occurred. The airplane veered left and came to rest approximately 600 feet (183 meters) from the runway.				
May 4, 1991	Rio de Janeiro, Brazil	Cessna Citation 500	substantial	7 none
The airplane was about halfway down Runway 20 at Jacarepagua Airport when the pilot rejected the takeoff. The airplane overran the runway, and the left-main landing gear separated.				
May 21, 1991	Ashaka, Nigeria	Cessna Citation 550	destroyed	3 fatal
The airplane struck terrain beyond the end of the runway during an attempted go-around with the flaps extended. The accident reportedly occurred in adverse weather conditions.				
June 17, 1991	Caracas, Venezuela	Gulfstream IIA	destroyed	4 fatal
The airplane struck a hill at the 3,000-foot level while descending at night to land at Oscar Machado Luzoaga Airport. The accident site was on the extended runway centerline, about 5.5 nautical miles (10.2 kilometers) from the threshold.				
July 1, 1991	Columbus, Ohio, U.S.	Learjet 25B	substantial	2 none
As the airplane was being flared for landing in a rain shower, the wind caused the airplane to drift right. The pilot attempted to correct the drift but lost visual reference with the runway. The airplane departed the left side of the runway onto soft terrain.				
July 2, 1991	Columbia, Tennessee, U.S.	Learjet 23	substantial	2 none
The pilot computed the landing performance for a landing on a wet runway with anti-skid wheel braking and concluded that sufficient runway was available. During the landing, the airplane began to oscillate longitudinally, and the pilot believed that the anti-skid braking system had failed. The pilot disengaged the anti-skid braking system and continued the landing. The airplane overran the departure end of the runway. Performance data indicated that the available runway length was not adequate for landing without anti-skid braking.				
July 22, 1991	Detroit, Michigan, U.S.	Learjet 23	destroyed	3 fatal
A witness said that the airplane was rotated for takeoff about 4,500 feet (1,373 meters) down the 5,147-foot (1,570-meter) runway and lifted off after traveling about 50 feet (15 meters). The Learjet remained low and slow after takeoff, then banked left and right in a nose-high attitude, settled and struck terrain about 200 feet (61 meters) beyond the runway.				
Sept. 4, 1991	Kota Kinabalu, Sabah, Malaysia	Gulfstream II	destroyed	12 fatal
The airplane struck Mount Marata while being positioned for an ILS approach to Runway 02. The point of impact was at the 4,000-foot level, 30 nautical miles (56 kilometers) south of the airport. The accident occurred during daylight, but the mountains were shrouded in clouds. About one minute before impact, the crew leveled the airplane at 2,500 feet, then began a climbing turn back toward the VOR.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Dec. 11, 1991	Rome, Georgia, U.S.	Beechjet 400	destroyed	9 fatal
After a VFR takeoff at 0937 local time, the captain requested an IFR clearance from ATC. The controller said that there was traffic in the area and told the crew to maintain VFR. While waiting for an IFR clearance, the crew became concerned about higher terrain and low ceilings. About 0940, the captain told the copilot to fly "back to the right." About one minute later, the cockpit voice recorder (CVR) stopped recording. The airplane struck terrain at about 1,580 feet.				
Dec. 23, 1991	Carlsbad, California, U.S.	Learjet 25B	substantial	3 none
Witnesses said that the airplane was "high and fast" on final approach and touched down about midfield on the 4,700-foot (1,434-meter) runway. The pilot said that he applied the wheel brakes but could not stop the airplane on the runway.				
June 12, 1992	Sheboygan Falls, Wisconsin, U.S.	Learjet 25B	destroyed	2 fatal
The captain occupied the right seat for the positioning flight. The airplane lifted off prematurely and remained in ground effect. The roll attitude oscillated slightly before the airplane rapidly rolled inverted and struck the ground.				
June 17, 1992	Cedar Rapids, Iowa, U.S.	North American Sabreliner 50	substantial	4 none
The crew completed an ILS approach to Runway 27 and requested, and received, clearance to circle to land on Runway 13. The wind was from 250 degrees at 21 knots. The crew was unable to stop the airplane on the runway. The nose landing gear collapsed when the airplane struck an elevated service road.				
Sept. 24, 1992	Hutchinson, Kansas, U.S.	Learjet 60	substantial	4 none
The crew was conducting a test flight that involved an intentional induced autopilot malfunction 80 feet above the runway. The crew was required to delay two seconds before recovery. The airplane landed hard during the attempted recovery.				
Nov. 6, 1992	Nashville, Tennessee, U.S.	Hawker Siddeley HS-125	substantial	5 none
The flight crew heard a crunch and observed a nose-gear-unsafe light. After several unsuccessful attempts to lower the landing gear, they elected to land the airplane with the nose landing gear partially extended. Subsequent investigation revealed that a mechanic had inadvertently left a flashlight in the upper section of the nose-gear well.				
Nov. 7, 1992	Phoenix, Arizona, U.S.	North American Sabreliner 60	substantial	8 none
During landing, the captain used aerodynamic braking and the thrust reversers to slow the airplane to about 60 knots. With about 4,000 feet (1,220 meters) of runway remaining, the captain applied the wheel brakes. No braking action was observed. Emergency braking procedures were not used. The airplane continued off the end of the runway, through a fence and a block wall.				
Nov. 22, 1992	Cleveland, Ohio, U.S.	Learjet 25B	substantial	5 none
The crew conducted an ILS approach with a tail wind and in heavy rain. The report said that the pilot added power to cushion the landing touchdown. Witnesses said that the airplane touched down with about 2,800 feet (854 meters) of runway remaining. The last 2,000 feet (610 meters) of the runway had a 0.85 percent downslope gradient. The airplane went off the end of the runway and collided with the localizer antenna.				
Nov. 27, 1992	Southampton, Hampshire, U.K.	Lockheed 1329	substantial	7 none
During the final segment of an ILS approach, the airplane encountered wind shear and the pilot increased power to compensate for a 10-knot loss of airspeed. During the landing roll, maximum wheel braking was used but was not effective; the crew perceived that the airplane was hydroplaning on the wet, 5,265-foot (1,606-meter) runway. Reverse thrust was engaged, but the crew received no indication that the thrust reversers had deployed correctly. The airplane ran off the end of the runway.				
Dec. 10, 1992	Quito, Ecuador	Rockwell Sabreliner 75A	destroyed	10 fatal
The crew made no further radio transmissions after acknowledging an ATC instruction to report overflying the ILS middle marker. The airplane was flown into high ground at about 9,850 feet, about 3,281 feet (1,001 meters) right of the extended runway centerline and about two nautical miles (four kilometers) from the threshold. The accident occurred during nighttime instrument meteorological conditions (IMC).				
Dec. 18, 1992	McCall, Idaho, U.S.	Dassault Falcon 10	substantial	2 serious, 2 minor
During takeoff on a contaminated runway, the copilot perceived a lack of acceleration. Just beyond midfield, the copilot called for a rejected takeoff. Nevertheless, the pilot elected to continue the takeoff. The airplane did not reach rotation speed, and the pilot attempted to rotate the airplane at the end of the runway. The airplane struck a snow bank. The report said that the parking brake was set in an intermediate position and that the parking-brake warning light had been dimmed.				
Dec. 18, 1992	Billings, Montana, U.S.	Cessna Citation 550	destroyed	8 fatal
The Citation was sequenced by ATC behind a Boeing 757, and the crews of both airplanes were cleared to conduct visual approaches. About 1.5 nautical miles (2.8 kilometers) from the runway, the Citation rolled rapidly to an inverted attitude and descended almost vertically into the ground. When the upset occurred, vertical separation between the airplanes was 600 feet to 1,000 feet (183 meters to 305 meters) and horizontal separation was decreasing below 2.6 nautical miles (4.8 kilometers).				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Jan. 8, 1993	Hermosillo, Mexico	Learjet 35	destroyed	9 fatalities
On arrival at Hermosillo, the crew reported at 9,000 feet and 25 nautical miles (46 kilometers) from the VOR. ATC cleared the crew to descend and to conduct the VOR/DME approach to Runway 23. A few minutes later, the crew reported turning inbound on final approach, 10 nautical miles (three kilometers) from the VOR. The airplane was on the extended runway centerline when it struck terrain at 1,200 feet about 6.5 nautical miles (12 kilometers) from the airport. The accident occurred in daylight IMC.				
March 17, 1993	Teterboro, New Jersey, U.S.	Learjet 35	substantial	5 none
Snow was falling when the crew conducted an ILS approach. ATC told the crew, "Last braking action [reported] fair by a Westwind about 20 minutes ago." The Learjet touched down in the runway touchdown zone. The crew engaged spoilers, thrust reversers and wheel brakes. The airplane drifted right and struck a snow bank. The left-main landing gear collapsed. The pilot said that the runway was covered with two inches to three inches (five centimeters to seven centimeters) of wet snow and that braking action was nil.				
May 26, 1993	Southampton, Eastleigh, U.K.	Cessna Citation 550	destroyed	5 minor
The crew was conducting a positioning flight from Oxford to Southampton. The commander landed with a reported tail wind of 15 knots. The airplane's tail wind limit was 10 knots. The airplane overran the wet runway and struck two vehicles on a highway.				
Aug. 26, 1993	Hailey, Idaho, U.S.	Dassault Falcon10	substantial	2 none
When the pilot selected the thrust reversers on landing, the reversers-in-transition annunciator light and the reversers-deployed annunciator light did not illuminate. Although the airplane flight manual warns against moving the reverser throttle levers into the power range without the illumination of the lights, the pilot did so, and forward thrust increased. The copilot moved the parking brake lever to full override, locking the main wheel brakes and overriding the anti-skid wheel braking system. The airplane skidded off the end of the runway.				
Sept. 5, 1993	Pecos, New Mexico, U.S.	Learjet 25D	destroyed	7 fatal
While descending to the destination, the pilot canceled the IFR clearance and declined VFR flight-following service. Witnesses observed the airplane being maneuvered at low altitude before it struck terrain. The report said that toxicological tests of tissue samples from the pilot and two passengers were positive for cocaine and alcohol.				
Sept. 30, 1993	Besançon, France	Dassault Falcon 10	destroyed	2 fatal
The airplane was slow to accelerate, and the pilot rejected the takeoff. The airplane could not be brought to a stop on the remaining runway. The airplane struck an embankment. The report said that the parking brake was engaged.				
Dec. 1, 1993	Tampa, Florida, U.S.	Cessna Citation 650	substantial	4 none
The pilot said that while exiting the runway onto a taxiway, the airplane began to turn into the wind. Nosewheel steering was engaged with negative results. Full power was applied to the thrust reversers. The airplane departed the taxiway and came to a stop on grass. The pilot then taxied forward, and the nosewheel struck a cement pad and collapsed. The report said that the left-main landing gear assembly anti-skid transducers were crossed, resulting in a malfunction of the anti-skid wheel braking system.				
Dec. 3, 1993	West Chicago, Illinois, U.S.	Cessna Citation 550	substantial	2 none
Weather conditions included a 200-foot overcast and 0.5 statute mile (0.8 kilometer) visibility in fog. The crew said that the airplane was about 200 feet above the ground after takeoff when it struck a flock of geese. They heard a loud bang, and the airplane yawed left and right. Instruments indicated a loss of right-engine power and a substantial fuel leak from the left wing. The crew declared an emergency and received radar vectors to Midway Airport, where the airplane was landed without further incident.				
Dec. 15, 1993	Goodland, Kansas, U.S.	Mitsubishi MU-300	destroyed	3 fatal
The airplane struck terrain in daylight IMC about one nautical mile (two kilometers) east of the outer marker soon after the crew was cleared to conduct an ILS approach. The CVR recording indicated that an overspeed condition occurred during the initial descent and that the airplane was flown through the localizer course. While the crew re-established the airplane on the localizer, airspeed decreased to the point where the stick-shaker stall-warning system activated. The stall warning continued until the airplane departed controlled flight and struck the ground.				
Dec. 15, 1993	Santa Ana, California, U.S.	Israel Aircraft Industries 1124A	destroyed	5 fatal
The crew of a Boeing 757 and the crew of the Westwind were vectored for landing on Runway 19R. Both crews were told to slow to 150 knots. The B-757 crew slowed below 150 knots, and the airplane was high on final approach and was being flown on a 5.6-degree glide path. The Westwind was flown on a three-degree glide path to about 2.1 nautical miles (3.9 kilometers) behind the B-757. ATC did not specifically advise the Westwind pilots that they were following a B-757. The Westwind captain discussed possible wake turbulence with the first officer and flew the ILS approach one dot high. While descending through approximately 1,100 feet, the Westwind encountered wake turbulence, rolled and descended steeply to the ground.				
Dec. 19, 1993	Melbourne, Florida, U.S.	Israel Aircraft Industries 1124	substantial	9 none
The crew conducted an uneventful landing after an uncontained failure of the no. 2 engine occurred in cruise flight. Examination of the failed engine indicated separation of a small segment near the rim of the second-stage low-pressure-turbine disk. Metallurgical examination indicated that the separation resulted from a machining anomaly and from inadequate heat treatment.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Jan. 20, 1994	Teterboro, New Jersey, U.S.	Mitsubishi MU-300	substantial	5 none
The airplane was landed on a runway that a NOTAM (notice to airmen) indicated was covered with 0.5 inch (1.3 centimeters) of snow and ice, with poor braking action reported. This information was disseminated by the automatic terminal information service (ATIS) and by ATC. The pilot said that braking action was poor as the airplane slowed from 80 knots to 40 knots and then became nil. Near the end of the runway, the pilot steered the airplane off the runway to avoid colliding with the approach lights. The nose landing gear collapsed when the airplane struck a snow bank.				
Jan. 24, 1994	Key Largo, Florida, U.S.	Learjet 35A	substantial	2 none
The airplane was landed short of the runway. The pilots said that the airplane sank rapidly in soft coral, and the nose landing gear collapsed.				
Jan. 27, 1994	Meadow Lake, Saskatchewan, Canada	Israel Aircraft Industries 1124A	destroyed	2 fatal
As the crew was circling the airplane to land on Runway 26, the airplane was observed to enter steeply banked rolling maneuvers at a lower-than-published circling altitude, leading to loss of control consistent with an accelerated stall. The airplane descended and struck the ground in a nose-high and slightly right-wing-low attitude. The report said that whiteout conditions may have contributed to the accident. Whiteout is a visibility-restricting phenomenon that occurs when a layer of cloudiness of uniform thickness overlies a snow-covered or ice-covered surface. Parallel rays of the sun are broken up and diffused when passing through the cloud layer so that they strike the snow surface from many angles. The diffused light then reflects back and forth countless times between the snow and the cloud, eliminating all shadows. The result is a loss of depth perception.				
Feb. 24, 1994	Cleveland, Ohio, U.S.	Beechjet 400	substantial	6 none
During approach, the copilot attempted unsuccessfully to activate the runway lights by keying his microphone. The crew said that they continued the approach and had the visual approach slope indicator (VASI) lights in sight. The report said that the runway did not have a VASI. About one minute before touchdown, the copilot told the pilot that he did not know where the runway was but that the pilot should continue the approach. About 45 seconds before touchdown, the pilot said that he had the runway in sight. The copilot said that he, too, had the runway in sight. The airplane struck terrain between the runway and a taxiway. Investigators found that none of the communication radios was tuned to the correct frequency to activate the pilot-controlled runway lights.				
March 17, 1994	Detroit, Michigan, U.S.	Dassault Falcon 900	substantial	9 none
After retracting the landing gear on takeoff from Washington (D.C.) National Airport, the flight crew heard a loud air noise coming from the nose landing gear area. They continued to their destination, Detroit Metropolitan Airport. The nose gear did not extend, and the crew landed the airplane with the nose gear retracted. The report said that when the nose gear was retracted on takeoff, the gear-door hooks did not contact the gear-door rollers on the lower nose gear strut. The nose-gear-strut pressure was found to be inadequate.				
April 4, 1994	Seville, Spain	Learjet 55	substantial	10 none
The crew turned back to the airport when electrical problems and hydraulic problems occurred seven minutes after takeoff. The crew declared an emergency, and ATC controllers observed fire at the left side of the airplane. The crew did not have the use of the flaps, spoilers or wheel brakes on landing. The airplane departed the runway at high speed, and the landing gear collapsed.				
April 6, 1994	Kigali, Rwanda	Dassault Falcon 50	destroyed	12 fatal
The airplane apparently was struck by ground fire during final approach. The president of Rwanda and the president of Burundi were aboard the airplane.				
May 30, 1994	Waukegan, Illinois, U.S.	Hawker Siddeley 125-3A	substantial	2 none
The airplane's sink rate increased during short final approach. The copilot (the pilot flying) applied elevator back pressure and nose-up trim, but the sink rate continued to increase. Through the combined efforts of both pilots, pitch was increased enough that the airplane touched down first on the main landing gear. The touchdown was hard. The report said that a trip-manifest container had lodged between the copilot's control column and seat frame.				
June 18, 1994	Chantilly, Virginia, U.S.	Learjet 25D	destroyed	12 fatal
The captain rejected two ILS approaches that were not stabilized. During the third ILS approach in IMC, the pilot descended the airplane below the published decision height without having visual contact with the runway environment. The airplane struck terrain 0.8 nautical mile (1.5 kilometers) from the runway. The report said that the accident might have been prevented if the airplane was equipped with a ground-proximity warning system (GPWS).				
July 13, 1994	Atlantic City, New Jersey, U.S.	Learjet 35	substantial	10 none
The airplane veered left before reaching V_1 (takeoff decision speed), and the pilot had difficulty maintaining directional control. He rejected the takeoff but could not stop the airplane on the remaining runway. The airplane struck a concrete barrier. The report said that the outer tire on the left-main landing gear ruptured during the takeoff roll; the left inner tire and both right tires then ruptured. There were signs that the tires were underinflated and had overheated.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Aug. 26, 1994	New Orleans, Louisiana, U.S.	Dassault Falcon 200	substantial	7 none
One second after calling out rotation speed (125 knots) on takeoff, the first officer observed a fluctuation on the right engine N_1 (fan speed) gauge and a warning light for the right engine. The first officer told the captain about the indications. The captain rejected the takeoff about six seconds later. The airplane accelerated through 136 knots before deceleration began. The airplane ran off the end of the runway. The report said that the crew did not apply maximum wheel braking during the rejected takeoff. The cause of the fluctuating gauge reading was not determined.				
Sept. 8, 1994	Reno, Nevada, U.S.	Hawker Siddeley HS-125-700A	substantial	4 none
The captain said that the airplane was near V_1 when he heard a loud bang and felt a vibration in the airframe. The captain rejected the takeoff. A second loud bang was heard as the airplane was stopped on a taxiway. The report said that both right-main landing gear tires had ruptured during the takeoff roll and that the fuselage fuel tank had been punctured by debris from the tires.				
Oct. 10, 1994	San Antonio, Texas, U.S.	Learjet 35A	substantial	2 none
During climb through Flight Level (FL) 200 (approximately 20,000 feet), the crew heard a noise that was followed by a loss of power from the right engine. They secured the right engine and continued to the destination. The report said that an uncontained failure of the right engine's no. 3 turbine wheel had occurred and that hydraulic lines in the equipment bay had been severed. During the landing roll, the crew exited on a taxiway but did not have sufficient control to stay on the taxiway.				
Oct. 14, 1994	Holland, Michigan, U.S.	Learjet 23	substantial	2 none
The airplane was landed short of the runway with a 10-degree to 15-degree right yaw. The crew heard a cracking sound, and the airplane veered left. The captain took control of the airplane and rejected the landing. A subsequent fly-by disclosed that the left-main landing gear was damaged and that the left wing-tip fuel tank was leaking. During the landing, the left-main landing gear collapsed.				
Dec. 6, 1994	Caracas, Venezuela	Israel Aircraft Industries 1123	substantial	2 none
The airplane ran off the left side of the runway while landing during a maintenance test flight in visual meteorological conditions (VMC). The crew said that the left wheel brake had failed and that they could not maintain directional control of the airplane.				
Dec. 14, 1994	Fresno, California, U.S.	Learjet 35A	destroyed	2 fatal, 1 serious, 20 minor
During arrival, the flight crew declared an emergency because of engine-fire indications. They flew the airplane toward a right base, but the airplane was observed flying past the airport. The flight crew was heard on tower frequency attempting to diagnose the emergency conditions and control the airplane. The airplane struck a street; the two pilots were killed, and 21 people on the ground were injured. Investigation revealed that special-mission wiring was not installed properly, resulting in a lack of overload current protection. The in-flight fire most likely originated from a short of the special-mission power-supply wires in an area that was not protected by current limiters. The fire resulted in false engine-fire-warning indications that prompted the pilots to shut down the left engine.				
Dec. 21, 1994	Buenos Aires, Argentina	North American Sabreliner 40	substantial	2 none
About 0422 local time in VMC, the cargo airplane overran the runway during a rejected takeoff. The report said that the airplane's maximum takeoff weight was exceeded and that the airplane was unable to accelerate to takeoff speed.				
Jan. 5, 1995	Isfahan, Iran	Lockheed 1329	destroyed	12 fatal
Soon after takeoff, as the airplane was being flown through about 2,000 feet, the pilot reported a problem with the cabin-pressurization system and requested clearance to return to the Shahid Babaei air force base. The airplane then struck terrain and was destroyed by fire.				
Jan. 9, 1995	Stuttgart, Germany	Cessna Citation 501	substantial	1 none
The airplane operator said that a bolt in the left-main landing-gear actuator broke, causing the gear to collapse on landing.				
Jan. 11, 1995	Newton, Iowa, U.S.	Cessna Citation 550	substantial	6 none
During an ILS approach, the airplane was flown right of the extended runway centerline. The pilot flying maneuvered the airplane to align it with the centerline. The left-main landing gear touched down off the left side of the runway in a snow bank, and the airplane exited the runway.				
Jan. 11, 1995	Masset, British Columbia, Canada	Learjet 35	destroyed	5 fatal
During an emergency medical services flight, the crew was conducting an instrument approach when the airplane struck the ocean eight nautical miles (15 kilometers) from the airport. The report said that the crew likely conducted the approach with reference to an incorrectly set altimeter.				
Feb. 15, 1995	Wauchula, Florida, U.S.	Cessna Citation 525	substantial	3 none
The pilot said that he flew the airplane at a faster-than-normal speed on final approach. The airplane touched down 2,304 feet (703 meters) from the approach end of the runway, which was 4,000 feet (1,220 meters) long, and ran off the end of the runway.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Feb. 21, 1995	Denver, Colorado, U.S.	Israel Aircraft Industries 1124	substantial	2 none
While conducting a preflight inspection of the airplane, the first officer opened the main oxygen supply valve in the cockpit and heard a loud hiss. The cockpit then was engulfed in flames, but the first officer exited the airplane uninjured. A laboratory analysis disclosed the presence of oil in a deposit on the interior of the oxygen cylinder.				
March 1, 1995	Hinton, Alberta, Canada	Mitsubishi MU-300	destroyed	4 none
After a straight-in, visual approach in daylight VMC, the airplane touched down about 1,000 feet (305 meters) beyond the displaced threshold of the runway and then bounced. The airplane touched down again but could not be brought to a stop on the runway. During the overrun, the airplane slewed sideways, causing the nose landing gear and left-main landing gear to collapse. The report said that the airplane was landed with a 12-knot tail wind. Prior to landing, the pilot received a report of calm wind conditions at a local airport and apparently believed that the destination airport also had calm winds.				
March 3, 1995	Gillette, Wyoming, U.S.	Israel Aircraft Industries 1124A	substantial	1 minor, 9 none
The airplane accumulated ice during the dark nighttime approach. The runway was covered with snow, and braking conditions were reported as fair to poor. After establishing the airplane on the glideslope, the captain called for landing gear extension but was advised by the first officer that airspeed was too high. The captain then extended the spoilers. The gear was extended before touchdown. The first officer conducted the "Before Landing" checklist silently, and neither pilot observed the annunciator light advising that the spoilers were still extended. The airplane touched down short of the runway, and the left-main landing gear separated.				
April 7, 1995	Santo Domingo, Dominican Republic	Hawker Siddeley HS-125	substantial	6 none
A pilot-rated passenger said that the airplane was about 25 feet to 50 feet (eight meters to 15 meters) above the runway when the pilot retarded the throttles. The airplane descended and landed hard.				
April 17, 1995	Alexander City, Alabama, U.S.	Learjet 35A	destroyed	8 fatal
En route to San Antonio, Texas, the pilot reported fuel balance problems and told ATC that he was diverting to Maxwell Air Force Base, Alabama. The pilot subsequently attempted to land at the Alexander City airport, which is about 35 nautical miles (65 kilometers) from Maxwell. Soon after ATC cleared the crew to conduct a visual approach, the airplane struck the ground about four nautical miles (seven kilometers) from the airport.				
April 24, 1995	San Salvador, El Salvador	Cessna 501 Citation	substantial	2 none
About 1630 local time during a visual approach in VMC, the copilot told the pilot that their altimeter indications were different. The power levers were in the idle position. Both crewmembers were looking inside the airplane when they felt a vibration. The pilot advanced the power levers, but the airplane stalled and struck trees about 2,500 feet (763 meters) from the runway and came to rest on an airport perimeter road.				
April 26, 1995	Walker's Cay, Bahamas	Cessna Citation 550	substantial	5 minor
During a daylight VMC approach, the airplane was landed short of the 2,500-foot (763-meter) runway. The right wing separated, and the airplane caught fire and slid about 300 feet (92 meters) before coming to a stop.				
April 27, 1995	Alice Springs, Northern Territory, Australia	Israel Aircraft Industries 1124	destroyed	2 fatal
The crew was conducting a practice nondirectional beacon (NDB) approach in clear, moonless nighttime conditions. The approach involved a stepped descent in three segments using three navigational aids. The pilot had briefed the copilot that they would descend no lower than 2,780 feet, the minimum altitude after flying over the final approach fix (FAF). After flying over the FAF, the pilot told the copilot to set the "minima" in the altitude alerter. The copilot said, "Setting 2,300 feet." This altitude was the published minimum descent altitude (MDA) for Category A airplanes and for Category B airplanes. The MDA for the Westwind, which is a Category C airplane, was 3,100 feet. Soon after the airplane was leveled at about 2,250 feet, it struck the top of a ridge. The report said that the crew had descended to the incorrect MDA before reaching the appropriate segment of the approach.				
May 6, 1995	Soto Cano, Honduras	Cessna Citation 550	substantial	3 none
During a daytime departure, the airplane struck an arresting cable at the departure end of the runway. The pilot said that airspeed was 70 knots when he saw the cable but that the airplane was too close to the cable to reject the takeoff. The pilot said that he had forgotten that the cable was on the runway.				
May 23, 1995	Rogers, Arkansas, U.S.	Learjet 35A	substantial	7 none
The right-outboard tire failed when the airplane was within 15 knots of V_1 during takeoff from a 6,011-foot (1,833-meter) runway. The pilot felt a vibration and heard a loud noise. The crew rejected the takeoff by closing the throttles, deploying the thrust reversers and applying full wheel braking. The airplane overran the departure end of the runway. The main landing gear collapsed after the airplane crossed a shallow drainage ditch.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
July 24, 1995	Englewood, Colorado, U.S.	Gulfstream V	substantial	9 none
During the landing roll, the left-main landing gear strut disconnected and the strut penetrated the landing gear fairing box.				
July 26, 1995	Minneapolis, Minnesota, U.S.	Cessna Citation 550	substantial	3 none
During the landing roll, the pilot deployed the thrust reversers and applied the wheel brakes, but the brakes had no effect. A mechanic, who was seated in the right front seat, applied his wheel-brake controls, but they had no effect. The airplane veered off the left side of the runway. The pilot said that he did not operate the emergency braking system, as recommended by the emergency procedure.				
Sept. 5, 1995	Lagos, Nigeria	Dassault Falcon 20	substantial	11 none
On arrival, the crew did not observe an indication that the left-main landing gear was down and locked. Further attempts were made to get the landing gear to extend properly, but there was no indication that the left-main landing was down and locked. During the landing roll, the left-main landing collapsed. The airplane veered off the runway onto soft ground, where the right-main landing collapsed.				
Oct. 12, 1995	Cleveland, Ohio, U.S.	Gulfstream II	substantial	9 none
The airplane struck construction barricades during landing. The pilot said that he was in the right seat during the approach and that the copilot, the pilot flying, was in the left seat. Both pilots said that they had ATIS information and NOTAM information about construction on the runway and about runway-use restrictions. They said that the sun was shining in their eyes and they did not see the construction barricades during the approach.				
Dec. 30, 1995	Eagle River, Wisconsin, U.S.	Cessna Citation 560	destroyed	2 fatal
The crew was circling to land after conducting a VOR/DME approach in IMC and icing conditions. The report said that the pilot failed to maintain airspeed. The airplane struck the ground about 0.25 nautical mile (0.46 kilometer) from the runway threshold. The wreckage path covered a distance of approximately 350 feet (107 meters). The leading edges of the left wing and horizontal stabilizer had accumulated approximately 0.125 inch (0.328 centimeter) of rime ice. Two witnesses said that they observed the airplane rolling left and right before impact.				
Dec. 31, 1995	East Naples, Florida, U.S.	Cessna Citation 550	destroyed	2 fatal
The crew was cleared to conduct the VOR/DME approach to Runway 17 at Marco Island Airport. The CVR recorded conversation between the pilots about the straight-in approach procedure but not about the circling-approach procedure or the missed approach procedure. The crew radioed that they were landing on Runway 35. During descent, about 587 feet AGL, the airplane struck an antenna support wire that severed about 8.5 feet (2.6 meters) of the left wing. The antenna, which is depicted on the approach chart, was 3.36 nautical miles (6.22 kilometers) from the threshold of Runway 17. The airplane rolled left, rolled right, pitched nose-down and struck the ground.				
Jan. 3, 1996	Ontario, Canada	Learjet 35A	substantial	4 none
The airplane struck a snow bank during a rejected takeoff at Oro–Barrie–Orillia Airport. The aircraft operator said that the captain allowed the first officer to occupy the left seat as pilot flying for a positioning flight. At about 100 knots, the airplane began to drift left of centerline. The captain, believing that the first officer was touching the wheel brakes, told him to "get off the brakes." The first officer told the captain that he was not applying the brakes. The captain took control and rejected the takeoff. The left-main landing gear struck snow and ice on the left side of the runway, and the airplane turned and slid sideways. The right-wing-tip fuel tank struck a snow bank and ruptured. Fuel was sprayed onto the airplane, and a flash fire burned until the airplane came to a stop.				
Jan. 6, 1996	Aspen, Colorado, U.S.	Learjet 60	substantial	2 none
The captain said that he aligned the airplane with what he thought was the runway centerline. The airplane touched down in a snow field 1,000 feet (305 meters) from the runway threshold and 25 feet (eight meters) right of the extended runway centerline. The nose landing gear collapsed, and the airplane skidded onto the runway. The captain said that he was unable to positively identify the runway environment because of the blending of the snow-covered runway with the surrounding snow-covered terrain. The runway had been plowed and swept. The runway lights were covered with plowed snow and were not visible or operating.				
Jan. 11, 1996	Los Mochis, Mexico	British Aerospace Hawker	substantial	5 none
The right wing struck the runway during touchdown in daylight IMC.				
Jan. 12, 1996	Gosselies, Belgium	Dassault Falcon 20	substantial	6 none
The airplane was landed with the landing gear retracted after the crew encountered hydraulic system problems.				
Jan. 17, 1996	Kano, Nigeria	British Aerospace Hawker 125	destroyed	14 fatal
The airplane was landed in open fields about 4.5 nautical miles (8.3 kilometers) from the runway threshold in nighttime VMC.				
Jan. 22, 1996	Greensboro, North Carolina, U.S.	Cessna Citation 550	substantial	2 none
During final approach to the Charlotte (North Carolina) airport, the crew observed no indication that the landing gear had extended. The pilot flew the airplane near the control tower, and ATC confirmed that the landing gear did not appear to be down. The pilot diverted to Greensboro and landed with the gear retracted. The report said that the hydraulic-valve-open center-bypass cannon plug was loose and was not functioning, and that the emergency gear-release system was not rigged correctly, which would have prevented the uplock hooks from releasing.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Jan. 24, 1996	Romulus, Michigan, U.S.	Dassault Falcon 10	substantial	8 none
The pilot observed an unsafe indication for the right-main landing gear when the landing gear was extended. The crew recycled the landing gear and observed the same unsafe indication. The crew retracted the gear and diverted to Detroit Metropolitan Airport. On arrival, the crew performed the "Landing Gear Abnormal Extension" checklist, but the unsafe indication remained. ATC told the crew that the landing gear appeared normal. During the landing, the right-main landing gear retracted. Examination of the right landing gear actuator revealed that one of the six shims that separate the spacers and help guide the safety-lock switch was out of position and lying on top of the lock assembly.				
Jan. 25, 1996	Louisville, Kentucky, U.S.	Learjet 35A	substantial	2 none
During the takeoff roll, at about V_1, the pilot heard a loud bang, and the airplane began to veer left. The pilot was unable to regain directional control, and the airplane departed the left side of the runway. The report said that the bang was caused by one of the main landing gear tires failing.				
Feb. 6, 1996	Ensenada, Mexico	Cessna Citation 550	destroyed	8 fatal
The airplane was flown into a hillside during an approach in darkness and fog. The report said that the pilot might have been conducting an unapproved nonprecision approach with the aid of a signal from a local radio station.				
March 31, 1996	Salt Lake City, Utah, U.S.	Cessna Citation 500	substantial	7 none
The pilot said that during the takeoff roll, a loud boom was heard and the right engine lost power. The pilot rejected the takeoff. He said that as the airplane was being taxied off the runway onto a taxiway, the right engine "blew." The pilot then taxied the airplane to the ramp. After the airplane was secured, the pilot found indications of an uncontained engine failure. Debris from the engine had punctured the side of the pressure vessel and damaged the wing. Further inspection revealed that the engine impeller had broken into two large pieces. A metallurgical examination of the impeller determined that a fatigue crack had originated from a groove produced during machining of the impeller.				
April 1, 1996	Raleigh–Durham, North Carolina, U.S.	Canadair Challenger	substantial	10 none
During an ILS approach in daylight IMC, the pilot observed a discrepancy in the landing gear indications. He retracted the landing gear and extended it again. The landing gear position-indicator lights indicated that the main landing gear was extended and locked, but that the nose gear was not extended and locked. The light in the gear handle was off, indicating that the system was functioning properly. The pilot did not use the emergency landing gear extension system. The airplane was landed, and the nose landing gear collapsed. Subsequent examination revealed an intermittently operating extend solenoid in the nose-gear-selector valve.				
April 24, 1996	Davao, Philippines	Dassault Falcon 20	destroyed	8 none
On takeoff, the airplane climbed about 80 feet before descending and touching down on the runway. The airplane subsequently overran the runway.				
May 1, 1996	Albuquerque, New Mexico, U.S.	Rockwell Sabreliner 80	substantial	5 none
The captain conducted a takeoff on Runway 21 with the wind from 330 degrees at six knots. After the airplane had accelerated to about 120 knots and had traversed about half the 10,000-foot (3,050-meter) runway, the captain rejected the takeoff when he heard a loud noise and felt a severe vibration. Subsequently, the airplane overran the runway onto soft terrain, and the nose landing gear collapsed. The report said that the left-outboard tire failed in fatigue, followed by the left-inboard tire "as the result of operation in an overdeflected condition. … Overdeflection is caused by operating the tire overloaded or underinflated."				
May 30, 1996	Toluca, Mexico	Learjet 24	substantial	5 none
On takeoff, the tires on the airplane's left-main landing gear apparently failed. After lift-off, the pilot elected to return for a landing. During the landing roll, the airplane veered off the left side of the runway.				
June 20, 1996	Kafa, Jos, Nigeria	Gulfstream II	destroyed	12 fatal
The airplane reportedly struck a radio-transmission mast during an approach.				
Aug. 3, 1996	Vagar, Faroe Islands, Denmark	Gulfstream II	destroyed	9 fatal
The airplane reportedly was flown into a hillside during final approach in daylight IMC.				
Aug. 8, 1996	Offenburg, Germany	Dassault Falcon 10	destroyed	4 fatal
The airplane reportedly was flown into rising terrain during the final stage of a visual approach in daylight IMC.				
Aug. 13, 1996	Royal Air Force Station Northolt, U.K.	Learjet 25B	destroyed	3 minor
The commander landed the airplane at about 158 knots and at a point on the runway where about 3,125 feet (953 meters) of runway remained. The commander did not deploy the spoilers after touchdown. The first officer did not observe that the spoilers had not been deployed after touchdown. The airplane overran the runway and collided with a motor vehicle.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Aug. 29, 1996	Milwaukee, Wisconsin, U.S.	Cessna Citation 525	substantial	3 none
After being cleared to climb from 6,000 feet, the pilot was advancing the throttles to climb power when he heard a loud bang and observed indications of a no. 2 engine failure. He secured the engine and conducted an uneventful landing. Examination revealed an uncontained high-pressure turbine-disk-blade retention-post failure.				
Sept. 30, 1996	Aspen, Colorado, U.S.	Israel Aircraft Industries 1125	substantial	3 none
The pilot said that the landing was normal. The anti-skid wheel braking system was engaged. The airplane slowed to 90 knots, then began drifting left. Differential braking, full-right rudder and nosewheel steering failed to correct the drift. The airplane struck two taxiway signs; the nose landing gear was sheared off, and its strut penetrated the pressure vessel. Examination disclosed that the right-inboard anti-skid generator canon plug was corroded, causing the anti-skid system to falsely sense a locked brake and to automatically release the brake.				
Oct. 30, 1996	Wheeling, Illinois, U.S.	Gulfstream IV	destroyed	4 fatal
The flight crew began a takeoff on Runway 34 with a crosswind from 280 degrees at 24 knots. After rolling about 1,340 feet (409 meters), the airplane veered left, off the runway. One of the pilots said, "Reverse." The other pilot said, "No, no, no, go, go, go, go, go." The airplane traversed a shallow ditch, which resulted in separation of the main landing gear, the flaps and a piece of left-aileron control cable. The airplane then became airborne after it encountered a small berm, and the left-wing fuel tank exploded. The main wreckage was located about 6,650 feet (2,028 meters) from the beginning of the takeoff roll. The report said that the nosewheel-steering-select control switch was found in the "Handwheel Only" position. The pilot routinely flew with the switch in the "Normal" position. The pilot and the copilot flew G-IVs for different companies. The interchange agreement between the two companies did not address mixed crews, procedural differences or airplane differences training.				
Dec. 6, 1996	Stephenville, Newfoundland, Canada	Learjet 36	destroyed	2 fatal
The airport manager said that there were snow squalls in the area when the flight crew conducted an ILS approach to Runway 28. Surface winds were from 040 degrees at 20 knots, gusting to 22 knots. A ground scar made by the left-main wheel was found in snow on the left edge of the 10,000-foot (3,050-meter) runway, about 1,750 feet (534 meters) beyond the runway threshold. Another ground scar made by the left-wing-tip fuel-tank fin began 3,650 feet (1,113 meters) beyond the threshold. The airplane came to rest 1,640 feet (500 meters) south of the airport.				
Dec. 24, 1996	Dorchester, New Hampshire, U.S.	Learjet 35A	destroyed	2 fatal
The first officer was in the left seat, flying the airplane, and the captain was in the right seat for the positioning flight to Lebanon, New Hampshire. Approaching the destination, the crew briefed, then conducted the ILS approach to Runway 18. The crew conducted a missed approach but did not follow the missed approach procedure. The captain later requested and received clearance for the VOR approach to Runway 25. During the procedure turn, the captain initially told the first officer to turn the airplane in the wrong direction. By the time the captain told the first officer the correct heading, the airplane had been outbound for about two minutes. The captain told the first officer to descend the airplane to 2,900 feet, although the procedure called for a minimum altitude of 4,300 feet until joining the inbound course to the VOR. As the airplane neared the inbound course to the VOR, the captain erroneously called the outer marker. The first officer agreed, and the captain said that they could descend to 2,300 feet. The first officer said that he was descending the airplane to 2,300 feet. Three seconds later, the airplane struck trees and terrain at the 2,300-foot level in mountainous terrain. The accident site was 10.3 nautical miles (19.1 kilometers) from where a descent to 2,300 feet was authorized.				
Jan. 1, 1997	Kansas City, Missouri, U.S.	Learjet 35	substantial	2 none
The crew conducted an ILS approach with excessive airspeed. The airplane was not configured correctly for landing; the flaps were extended 20 degrees, rather than the landing setting of 40 degrees. The airplane touched down with approximately 2,000 feet (610 meters) of runway remaining. The airplane overran the wet runway and struck two airplanes and a hangar.				
Jan. 16, 1997	Muscatine, Iowa, U.S.	Learjet 24	substantial	2 none
The pilot said that the airplane began to drift left on touchdown. He attempted to reject the landing, but the airplane traversed snow at the runway's left edge and veered off the runway.				
Jan. 24, 1997	Wilkes-Barre, Pennsylvania, U.S.	Cessna Citation 650	substantial	3 none
The pilot said that during an ILS approach to Runway 04, he received an update on the current winds, which were reported from 120 degrees at 18 knots, gusting to 25 knots. He said that he used a 20-degree heading correction to stay on the ILS localizer course. On short final, the pilot aligned the airplane with the runway and touched down in the first 1,000 feet (305 meters) of the runway. He said, "After rolling down the runway more than 500 feet [153 meters], the right wing suddenly appeared to be rising. At the same time, the airplane started to veer left. Full right rudder and brake were applied in order to keep the airplane near the center of the runway. The airplane came to stop 20 feet [six meters] left of the runway centerline. After evacuating the airplane, [we] observed the left-main landing gear folded."				
Jan. 24, 1997	Washington, Indiana, U.S.	Cessna Citation 501	substantial	4 none
The pilot said that the wheel brakes appeared to be ineffective on landing. The airplane overran the runway, struck a ditch and came to a stop on a taxiway with the nose landing gear collapsed. The report said that the runway apparently was covered with ice.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Feb. 7, 1997	Salta, Argentina	Dassault Falcon 20	destroyed	4 fatal
The airplane reportedly was flown into high terrain while being positioned for an ILS approach in daylight IMC. The accident site was at 6,890 feet, 25 nautical miles (46 kilometers) south-southwest of the airport.				
Feb. 19, 1997	Guatemala City, Guatemala	Israel Aircraft Industries 1124A	destroyed	5 fatal
The airplane struck terrain nine nautical miles (17 kilometers) south of the airport during a localizer/DME approach in nighttime VMC to Runway 01 at La Aurora International Airport.				
Feb. 27, 1997	Greenville, South Carolina, U.S.	Learjet 35	substantial	1 minor, 1 none
The pilot said that he was cleared for an ILS approach and had to use spoilers to intercept the glideslope. The landing gear was extended at the outer marker as the airspeed was slowed through 200 knots. As the airspeed decreased, the spoilers were retracted and the flaps were extended 20 degrees. The airplane drifted right, and flaps were extended to 40 degrees as the drift was corrected. During the landing, the airplane floated and touched down long. The spoilers, wheel brakes and full reverse thrust were applied. There was no braking action due to hydroplaning. The airplane overran the runway, vaulted off a 25-foot (eight-meter) embankment, skidded across a road and struck a ditch.				
March 3, 1997	Ardabil, Iran	Dassault Falcon 20	destroyed	4 fatal
The airplane was inbound to land at Ardabil in IMC when it struck terrain.				
March 7, 1997	Medellin, Colombia	Cessna Citation 500	destroyed	2 fatal
The airplane was flown into a mountain about 12 minutes after takeoff from Pereira for a flight to Medellin. The pilot reported "technical problems" soon before the accident.				
March 20, 1997	Hailey, Idaho, U.S.	North American Sabreliner 40	substantial	3 none
The pilot said that during the landing roll, the thrust reversers were deployed and the airplane began to slowly veer left. The pilot attempted to correct, but the airplane continued off the side of the runway and struck a runway marker and a snow bank. The nose landing gear collapsed. Examination of the electrical system revealed a short to the command potentiometer, which affected the primary nosewheel steering system and the standby nosewheel steering system.				
March 25, 1997	Flushing, New York, U.S.	Gulfstream II	substantial	4 none
About 0430 local time, ATC cleared ground personnel in a vehicle to perform maintenance on lights on Runway 13/31. The vehicle's engine later stalled, and the ground personnel were not able to restart the engine. At 0507, the Gulfstream crew called inbound for landing. The local controller acknowledged the call and scanned the runway, but did not see the vehicle. The controller cleared the crew to land on Runway 31. At 0510, the ground personnel observed the airplane on approach and radioed the ground controller that they were stuck on the runway. The controller then radioed, "Go around, airplane on the runway, go around, airplane on the runway, go around, seven fox juliet [the airplane's registration number], go around." Moments later, the airplane struck the vehicle.				
March 26, 1997	Chamblee, Georgia, U.S.	Dassault Falcon 900B	none	1 serious, 2 none
As the airplane was cruising at FL 310, light turbulence was encountered. The crew was cleared to descend in preparation for landing at the destination airport. Descending through 30,000 feet, the airplane began to encounter moderate turbulence. As the airplane descended through 27,000 feet, a flight attendant fell to the floor of the aft lavatory. Her fall resulted in a broken ankle.				
April 3, 1997	Buffalo, New York, U.S.	Cessna Citation 650	substantial	3 none
While being vectored for the final approach in nighttime VMC, the flight crew lost radio contact with the control tower and smelled smoke. After landing and taxiing the airplane to the ramp, the crew was notified by ground personnel of flames penetrating the top of the aft fuselage between the engines. The fire was extinguished by airport firefighters. Examination of a hydraulic return line in the aft equipment bay revealed indications of electrical arcing and a small hole through which fluid could escape. A 115-volt electrical line used to heat the horizontal stabilizer also had indications of chafing. In addition to the hydraulic fluid, a pressurized fuel line to the auxiliary power unit was damaged by the fire and was leaking fuel.				
April 21, 1997	Chamblee, Georgia, U.S.	British Aerospace 125-800A	substantial	2 none
The captain said that the airplane was in cruise flight at FL 390 when he began to feel physical discomfort. As the airplane neared the top-of-descent point, he was unable to continue his cockpit duties and went to the passenger cabin. The first officer continued the flight and conducted an uneventful landing. Later that evening, the captain passed a kidney stone.				
April 30, 1997	Miami, Florida, U.S.	Gulfstream II	substantial	2 none
The pilot said that the nose landing gear collapsed after thrust reverser application on landing. Both flight crewmembers told investigators that they had observed landing gear down-and-locked visual indications while conducting the checklist. The airplane manufacturer found that the nose-gear-retract actuator and/or the microswitch roller guard were misrigged, a seal had failed in the retract actuator and the downlock-overcenter-link assembly had excessive friction. The manufacturer said that its examination of the nose-gear assembly did not reveal a specific cause for the failure.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
May 7, 1997	Atlantic Ocean	Learjet 31A	substantial	3 none
The airplane was at FL 230 when the crew received clearance to descend to 13,000 feet. The instructor pilot took control of the airplane to demonstrate an emergency descent. While descending, the first officer (student) believed that the instructor pilot was disoriented and assisted in the recovery. The instructor pilot said that he was disoriented and had allowed the airplane to reach maximum airspeed. After the airplane was landed, a mechanic observed that the refueling door was missing and that the horizontal stabilizer was damaged.				
May 16, 1997	Great Falls, Montana, U.S.	Learjet 35A	substantial	2 minor
The first officer, who was the pilot flying, said that the captain decreased power on the left engine during takeoff as a training exercise. The first officer said that there had been no preflight discussion of emergency-procedures practice. A loss of control occurred after the airplane became airborne about 3,500 feet (1,068 meters) down the runway. The airplane struck terrain left of the runway, and a fire erupted. Both airspeed indicator bugs were found set nine knots to 11 knots below the V_1 speed indicated on the takeoff and landing data card.				
June 11, 1997	Berry Island, Bahamas	Cessna Citation 501	substantial	8 none
The pilot said that the airplane was landed at about the landing reference airspeed with full flaps extended. During the landing roll on the wet runway, with the speed brakes deployed, the anti-skid braking system activated and the wheel brakes applied, he observed that the airplane was not decelerating. He elected to go around and applied full thrust to both engines; he did not recall whether he partially retracted the flaps. The airplane struck trees past the departure end of the runway and came to rest upright.				
June 30, 1997	White Plains, New York, U.S.	Dassault Falcon 10	substantial	4 none
The left-main landing gear collapsed on landing.				
July 2, 1997	Elstree Aerodrome, Hertfordshire, U.K.	Cessna Citation 501	substantial	4 none
The commander was monitoring the flight while a private pilot with 280 flight hours, including 41 flight hours in Citations, conducted a visual approach in daylight VMC. Witnesses said that the final approach was steep and that the airplane landed short of the threshold in a high nose-up attitude. The pilot flying experienced difficulty in maintaining directional control. The commander took control and brought the airplane to a stop on the runway. The crew observed that the tire on the right-main landing gear had become detached.				
July 5, 1997	Ardmore, Oklahoma, U.S.	North American Sabreliner 80	substantial	2 none
Prior to the accident flight, the airplane was repainted by a maintenance facility at the departure airport. When the landing gear was retracted after takeoff, the pilot observed that the landing gear warning light was illuminated. He extended the landing gear, and the down-and-locked indicator light for the right-main landing did not illuminate. Emergency gear-extension procedures did not correct the anomaly. The pilot decided to return to the airport and not to use thrust reversers during the landing roll to minimize yaw. He said that there was "no significant pedal pressure" when he applied wheel brakes after touchdown, and the airplane overran the runway. The right-main landing gear collapsed, and the right wing struck the ground. Examination revealed that the main landing downlock pins had been painted, which resulted in the right pin sticking in the retracted (unlocked) position when the gear was retracted after takeoff. The power-brake-valve pistons also had been painted, which resulted in the left piston sticking in the emergency (power-off) position when the pilot tested the emergency brakes before takeoff.				
July 15, 1997	Avon Park, Florida, U.S.	Learjet 35A	substantial	2 minor
Witnesses observed the airplane touch down on the runway and take off. One witness said, "By the time the pilot was on the runway, he had wasted approximately 1,200 [feet] to 1,500 feet [366 meters to 458 meters] of Runway 4. They hit reverse thrusters [which] were on full bore till they crossed Runway 27 and 09." The witness said that the airplane climbed to about 40 feet, "wobbled" left and right at a slow airspeed, crossed over a highway, struck wires, descended into a field and began to burn. Examination of the left thrust reverser revealed that the translator was in the deployed position, with the blocker doors fully open, and that both pneumatic latches were in the unlocked position. Examination of the right thrust reverser revealed that the translator was in the deployed position, with the blocker doors fully closed, and that one pneumatic latch was in the locked position and the other latch was in the unlocked position. The thrust-reverser switch was found in the "NORMAL" position.				
July 21, 1997	Ranong, Thailand	Learjet 31	destroyed	2 fatal
The airplane reportedly was flown into the side of a mountain at the 3,900-foot level, about 100 feet (31 meters) below the summit, during descent to Ranong during a training flight. The accident occurred in daylight, but the mountains might have been shrouded by clouds.				
Aug. 13, 1997	Lexington, Kentucky, U.S.	Dassault Falcon 20	substantial	2 none
The airplane was about five nautical miles (nine kilometers) from the airport during an ILS approach when the pilot acquired visual contact with the airport, the runway lights and the VASI. Over the approach lights, the airplane encountered heavy rain. The copilot observed that the airplane was below on-path VASI indications and the glideslope. The pilot applied power and initiated a go-around, but the airplane landed hard on a grass bank about 13 feet (four meters) from the runway.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Sept. 2, 1997	Aberdeen, Mississippi, U.S.	Learjet 31	substantial	2 none
The pilot said that the airplane was high and fast on final approach, and that because of restricted visibility in haze, he initiated a go-around. The pilot and copilot did not recall retracting the landing gear. During the second approach, the pilot said that he did not extend the gear because he was "sure in his mind that the gear was already down." The airplane was landed with the gear retracted. The airplane slid about 3,000 feet (915 meters), and a fire erupted below the right wing root. The pilots were unable to extinguish the fire with hand-held fire extinguishers.				
Oct. 9, 1997	Harbin, China	Cessna Citation 650	substantial	(not available)
The landing gear collapsed on landing.				
Oct. 29, 1997	Sheboygan, Wisconsin, U.S.	Learjet 35A	substantial	4 none
The pilot said that the airplane had just reached rotation speed during takeoff when a deer "bolted across the front of the airplane from right to left" and was struck by the left wing. The pilot said that he had to use full-right aileron and full rudder to keep the airplane level until it reached a low cruise speed. The pilot continued the flight to a larger airport and landed without further incident. The departure airport was in a wooded area and did not have a perimeter fence.				
Oct. 31, 1997	Cananéla, Brazil	Cessna Citation 500	destroyed	3 fatal
Following an apparent global positioning system (GPS)-assisted approach in daylight IMC, the airplane was landed fast with a 15-knot to 20-knot tail wind component and then overran the wet, 4,100-foot (1,251-meter) runway. The airplane continued down a slope, across a road and eventually came to a stop among houses.				
Jan. 2, 1998	Tampico, Mexico	Learjet 24	destroyed	3 fatal, 5 serious
The copilot said that the airplane was being flown on a DME arc to intercept the ILS localizer when it struck the ground. Nighttime IMC prevailed in the area.				
Jan. 6, 1998	West Mifflin, Pennsylvania, U.S.	Cessna Citation 500	destroyed	1 serious, 2 minor
The pilot was conducting an ILS approach in daytime IMC. Landing reference speed (V_{REF}) was 110 knots. ATC radar data indicated a 160-knot groundspeed from the outer marker to 1.8 nautical miles (three kilometers) from touchdown. The airplane was landed long, overran the runway, struck the ILS localizer antenna and came to a stop at the edge of a mobile-home park. The airplane was not equipped with thrust reversers or an anti-skid braking system.				
Jan. 13, 1998	Houston, Texas, U.S.	Learjet 25B	destroyed	2 fatal
During a positioning flight, the crew conducted a missed approach in IMC when a warning flag appeared on the captain's horizontal situation indicator (HSI) after passing the FAF on an ILS approach. During the second ILS approach, the captain transferred control to the first officer after the airplane had crossed the FAF. The airplane was flown below the glideslope and struck 80-foot (24-meter) trees and terrain. Postaccident testing revealed that the first officer's instruments displayed a false full fly-down glideslope indication because of a failed amplifier in the navigation receiver. The glideslope deficiency had been discovered two months before the accident by another flight crew. A repair station misdiagnosed the problem as "sticking" needles in the cockpit instruments. The operator deferred further maintenance of the instruments.				
Jan. 16, 1998	Exeter Airport, Devon, U.K.	Cessna Citation 650	substantial	10 none
Two seconds after touchdown, the airplane was decelerating below approximately 120 knots when it struck a deer on the runway. The report said that darkness prevailed at the time of the accident and that the deer, which is believed to have jumped over a four-foot (one meter) airport-boundary fence, would not have been visible to tower controllers or to the pilots.				
Jan. 29, 1998	Horseshoe Bay, Texas, U.S.	Cessna Citation 500	substantial	2 none
The airplane struck a deer during the landing roll. As the airplane was taxied to the ramp, fuel began to leak from the left wing. An antler was found embedded in the left wing and fuel tank. Approximately 150 gallons (568 liters) of fuel leaked onto the runway, taxiway and ramp.				
Feb. 1, 1998	Al Manamah, Bahrain	Learjet 36A	substantial	7 none
The pilot said that the airplane had accelerated to 120 knots on the takeoff roll when both left-main landing gear tires ruptured. The airplane swerved left, and the pilot applied right rudder and wheel brakes to realign the airplane with the runway. Both right-main landing gear tires then ruptured. The pilot deployed the drag chute. The airplane veered off the right side of the runway.				
Feb. 6, 1998	Chambery, France	Gulfstream II	destroyed	5 none
The crew was conducting an ILS approach when the airplane struck a lake about 0.6 nautical mile (one kilometer) from the runway. The airplane floated a few minutes, allowing the occupants to exit, before it sank in 90 feet (28 meters) of water. VMC prevailed at the airport, but there was mist over the lake, which was still and glassy. The report said that the pilot had lost visual contact with the runway environment but continued the approach.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Feb. 18, 1998	Peterborough, Ontario, Canada	Dassault Falcon	substantial	2 none
The crew conducted an NDB approach in nighttime IMC. A Learjet crew had reported braking action as good on the wet runway. The Falcon was landed within the runway touchdown zone, and the speed brakes were extended. The crew said that wheel braking action was fair during the initial portion of the landing roll but decreased to near nil as the airplane decelerated from a touchdown speed of 125 knots. The captain disengaged the anti-skid braking system and deployed the drag chute when it became apparent that he might not be able to stop the airplane on the runway. The airplane drag chute was found 3,200 feet (976 meters) from the runway approach threshold, at about the point the crew recollected deploying it. The crew said that they had not released the drag chute after deploying it. The airplane was not equipped with thrust reversers. There were indications that all four tires on the main landing gear hydroplaned before the airplane overran the runway.				
March 4, 1998	Oakdale, California, U.S.	Learjet 23	substantial	2 none
The pilot said, in his accident report, that there was no crew action to extend the landing gear prior to touchdown.				
March 4, 1998	Manistee, Michigan, U.S.	Cessna Citation 650	substantial	9 none
The airplane touched down approximately 3,200 feet (976 meters) down the 5,502-foot (1,678-meter) runway and ran off the end of the runway. The nose landing gear collapsed, puncturing the pressure vessel. Flight data recorder (FDR) data indicated that the airplane touched down at 138 knots. The crew called out a V_{REF} during the approach of 132 knots.				
April 4, 1998	Marietta, Georgia, U.S.	Cessna Citation 525	destroyed	5 fatal
The airplane collided with a Cessna 172 at about 3,400 feet in VMC. The Citation was on a northerly heading, and the 172 was heading southwest. The approach controller who was communicating with the Citation crew said that he did not observe the primary target of the 172. The approach control facility did not have conflict-alert software. The selector switch on the 172's transponder was found in the "OFF" position.				
May 10, 1998	Palm Springs, California, U.S.	North American Sabreliner 65	substantial	8 none
An uncontained engine failure occurred during the takeoff roll. The high-pressure centrifugal-impeller disk burst, and debris exited through the engine cowling. Metallurgical examination of the disk revealed subsurface fatigue cracks near an area that had been reworked to remove stresses in accordance with a service bulletin.				
May 12, 1998	Monroe, Michigan, U.S.	Dassault Falcon 20	substantial	2 none
The pilot said that the flight controls were free during the preflight check and before-takeoff check. He said that when the airplane accelerated to V_{REF} (125 knots), he pulled on the control column, but it would not move. He rejected the takeoff, and the airplane ran off the end of the runway into a field. Examination of the airplane failed to reveal any failure/malfunction which would have prevented normal operation of the flight controls.				
May 23, 1998	Orlando, Florida, U.S.	Learjet 24B	substantial	6 none
During the landing roll, the airplane's wheel braking system failed as a result of hydraulic fluid leak(s). The pilot told the first officer to deploy the drag chute and engage the emergency-braking system. The first officer said that application of the emergency-braking system caused the airplane to yaw. The first officer then disengaged and re-engaged the emergency-braking system several times. The airplane overran the end of the runway and struck the ILS back course antennas.				
June 19, 1998	Fishers Island, New York, U.S.	Cessna Citation 500	substantial	4 none
The airplane was landed on a dark night on a 2,328-foot (710-meter) runway. The pilot and copilot said that the airplane touched down on the "numbers" and that after initial braking and deceleration, the wheel brakes ceased to work although the brake pedals remained firm. The pilot attempted to reach the emergency brake handle but was restrained by his shoulder harness, which had locked. The airplane struck a rock seawall at the departure end of the runway. Postaccident examination found an intermittent short in the wiring on the right-wheel anti-skid braking system.				
July 2, 1998	Hamilton, Montana, U.S.	Dassault Falcon 900	substantial	9 none
The pilot said that after a normal approach and touchdown, he applied the wheel brakes and thrust reversers. As the airplane slowed to about 70 knots, it veered right and exited the side of the runway. The pilot regained directional control after the airplane exited the runway. Before the airplane came to a stop, the right wing struck VASI lights. Postaccident testing of the anti-skid generators revealed that they did not function to the manufacturer's specifications.				
July 18, 1998	Florence, Kansas, U.S.	North American Sabreliner 80	substantial	2 fatal
After deplaning a passenger, the pilot conducted a low pass over the airport, followed by a steep climb to 10,000 feet. Seven minutes later, the CVR recorded the pilot saying to the copilot, "You're going to pitch up now and take it all the way around here. … Pitch up, 20 degrees up." About 27 seconds later, the CVR recorded an exclamation. Eight seconds later, the airplane struck terrain. Recorded radar data indicated that the airplane's altitude about the time the nose was pitched up was 15,900 feet and that the airplane struck terrain about 37 seconds later.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
July 24, 1998	Rawlins, Wyoming, U.S.	Cessna Citation 500	substantial	2 minor
The captain said that the airplane felt "sluggish" during the takeoff roll and that after rotation, the airplane climbed 10 feet, "shuddered" and sank. The captain rejected the takeoff, landed the airplane on the runway, applied wheel brakes and deployed the drag chute. The drag chute separated, and the airplane went off the runway, down a hill, through a fence, across a road and grassy area, across another road, through a chain-link fence, and struck a power pole. The captain said that they had calculated takeoff performance using inappropriate data and had failed to consider the wet runway and wind shift. The report said that the drag chute riser had fractured at a point where it passed through a lightning hole, which did not have a nylon grommet installed.				
Aug. 28, 1998	El Paso, Texas, U.S.	Dassault Falcon 20	substantial	1 serious, 2 minor
The crew conducted a no-flaps takeoff, which called for a V_1 of 141 knots. The first officer was the pilot flying. The crew reported that the initial takeoff roll from the 11,009-foot (3,357-meter) runway was normal. At approximately 120 knots, the flight crew heard a loud bang and felt a vibration. The captain told the first officer to reject the takeoff. The flight crew said that the wheel brakes were not effective in slowing the airplane. The airplane overran the runway, went through the airport's chain-link perimeter fence, collided with three vehicles on a highway and went through a second chain-link fence before stopping. The report said that the flight crew had been given an inaccurate weight for the cargo and that the airplane was 942 pounds (427 kilograms) over maximum takeoff weight.				
Sept. 26, 1998	Fairoaks, U.K.	Cessna Citation 560	substantial	2 minor, 1 none
After touchdown, the commander selected full thrust reverse on both engines and applied moderate wheel braking. He said that the airplane initially decelerated adequately, but the deceleration rate decreased. The copilot said that the runway was damp and appeared "shiny." When he realized that he could not stop the airplane on the runway, the commander stowed the thrust reversers and attempted to shut down the engines. After leaving the runway, the airplane traveled 820 feet (250 meters) before stopping.				
Sept. 28, 1998	Pueblo, Colorado, U.S.	Cessna Citation 551	substantial	4 none
The pilot said that after a normal landing, he pushed the control column forward and began to deploy the thrust reversers. The front of the airplane began to "veer and then oscillate up and down," and the airplane felt "very stiff up front as if [it] had hit something." The airplane became airborne, touched down again and went off the side of the runway. Control tower personnel said that the pilot appeared to have made a hard landing.				
Oct. 27, 1998	Wallops Island, Virginia, U.S.	Learjet 45	substantial	2 minor, 1 none
The flight crew was participating in water-ingestion tests, which required multiple landing rolls through a pool on the runway. On one landing, the airplane's left-main landing gear and nose landing gear tracked through the pool, while the right-main landing gear tracked outside the pool. The airplane veered left, departed the runway and struck a pickup truck parked adjacent to the runway. The airplane came to a stop inverted and on fire.				
Nov. 20, 1998	Mexico City, Mexico	Learjet 24D	destroyed	7 none
The airplane reportedly could not be rotated for takeoff, and the pilot rejected the takeoff. Full wheel braking, spoilers and the emergency parachute were used in an attempt to stop the airplane. As the airplane neared the end of the runway, the pilot steered it off the left side of the runway. The airplane encountered rough ground, where its nose landing gear and main landing gear broke away. After the airplane stopped, a fire erupted near the damaged right wing-tip tank and spread to the rest of the wing before it was extinguished.				
Dec. 2, 1998	Umpire, Arkansas, U.S.	Cessna Citation 501	substantial	1 fatal
The pilot was flying his repainted airplane back to his home base. Witnesses about 17 nautical miles (31 kilometers) from the departure airport observed the airplane in a 90-degree right bank. The airplane then rolled inverted and entered a near-vertical descent. The report said that there was no indication of pilot incapacitation or mechanical failure.				
Dec. 17, 1998	Los Angeles, California, U.S.	Learjet 55B	substantial	7 none
At 0850 local time in VMC, the airplane was landed with the landing gear retracted after the crew reported a progressive loss of all electrical systems. A preliminary inspection indicated that the no. 1 battery was leaking electrolyte through a crack in the battery case.				
Dec. 30, 1998	St. John's, Newfoundland, Canada	Dassault Falcon 20D	substantial	2 none
The crew was conducting an instrument approach when severe turbulence and wind shear were encountered. This resulted in a sudden loss of altitude and impact with the tops of trees. The crew conducted a wind shear recovery, declared an emergency and then conducted an uneventful approach and landing.				
Jan. 18, 1999	Paris, France	Cessna Citation 550	minor	4 none
At 2010 local time, the crew experienced a runaway autopilot during climb-out.				
Jan. 22, 1999	Columbus, Ohio, U.S.	Cessna Citation 650	substantial	4 none
While landing, the airplane's right-main landing gear collapsed. The airplane veered off the right side of the runway and struck a taxiway sign. Examination of the landing gear system revealed no malfunctions or internal component failures. Further testing revealed that it was possible for the airplane's side-brace actuator to unlock mechanically by repeated cyclic compressive loading. Winds reported at the airport about 30 minutes prior to the accident were from 170 degrees at 14 knots, with 19-knot gusts.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Jan. 28, 1999	Chicago, Illinois, U.S.	Learjet 35	substantial	2 none
The copilot, the pilot flying, said that at one nautical mile (two kilometers) from the end of the runway, the airplane was stabilized on the glideslope and localizer at a landing reference speed of 122 knots. Crossing the runway threshold, the pilot called out, "Ref [V_{REF}], three green, cleared to land." Approximately three feet above the runway, the pilot called out, "Ref minus 10 [knots indicated airspeed]." The pilot said that while making this callout, he felt a slight increase in sink rate, followed immediately by a violent right roll. The right wing-tip fuel tank struck the runway surface. Examination of the airplane revealed no anomalies.				
Feb. 16, 1999	Van Nuys, California, U.S.	Gulfstream II	substantial	4 none
The pilot flew the airplane on final approach above V_{REF} (125 knots) and landed long. The airplane overran the runway and struck parked airplanes. The report said that during descent from 8,000 feet and within 13 nautical miles (24 kilometers) of the airport, the airplane reached speeds greater than 300 knots and attained descent rates in excess of 4,000 feet per minute. At 1.5 nautical miles (2.7 kilometers) from the runway and 700 feet above the airport, the airplane was descending at 3,000 feet per minute and flying at more than 200 knots.				
Feb. 18, 1999	Columbus, Nebraska, U.S.	Mitsubishi MU-300	substantial	8 none
The captain said that they conducted the VOR/DME Runway 32 approach and that they checked the automated weather-observing system (AWOS) during the approach. The weather was reported as a few clouds at 100 feet, 1,000 feet overcast and 1.25 statute miles (2.02 kilometers) visibility. The captain said that they descended to the circling minimum of 1,940 feet and circled the runway to the left to verify that the snow-removal equipment was clear of the runway. He said, "As we approached, I slightly overshot the final [approach course] but corrected promptly by making a low turn near the runway for realignment." He said that the airplane touched down on the first third of the runway and that he perceived that the "braking action was not very good." The airplane overran the runway. The report said that the first 3,000 feet (915 meters) of the runway had an asphalt surface and the remaining 2,682 feet (818 meters) had a concrete surface. The runway had been plowed prior to the Mitsubishi's landing; however, braking action was still being reported as poor.				
March 13, 1999	Durango, Colorado, U.S.	Gulfstream IV	substantial	2 none
The airplane was at FL 410 when the crew observed low fuel flow and low exhaust gas temperature indications for the left engine. They also observed that the left engine's oil temperature and fuel temperature were increasing. They requested clearance to descend, and as the captain reduced power, the left-engine fire-warning light illuminated. The captain pulled the left fire T-handle, and the fire-warning light extinguished. The crew secured the engine, requested emergency equipment to be standing by in Durango and landed without further incident. Examination of the left engine revealed that the lower-forward area of the nacelle was damaged by fire. Further examination revealed that an alternator wire had chafed against a fuel line.				
March 21, 1999	Scottsdale, Arizona, U.S.	Rockwell Sabreliner 80	substantial	6 none
The airplane collided with a Piper PA-28-181 on a taxiway parallel to the runway. Both airplanes had been landed on the same runway. The local controller issued taxi instructions to the Sabreliner crew and told the crew to monitor the ground control frequency after turning off the runway. The ground controller issued taxi instructions to the Piper pilot. The Piper pilot observed the Sabreliner exiting the runway and continued taxiing because it appeared that the Sabreliner was stopping and no other instructions had been issued by the ground controller. When the Piper reached the intersection, the pilot realized that the Sabreliner wasn't stopping. The Piper pilot attempted to turn right and avoid the airplane. The left wing of the Piper struck the forward avionics bay of the Sabreliner. The Sabreliner first officer was looking down at the pedestal while changing radio frequencies when the airplane crossed the taxiway hold bars. The Sabreliner crew said that they did not see the Piper.				
March 25, 1999	State College, Pennsylvania, U.S.	Cessna Citation 550	substantial	2 none
The airplane's left-main landing gear actuator was removed for overhaul, and a temporary replacement was installed. While taxiing after landing, the airplane's left-main landing gear collapsed. Disassembly of the actuator revealed that the lock ring was installed upside-down.				
March 30, 1999	Rogers, Arkansas, U.S.	Learjet 35A	substantial	2 minor, 8 none
A high rate of descent developed on final approach, and the airplane touched down hard 12 feet (four meters) from the runway. The left-main landing gear separated after striking the concrete foundation supporting the runway's approach light system. The captain said that "an unusual descent rate developed on short final approach" and that he tried to arrest the descent. According to the CVR recording, about 33 seconds before impact, the first officer said, "Ref [plus] 10, sinking a thousand [feet per minute]." The winds were reported from 150 degrees at 13 knots, with gusts to 19 knots. The pilot of a single-engine airplane that was landed at the airport 30 minutes prior to the accident reported a 15-knot to 20-knot loss of airspeed on final approach.				
March 30, 1999	St. Mawgan Airport, Cornwall, U.K.	Cessna Citation 550	substantial	8 none
The surface wind was from 160 degrees at 10 knots, and Runway 13 was in use. The commander requested clearance for an ILS approach to Runway 31 because he believed that a coupled ILS approach, even with a tail wind, was a better option than a PAR (precision approach radar) approach to Runway 13. The commander said that he flew an uneventful coupled approach. He was cleared to land four nautical miles (seven kilometers) from the runway and was told that the surface wind was from "170 degrees, 12 knots, which is a seven-knot tail wind." He disconnected the autopilot when he acquired visual contact with the runway at 280 feet AGL. The commander perceived that the visual part of the approach was normal until, about 140 feet AGL, he was "temporarily blinded by the landing lights reflecting from light mist." He was about to initiate a missed approach when the runway became visible again. However, a higher-than-normal rate of descent had developed, and the airplane sank rapidly into the glare of the approach lights. The airplane struck and damaged PAR equipment.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
April 14, 1999	Finland	Learjet 55	substantial	2 none
The accident involved an uncontained engine failure.				
April 17, 1999	Beckley, West Virginia, U.S.	Raytheon Beechjet 400A	substantial	6 serious, 2 minor
The airplane was 100 feet above the runway threshold when the first officer said, "V_{REF} plus about 20." The airplane touched down about 1,650 feet (503 meters) from the approach end of the 5,000-foot (1,525-meter) runway. The pilot said that as usual, he applied light wheel braking and attempted to actuate the airplane's thrust-reverser system; however, the thrust-reverser handles could not be moved beyond the "Deploy-Reverse-Idle" position. After the pilot cycled the levers two or three times, he began to apply maximum wheel braking. A passenger said that when he saw the end of the runway, the airplane seemed like it was still moving "pretty fast." As the airplane approached the end of the runway, the passenger saw smoke, which he believed was coming from the airplane's tires. The airplane overran the runway and stopped on a plateau about 90 feet below the runway elevation. Examination of the airplane, including the thrust-reverser system, did not reveal any pre-impact malfunctions.				
April 27, 1999	Avalon, Victoria, Canada	Learjet 35A	minor	2 none
The pilot flying was undergoing a proficiency check under the supervision of a flight instructor who occupied the right seat. During takeoff, at V_1, the instructor simulated an engine failure by placing the throttle lever in the idle position. The pilot flew a 700-foot circuit in the after-takeoff configuration of landing gear up and flaps extended eight degrees. Flaps 20 was selected during the base turn. The airplane was flared normally with both throttle levers in the idle position. As the airplane settled, a slight vibration was noticed, and both pilots became aware that the landing gear was still retracted. Go-around power was applied, and the airplane climbed away. The landing gear was cycled normally, and the crew returned for a full-stop landing. Inspection of the airplane showed that the only evidence of a runway strike was abrasion of the lower-fuselage-mounted antenna.				
July 1, 1999	Hyannis, Massachusetts, U.S.	Learjet 60	substantial	4 none
While being vectored for the Runway 24 ILS approach, as the flaps were selected to 20 degrees and the landing gear was extended, the crew noted that the left and right amber "HYDR PRESS" (hydraulic pressure) warning lights illuminated. The crew discussed whether to continue or to divert to another airport. The captain decided to proceed to the destination airport, which had a 5,425-foot (1,655-meter) runway. After touchdown, the captain applied normal wheel braking, but the brakes did not respond. Additionally, the crew attempted to use the thrust reversers, which also did not respond. The captain then attempted to apply emergency braking, but the emergency-brake lever would not move. The captain told the first officer to engage the emergency-braking system. The captain then announced that he was rejecting the landing. About the same time, the first officer successfully engaged the emergency brakes. The airplane overran the wet runway, struck a localizer antenna and stopped in a fence. Examination of the airplane revealed that the left-main landing gear actuator-extend hose was leaking hydraulic fluid and had not been torqued to specifications.				
Aug. 16, 1999	Fort Lauderdale, Florida, U.S.	Canadair Challenger 600	substantial	3 none
While the flight was en route from Pueblo, Colorado, to Columbia, South Carolina, the captain's windshield delaminated, and the flight was diverted to Fort Lauderdale, where repairs could be performed. The first officer was flying the airplane and had been instructed by the captain to make a firm landing to get the airplane's weight on the wheels, because the airplane was light. The landing was firm, and the first officer activated the thrust reversers. As the nose landing gear touched down, the airplane began veering left. Attempts to regain directional control were not successful, and the airplane ran off the left side of the runway and struck a taxiway sign. The nose landing gear collapsed. At the time of the accident, the flight crew had been on duty about 17 hours, 45 minutes.				
Aug. 17, 1999	Las Vegas, Nevada, U.S.	British Aerospace Hawker	substantial	8 none
On departure from Salina, Kansas, at about rotation speed, the crew felt a "violent vibration" and thought that they might have "blown a tire." The takeoff was completed safely and the landing gear was retracted. Soon thereafter, hydraulic pressure began to decrease. The pilot decided to continue to the destination and told ATC about the hydraulic-system problem. The crew was not able to extend the landing gear and conducted a gear-up landing. A subsequent inspection indicated that the left-inboard main-landing gear tire had failed and shed about 30 inches (76 centimeters) of tread. Black marks extending from the tire were found on the landing gear actuator and valve body, which was leaking.				
Aug. 27, 1999	Glennallen, Alaska, U.S.	Learjet 35	substantial	4 none
During final approach, in an attempt to decrease altitude and align the airplane with the runway centerline, the first officer turned the airplane right, retarded the throttles and applied nose-down elevator control. As the airplane passed over the runway threshold, airspeed decreased rapidly and an excessive descent rate developed. The captain took control of the airplane and applied full power to cushion the touchdown. The captain said that the touchdown was "firm" but "within acceptable limits." He said that the initial touchdown was on the left-main landing gear and with the left wing low. A post-landing inspection was not conducted. About 45 minutes later, the pilots, two flight nurses and one patient boarded the airplane for the return trip to Anchorage. After the airplane's arrival in Anchorage, an inspection by ground personnel revealed a 3.3-foot (0.9-meter) scrape on the lower portion of the left wing tip fuel tank and wrinkling of the upper left wing panel, adjacent to the left wing tip fuel tank attach point.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Aug. 29, 1999	Adwa, Ethiopia	Learjet 35A	destroyed	2 fatal
The airplane was being flown over Eritria when a loss of radio contact with ATC occurred. The airplane later was found to have struck terrain. The Ethiopian Defense Force reported a shoot-down of an airplane in the vicinity. An IFR flight plan had been filed under International Civil Aviation Organization regulations from Luxor, Egypt, to Nairobi, Kenya.				
Sept. 14, 1999	Bucharest, Romania	Dassault Falcon 900	minor	7 fatal, 2 serious, 4 minor
The crew was conducting a descent to land in Bucharest. The pilot pulled back the control column to level the airplane at 15,000 feet while the autopilot was engaged. The autopilot then automatically disengaged, and several pilot-induced pitch oscillations occurred. The pitch oscillations were exacerbated by failure of the flight-control artificial-feel-adjusting system ("Arthur unit") in the low-speed position. The report said that the cabin was destroyed during the upset.				
Sept. 26, 1999	Nantucket, Massachusetts, U.S.	Israel Aircraft Industries 1124	substantial	4 none
During climb after departure, the left engine failed. All procedures were accomplished to secure the engine, and the airplane was landed uneventfully. Examination of the airplane revealed extensive damage to the left-engine nacelle and turbine section. The first-stage low-pressure-turbine disk was found to have separated from the low-pressure turbine shaft and penetrated the inner-stage transition liner.				
Sept. 26, 1999	Gainesville, Georgia, U.S.	Learjet 24	substantial	2 serious, 3 minor
The pilots said that the approach and landing were normal. During landing roll-out, about 2,000 feet (610 meters) down the runway, the brakes became ineffective. The airplane continued to roll off the end of the runway, down an embankment and across a four-lane road, and came to a stop in a drainage ditch. Examination of the main landing gear brakes showed that three of the four brake assemblies were worn beyond allowable limits and all four anti-skid generators were not producing voltage within allowable limits. The outboard right-main tire had failed during landing roll due to the malfunctioning anti-skid system. The airplane had received a maintenance inspection two days before the accident that required inspection of the landing gear brake assemblies for wear, cracks, hydraulic leaks and release.				
Oct. 9, 1999	Holland, Michigan, U.S.	Dassault Falcon 900B	substantial	1 serious, 4 none
The captain said that when the airplane was at about 11,400 feet, it appeared that the airplane was going to descend below the assigned altitude, 11,000 feet. The first officer, who was the pilot flying, said that he pulled back on the control column to initiate the level-off without disengaging the autopilot. He said that when he relaxed back pressure on the control column, the airplane pitched nose-down violently and three or four pitch oscillations occurred before the airplane was brought under control. The airplane load factors reached magnitudes between plus 3.3 g (i.e., 3.3 times standard gravitational acceleration) and minus 1.2 g. The flight attendant, who was not wearing a seat belt, was seriously injured.				
Oct. 15, 1999	Parma, Italy	Mitsubishi MU-300	destroyed	8 none
The flight crew apparently undershot the final stage of an ILS approach in daylight IMC. The point of impact was about two nautical miles (four kilometers) from the runway threshold.				
Oct. 19, 1999	Fayetteville, North Carolina, U.S.	British Aerospace 125-700A	substantial	3 none
The left-main landing gear did not extend at the destination airport. The crew departed the traffic pattern, orbited the airport and conducted the alternate landing-gear-extension procedures. The left-main landing did not extend. The crew diverted to an airport with aircraft rescue and fire fighting service, conducted a fly-by, then climbed to altitude where g-loading maneuvers were performed to extend the left-main landing gear. The gear could not be extended. The airplane was landed with the left-main landing gear retracted. Examination of the airplane revealed that the lugs on the cylinder head of the left-main landing gear jack were fractured.				
Oct. 25, 1999	Aberdeen, South Dakota, U.S.	Learjet 35	destroyed	6 fatal
The airplane departed from Orlando, Florida, for a flight to Dallas, Texas, about 0920 local time. Radio contact with the flight was lost north of Gainesville, Florida, after ATC cleared the crew to climb to FL 390. Military pilots who intercepted the Learjet said that the airplane's windshield appeared to be frosted or covered with condensation. The military pilots could not see into the cabin. They did not observe any structural anomaly or other unusual condition. The military pilots observed the airplane depart controlled flight and spiral to the ground.				
Nov. 27, 1999	Boise, Idaho, U.S.	Dassault Falcon 20	substantial	2 none
After extending the landing gear, the down-and-locked indication (green light) for the left-main landing gear did not illuminate. The crew conducted the emergency checklist procedure for abnormal gear extension with no success. The airplane subsequently was landed with the left-main landing gear retracted. Inspection of the landing gear revealed that a pin, which is part of the forward gear-door uplock, was corroded and cracked at the point of rotation, preventing proper movement of the gear-door uplock.				
Nov. 29, 1999	Seattle, Washington, U.S.	Rockwell Sabreliner 65	substantial	8 none
After the Sabreliner was landed, a ground controller cleared the crew to taxi to the ramp. It was a dark night, and light rain was falling. Approximately three minutes later, a Piper Cheyenne was landed, and the crew was cleared to taxi to the ramp. While the Cheyenne was taxiing to the ramp, the ground controller told the pilot to follow a Sabreliner that was ahead on the taxiway going to the ramp. The Cheyenne pilot said that he had the Sabreliner in sight. The Cheyenne pilot said that as he neared the ramp, he looked to the right, for a parking slot. When he looked ahead, the landing light illuminated the tail end of an airplane approximately six feet (two meters) ahead. The pilot applied the brakes, but the Cheyenne struck the tail of the Sabreliner, which had been stopped on the taxiway.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Dec. 9, 1999	Branson, Missouri, U.S.	Cessna Citation 525	destroyed	6 fatal
At 1501 local time, the pilot requested a GPS approach to Runway 11. Springfield Approach told the pilot to descend to 3,000 feet and cleared him for the approach. At 1507, Springfield radar showed the airplane crossing the initial waypoint at 3,000 feet and turning to the 116-degree approach heading. The airplane then was flown to 2,500 feet. At 1508, Springfield Approach cleared the pilot to change to the advisory radio frequency and said, "Call me back with your cancellation or your miss." The pilot acknowledged the instruction. At 1509, Springfield radar showed the airplane begin a descent from 2,500 feet. The last radar contact a few seconds later showed the airplane five nautical miles (nine kilometers) from the airport on a 296-degree radial, at 2,100 feet. The airplane struck a hill 3.7 nautical miles (6.9 kilometers) from the airport. The report said that weather conditions were below the published minimums for the GPS approach and that the pilot descended below the minimum altitude for a segment of the GPS approach.				
Dec. 12, 1999	Gouldsboro, Pennsylvania, U.S.	Israel Aircraft Industries 1124A	destroyed	3 fatal
After a five-hour flight, the crew began a descent to the destination airport. ATC told the crew to cross a VOR at FL 180. The flight crew then was told to cross an intersection at 6,000 feet. The instruction required a descent of 12,000 feet within 36 nautical miles (67 kilometers). The flight crew acknowledged the clearance, and no further radio transmissions were received from the crew. The airplane struck treetops and the ground. The accident flight was the airplane's first flight after maintenance. Work that was accomplished during the maintenance included disassembly and reassembly of the horizontal-stabilizer-trim actuator. Examination of the actuator revealed that it had not been assembled properly.				
Dec. 21, 1999	Cordele, Georgia, U.S.	Cessna Citation 551	destroyed	1 fatal
ATC said that the pilot was given radar vectors to the FAF and cleared for the localizer approach to Runway 10. Recorded radar data showed that the airplane began the approach at 1,900 feet, as published, and descended to 600 feet, as published. The airplane then flew over the airport. The controller said that he was waiting for the missed-approach call as he observed the airplane climb to 700 feet. The airplane then descended to 600 feet and disappeared from radar. The airplane struck treetops and terrain. The report said that the pilot failed to follow the published missed approach procedure.				
Dec. 26, 1999	Milwaukee, Wisconsin, U.S.	Israel Aircraft Industries 1124A	destroyed	6 none
During activation of the crew-oxygen system while the airplane was being taxied to the runway, a fire erupted and consumed the pressure vessel. Examination of the oxygen system components revealed that the fire's initiation location was the first-stage pressure reducer in the oxygen-regulator assembly.				
Jan. 1, 2000	Homestead, Florida, U.S.	Cessna Citation 550	substantial	3 none
The pilot said that he was flying the airplane at 1,000 feet and 200 knots five nautical miles (nine kilometers) from the destination airport when the right wing struck a bird. The pilot told the control tower about the bird strike and landed the airplane without further incident.				
Jan. 27, 2000	Dallas, Texas, U.S.	Mitsubishi MU-300	substantial	6 none
During the descent and approach, the airplane accumulated moderate clear ice, and a warning light indicated that the horizontal stabilizer heat system had failed. The crew elected to continue the approach "to get the airplane out of the icing conditions and on the ground as soon as possible." Because of the possibility of ice on the horizontal stabilizer, the crew decided to keep the speed up and touched down at 120 knots, rather than at 108 knots, and with 10 degrees of flap, rather than 30 degrees. The airplane touched down about 1,500 feet (458 meters) past the runway threshold. The runway was 7,753 feet (2,365 meters) long and had a grooved concrete surface. The runway reportedly was covered with ice and slush. During the landing roll, the airplane appeared not to be slowing significantly. When it became obvious to the crew that the airplane would overrun the runway, the pilot flying steered the airplane off the runway. The airplane continued down a steep slope, and the nose landing gear collapsed.				
March 5, 2000	Key Largo, Florida, U.S.	Cessna Citation 560	substantial	2 none
The pilot completed the before-landing check, which included extending the landing gear, several miles from the runway on final approach. The pilot said that the landing gear indicator lights were green, indicating that the gear was down and locked. After the airplane landed, the pilot deployed the thrust reversers. About the same time, the nose landing gear retracted into the wheel well. The airplane slid and stopped 2,000 feet (610 meters) from the end of the runway. Initial examination of the airplane disclosed a mechanical failure of the nose-gear-lock actuator. During subsequent functional testing of the assembly, however, no mechanical problem was detected.				
March 12, 2000	Jackson, Wyoming, U.S.	Learjet 60	substantial	2 none
The airplane departed from Provo, Utah, with its thrust reversers mechanically pinned closed. The crew conducted the ILS approach with a 6.5-knot tail wind to Jackson Hole Airport's Runway 18, which was 6,299 feet (1,921 meters) long and was contaminated with ice. During the landing roll, the captain used the emergency-braking system, which deactivated the anti-skid braking system. The airplane overran the runway into deep snow.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
March 17, 2000	Hyannis, Massachusetts, U.S.	Dassault Falcon 900	substantial	4 none
The pilot said that the VOR Runway 6 approach to Hyannis had been briefed prior to departure. The ATIS said that winds at Hyannis were from 040 degrees at 20 knots, gusting to 33 knots, visibility was 0.5 statute mile (0.8 kilometer) with snow and freezing fog and that ceilings were at 900 feet broken, 1,400 feet broken and 2,000 feet overcast. The ILS Runway 15 approach was in use. The crew determined that visibility was below minimums for the VOR Runway 6 approach and that the tail wind component for the ILS Runway 15 approach would exceed the airplane's tail wind limit. The pilot requested clearance for the ILS Runway 24 approach, and the airplane was then vectored to and cleared for that approach. After touchdown, the pilot applied maximum reverse thrust and wheel braking, and called for the "air brakes." As the airplane continued down the runway, he noticed an acceleration and a lack of braking effectiveness. However, he decided not to attempt a go-around. The airplane overran the runway. Two occupants of vehicles on a public road received minor injures.				
March 26, 2000	Buda, Texas, U.S.	Cessna Citation 525	destroyed	1 fatal
Nearing a private airport that did not have a published instrument approach, the pilot told ATC that he had the airport in sight and canceled his IFR flight plan. The airplane struck a tree approximately 4,000 feet (1,220 meters) from the airport and then struck the ground inverted. A local weather observation facility was reporting an overcast ceiling at 400 feet AGL and visibility four statute miles (six kilometers) in mist. Local residents said that there was heavy fog and drizzle at the time of the accident. The pilot had filed an alternate airport that had an ILS approach.				
April 2, 2000	Pine Knot, Kentucky, U.S.	Israel Aircraft Industries 1125	none	4 none
A total loss of the airplane's gyroscopic reference system occurred during cruise flight in VMC over Pine Knot.				
April 4, 2000	Opa Locka, Florida, U.S.	Dassault Falcon 20	substantial	2 none
The pilot said that the landing gear failed to extend. The crew conducted a go-around and the "Emergency Gear Extension" checklist. The result was a down-and-locked indication for the nose landing gear and the right-main landing gear, but no indication that the left-main landing gear had extended. Both hydraulic system quantities began decreasing, and the pilots felt a loss of boost pressure in their control columns. The crew declared an emergency and landed with reference to the "Two Gear Down/One Gear Up" checklist. The airplane veered off the left edge of the runway. Examination of the left wheel well revealed the failure of two bolts attaching the hydraulic emergency-slide valve to the left-main landing gear door-actuating cylinder.				
April 5, 2000	Marianna, Florida, U.S.	Learjet 35	destroyed	3 fatal
About four nautical miles (seven kilometers) from the airport, the pilot canceled his IFR clearance and reported the airport in sight. Witnesses said that the airplane was at a low altitude when it entered a right base leg less than a 0.5 nautical mile (0.9 kilometer) from the runway. The airplane pitched nose-up and right-wing-low. The airplane then struck trees and wires, caught fire and struck a road. This was a training flight to prepare the left-seat pilot to retake a Learjet type rating check ride that he had failed on March 24, 2000. He had failed the check ride because, while performing an ILS approach with a simulated engine failure, he allowed the airspeed to decrease below V_{REF}.				
May 2, 2000	Orlando, Florida, U.S.	Cessna Citation 501	substantial	2 none
The preliminary report said that the pilot silenced the landing gear warning horn and forgot to lower the landing gear. Just prior to touchdown, the pilot attempted to lower the landing gear. The airplane touched down with the landing gear in transit, and the right-main landing gear collapsed. The airplane skidded approximately 2,500 feet (763 meters) before stopping.				
May 2, 2000	Lyon, France	Learjet 35A	destroyed	2 fatal, 3 minor
The airplane was en route from Farnborough, England, to Nice, France. The preliminary report said that the crew declared an emergency during descent from FL 390 to FL 370. They said that an engine had failed and that they were descending below FL 370. ATC acknowledged the emergency and cleared the crew to descend. The crew requested vectors to the nearest airport with a runway at least 5,250 feet (1,600 meters) long. ATC offered Lyon Satolas, and the crew accepted. The flight was given radar vectors to intercept the ILS approach to Runway 36. On a straight-in final in VMC, near the approach end of the runway, the airplane was observed to bank left. The left-wing-tip fuel tank struck the ground, and the airplane came to rest upright to the left of the runway.				
May 10, 2000	Kaunakakai, Hawaii, U.S.	Rockwell Sabreliner 65	destroyed	6 fatal
The airplane struck mountainous terrain after the flight crew terminated an instrument approach and proceeded visually at night. The crew had selected the wrong radio frequency for the pilot-controlled light system. The report said that the dark visual scene on the approach path and the absence of a visual glide path indicator system were conducive to producing a false perception that the airplane was at a higher altitude.				
June 13, 2000	Peterborough, Ontario, Canada	Dassault Falcon 20	substantial	2 minor
The preliminary report said that the flight crew received clearance to conduct the NDB Runway 09 approach during nighttime IMC. The crew did not acquire visual contact with the runway environment, and they conducted a missed approach. During the second NDB approach, the crew acquired visual contact with the runway environment. The airplane touched down near the runway midpoint, and the captain, the pilot flying, elected to reject the landing. The captain then conducted a left visual circuit to attempt another landing. As the airplane was turning onto final approach, it pitched nose-down, banked left and struck terrain.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
June 23, 2000	Boca Raton, Florida, U.S.	Learjet 55	destroyed	4 fatal
The Learjet departed from an uncontrolled airport, and the crew was not in radio communication with ATC during a VFR climb. An Extra EA-300S departed VFR from a controlled airport nearby, and the pilot requested and received a frequency change from the airport control tower. Both airplanes were in right turns when they collided at about 2,400 feet two minutes later.				
June 27, 2000	Fort Lauderdale, Florida, U.S.	Dassault Falcon	substantial	2 none
The airplane was climbing through about 200 feet on takeoff when the crew heard a loud bang and felt extreme vibrations. The captain said that the no. 2 engine gauge indications "went to zero" and that there was no indication of fire. The first officer continued flying the airplane around the pattern and made an uneventful landing. Examination revealed that a three-foot (one-meter) section of the right-engine nacelle had torn outward, in line with the high-pressure turbine disk, and that the turbine disk had a groove consistent with contact with a static seal.				
July 10, 2000	Nashville, Tennessee, U.S.	Cessna Citation 560XL	substantial	7 none
While taxiing, the pilot said that he applied wheel brakes and left rudder to make a 90-degree left turn, but the airplane did not respond. The report said that the crew did not engage the emergency-braking system. The airplane continued to gain speed straight ahead, exited the taxiway and struck a building. Testing of braking-system components indicated no malfunctions.				
Aug. 14, 2000	Ironwood, Michigan, U.S.	North American Sabreliner 80	substantial	2 fatal, 2 serious
The pilot received a weather briefing that included information about a convective SIGMET (significant meteorological information) and a severe-weather watch. The weather briefer told the pilot that a route to the southeast would keep the flight out of the heavy weather and that "you'll get clobbered if you go due east." After departure, the pilot requested a turn to the northeast to stay clear of weather. While in the climb, the crew was advised of a weather watch for the area of their flight. The CVR indicated that continuous engine ignition was not selected prior to encountering turbulence. About 23 minutes after takeoff, the airplane was climbing through about 30,800 feet when the pilot reported a dual engine failure due to a lightning strike. The copilot established a descent at 170 knots, the best-glide airspeed. The airplane was vectored near a Level 5 thunderstorm during the emergency descent. Two airstarts were attempted while the airplane was above the maximum altitude for an airstart. Two more airstarts were attempted within the airstart envelope but were unsuccessful. The airplane struck heavily wooded terrain.				
Sept. 6, 2000	Sheridan, Wyoming, U.S.	Gulfstream IV	none	1 serious, 11 none
The predeparture weather briefing received by the pilot called for occasional moderate turbulence below FL 180. The captain said that while descending through FL 260, the airplane encountered unforecast turbulence. One passenger was "thrown about the cabin" and sustained a broken ankle while returning to his seat after securing the galley at the pilot's request.				
Oct. 6, 2000	Rouyn-Noranda, Quebec, Canada	Cessna Citation 550	minor	3 none
The airplane was on initial climb when the crew noticed smoke in the cockpit. The crew donned oxygen masks, declared an emergency and asked for clearance for an immediate return VFR to Rouyn. The airplane was landed safely. Initial investigation revealed that the smoke was generated by the overhead fan forward of the rear pressurization bulkhead. Two screws had become loose and jammed the fan rotor, causing the fan to overheat. The 20-ampere circuit breaker for the fan did not trip.				
Oct. 17, 2000	Van Nuys, California, U.S.	Gulfstream II	substantial	3 none
The Gulfstream crew was conducting an ILS approach in VMC and had been sequenced behind a Beech King Air C90 that was on a straight-in visual approach. The report said that the King Air pilot had set an incorrect code in the airplane's transponder and that an ATC computer software anomaly caused the King Air's data block to be suppressed on the approach controller's radar display. The approach controller told the Gulfstream crew that the King Air was one nautical mile (two kilometers) ahead, but the Gulfstream crew did not acquire visual contact with the other airplane. After establishing radio contact with the tower controller, the Gulfstream crew asked if there was any traffic in their vicinity, and the tower controller said, "Nothing reported." The tower controller realized his mistake approximately 16 seconds later, after the airplanes had collided 2.5 nautical miles (4.6 kilometers) from the runway. The bottom of the G-II's left wing was scratched, and the left-wing flap and wing-tip fairing were bent. The upper fuselage of the King Air was dented, and skin was torn on the upper surface of the right wing. Both airplanes were landed without further incident.				
Oct. 23, 2000	Morristown, New Jersey, U.S.	Raytheon Beechjet 400A	none	4 none
During descent for landing, an uncommanded right-aileron-trim input to the "up" (wing-down) position occurred. Attempts to raise the right wing through the use of the roll-trim-select switches were unsuccessful. Both pilots used full-left roll input to maintain control of the airplane. As airspeed decreased, controllability improved and an uneventful landing was made. The report said that examination of the roll-trim-control printed circuit board revealed that the relays on the board had developed a "time lag," causing them to stick in the closed position.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Dec. 2, 2000	Vancouver, British Columbia, Canada	Learjet 35A	none	(not available)
While climbing through FL 290, the airplane began turning right with five degrees of bank, although the autopilot was engaged and there was no reason for such a turn. The crew disengaged the autopilot and found that they could not move the ailerons. The right bank increased to about 20 degrees. The crew told ATC about the control difficulties and consulted the flight control malfunction checklist. After four or five attempts to move the ailerons, there was a small movement and the angle of bank decreased to about 15 degrees. Continued application of force on the aileron controls resulted in further movement until full aileron control returned. The crew flew the airplane back to Vancouver and landed without further incident. The report said that water had collected in the aileron brush seals while the airplane was on the ground and subsequently froze, effectively freezing the ailerons, when the airplane climbed above the freezing level. Wear and matting of the seals, and likely too much grease, affected the seal channels so that they failed to allow the free passage of water.				
Dec. 20, 2000	Jackson, Wyoming, U.S.	Hawker Siddeley 125-700	substantial	4 none
The flight crew was conducting an ILS approach at a high-altitude airport (elevation, 6,445 feet) in a mountainous area, at night. The control tower was closed. Activation of the airport lights required keying a microphone with the radio tuned to the common traffic advisory frequency (CTAF). The copilot made multiple attempts to activate the runway lights using the UNICOM frequency, which had been the CTAF until about six months earlier. The report said that the captain continued the approach below approach minimums without the runway lights on. The captain said that during the landing flare, strong crosswinds and blowing snow created a whiteout condition. The airplane touched down 195 feet (59 meters) left of the runway centerline in snow-covered terrain between the runway and taxiway. Two ILS Runway 18 approach charts were found in the airplane. One was out of date and showed the UNICOM frequency as the CTAF. The other was current and showed the control tower frequency as the CTAF.				
Jan. 4, 2001	Schenectady, New York, U.S.	Learjet 35	substantial	3 none
The captain said that prior to departure, the flight controls were tested, with no abnormalities noted, and the takeoff pitch trim was set to the "middle of the takeoff range," without referring to any available horizontal-stabilizer-trim-setting charts. During the takeoff roll, the pilot attempted twice to rotate the airplane, then rejected the takeoff halfway down the 4,840-foot (1,487-meter) runway because the controls "didn't feel right." The airplane overran the runway, struck a fence and stopped near a road. Examination of the airplane revealed that the horizontal stabilizer was positioned at minus 4.6 degrees, the maximum nose-down limit within the takeoff range (the minimum nose-down limit is minus 7.4 degrees). The horizontal stabilizer trim and elevator controls moved freely through their full ranges of travel. The report said that a horizontal stabilizer trim setting of minus 7.2 degrees was appropriate for the airplane's loading.				
Jan. 14, 2001	Troy, Alabama, U.S.	Learjet 60	substantial	2 serious
Witnesses said that the airplane struck a deer soon after touchdown, continued down the runway with the tires smoking and veered off the right side of the runway. The airplane crossed a taxiway, struck a ditch and burst into flames. The report said that calculations indicated that the airplane touched down with a groundspeed of 210 knots.				
Jan. 31, 2001	Salcea, Romania	Cessna CitationJet	substantial	10 none
The airplane was landed short and to the left of the extended runway centerline. The landing gear was destroyed, and other structural damage occurred.				
Feb. 3, 2001	New Orleans, Louisiana, U.S.	Hawker 125-700A	substantial	3 none
The pilot said that the airplane was being flown at 4,000 feet over Lake Pontchartrain when the flight crew heard a bang, which they believed was a bird strike. The pilots landed uneventfully in New Orleans. Postflight examination revealed that the left wing's fuel-tank vent was blocked with duct tape and that the fuel tank had collapsed. The pilot said that the fuel tanks had been repaired and pressure-tested prior to the flight, and that the mechanic removed the duct tape from the right fuel-tank vent; however, the mechanic and the flight crew failed to notice the duct tape over the left fuel-tank vent. The flight crew said that there were no streamers or markers to indicate that the fuel-tank vent was covered with duct tape.				
Feb. 4, 2001	Fort Pierce, Florida, U.S.	Learjet 25	substantial	3 none
During takeoff, the pilot experienced a landing gear retraction problem. Soon after touchdown, the left-main landing gear broke away from the airframe. Directional control of the airplane was lost, and the airplane skidded off the left side of the runway. Examination of the airplane's maintenance records revealed that the landing gear assembly had been removed and reinstalled during a recent maintenance procedure. Further examination revealed that the left-main landing gear trunnion pin was improperly installed and secured.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Feb. 8, 2001	Nürnberg, Germany	Learjet 35A	destroyed	3 fatal
The flight crew reported a loss of power from the no. 1 engine during initial climb in VMC. A loss of control then occurred, and the airplane struck trees and terrain.				
Feb. 14, 2001	Punta Gorda, Florida, U.S.	Learjet 35A	substantial	5 none
The airplane was landed hard on Runway 03. The left-main landing gear tires ruptured, and the airplane traveled about 4,100 feet (1,251 meters) down the runway before stopping. The pilot said that during the first approach, he lost sight of the runway at 800 feet because of light fog. He conducted a missed approach and stayed in the landing pattern. During the second approach, he was distracted by the fog. The copilot advised him to go around again, but the pilot continued the landing. He said that the landing was hard but that he did not realize he had a problem until the airplane began pulling left. The reported visibility at the time of the accident was 0.25 statute mile (0.40 kilometer).				
Feb. 26, 2001	Sault Ste. Marie, Michigan, U.S.	Cessna Citation 500	substantial	4 none
The captain said that he conducted the VOR approach to Runway 32. At 2,500 feet, the airplane descended below the clouds, and the captain initiated a visual straight-in approach. After aligning the airplane with the runway, he noticed that there was contamination on the runway — "maybe compacted snow or maybe ice with fresh snow over it." The captain briefed the first officer that they would conduct a go-around if by midfield they were not decelerating adequately. The captain said that they touched down within the first third of the runway. Close to midfield, the airplane oscillated longitudinally. Past midfield, the captain called for a go-around. The first officer said that the captain increased power and he disengaged the airbrake system. The first officer said, "There [was] not enough runway. I braced myself as the airplane went into the snow." The first officer said that braking action had been reported as nil. A NOTAM stated, "Icy runway, nil braking."				
March 8, 2001	Hamburg, Germany	Cessna CitationJet	substantial	1 none
The landing gear collapsed during the landing roll.				
March 9, 2001	Bridgeport, Connecticut, U.S.	Hawker Siddeley 125-3A	substantial	2 none
The ATIS indicated that visibility was 0.5 statute mile (0.8 kilometer) with snow and fog and that the ILS Runway 06 approach was in use. Braking action advisories were in effect, and all surfaces were covered with thin wet snow. During the approach to the airport, with the first officer flying, the captain observed that the hydraulic-pressure indication was normal, and he performed a "brake test." The tower controller advised the flight crew that a Piper Navajo pilot had just landed and reported a 250-foot ceiling, 0.75-statute-mile (1.21-kilometer) visibility and good braking action. On final approach, the Hawker broke out of the overcast about 400 feet AGL; the runway appeared dry, with snow blowing across it. As the airplane touched down about 1,463 feet (446 meters) beyond the approach end of the 4,677-foot (1,426-meter) runway, the first officer found that the wheel brakes were ineffective, and she retracted the flaps to slow the airplane. The airplane did not decelerate, and the first officer engaged the emergency-braking system, then the parking brake. The airplane overran the runway and struck a nonfrangible fence.				
March 29, 2001	Aspen, Colorado, U.S.	Gulfstream III	destroyed	18 fatal
The airplane struck terrain on final approach about 2,400 feet (732 meters) from Runway 15 in nighttime IMC. The report said that the flight crew operated the airplane below the MDA for the VOR/DME approach without appropriate visual references. Tower controllers had not received a NOTAM about a nighttime restriction on the approach. The report said that the flight had departed late and that the pilot was pressured by the charter customer to land at Aspen.				
April 3, 2001	Ashwaubenon, Wisconsin, U.S.	Cessna Citation 501	destroyed	1 fatal, 3 serious, 4 minor
Soon after takeoff from Green Bay, Wisconsin, the pilot told ATC, "We have a little problem here. We're going to have to come back." The weather was reported as ceilings at 200 feet broken and 800 feet overcast, and visibility 0.5 statute mile (0.8 kilometer) with snow and fog. The crew requested clearance to conduct a visual approach. The controller said, "[You would] like a contact approach, [is] that what you're saying?" There was no response from the pilot. ATC radar showed the airplane at 160 feet AGL 1.3 nautical miles (2.4 kilometers) from the airport. Radar contact then was lost. A witness said, "It was snowing moderately. … I noted a white private jet flying … at approximately a 75-[degree to] 80-degree angle perpendicular to the ground with its left wing down and teetering slightly. It then crossed Main Street with the lower wing tip approximately 20 [feet] to 30 feet [six meters to nine meters] above the power wires. The plane became more perpendicular to the ground at a 90-degree angle with the left wing down and lost altitude, crashing into the Morning Glory Dairy warehouse building." An examination of the airplane revealed no pre-impact anomalies.				
May 12, 2001	San Diego, California, U.S.	Gulfstream IV	substantial	13 none
The pilot of a parked Bell 206B helicopter said that he had started the engine and observed the Gulfstream coming down the taxiway. He saw line-service personnel direct the Gulfstream crew to continue taxiing between the helicopter and another airplane. The helicopter's main rotor blade struck the Gulfstream's winglet.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
June 7, 2001	Victorville, California, U.S.	Learjet 24A	substantial	3 none
The pilot conducted the first touch-and-go landing. The copilot conducted the second touch-and-go landing. During the third approach, at 50 feet, the copilot disengaged the yaw damper and inadvertently induced a Dutch roll oscillation. The airplane rapidly decelerated and developed a high sink rate. The right wing-tip fuel tank struck the ground and separated from the airplane, and the airplane bounced back into the air. The airplane then landed hard. The main landing gear collapsed, and the airplane skidded to a stop off the right side of the runway. The report said that the pilot had not demonstrated the handling characteristics of the airplane with the yaw damper off.				
June 11, 2001	Oxford, U.K.	Cessna Citation 550	substantial	5 none
The commander reported that the before-landing checks had been conducted and that a standard visual approach had been flown to Runway 20, followed by a short-field landing. The wheel brakes, thrust reversers and speed brakes were engaged. The landing gear warning horn sounded, and the landing gear warning light illuminated. The nose gear then collapsed, and the airplane slid to a stop on the runway.				
June 12, 2001	Salina, Kansas, U.S.	Learjet 25D	substantial	2 serious
During a test flight, an elevator-system oscillation occurred during an intentional high-speed dive outside the normal operating envelope. The report said that the aft-elevator-sector clevis fractured due to reverse bending fatigue caused by vibration, resulting in a complete loss of elevator control. The flight crew said that pitch control was re-established by using horizontal stabilizer pitch trim. During final approach, the airplane's nose began to pitch down and the pilot flying was unable to raise the nose using a combination of horizontal stabilizer trim and engine power. The airplane landed short of the runway, striking an airport-perimeter fence and a berm.				
July 19, 2001	Teterboro, New Jersey, U.S.	Raytheon Beechjet 400	none	2 none
The airplane was approximately 10 nautical miles (19 kilometers) west of the airport at 4,000 feet and indicating 220 knots when the captain felt an abnormal yaw input and lost rudder control. Perceiving that the yaw damper had failed, he disengaged the yaw damper, but rudder control was not regained. The captained continued the approach and landed uneventfully. An inspection by maintenance personnel revealed that the right-aft rudder cable had separated in overload created by a bend or kink in the cable.				
Aug. 24, 2001	Ithaca, New York, U.S.	Learjet 25	destroyed	2 fatal
During departure, with the first officer flying, the airplane struck a fence and terrain about 1,000 feet (305 meters) beyond the departure end of the runway. A witness had observed the airplane rotate about 3,500 feet (1,068 meters) from the departure end of the runway and begin to climb at a steep angle. The witness lost sight of the airplane in fog about 150 feet AGL.				
Aug. 28, 2001	Detroit, Michigan, U.S.	Dassault Falcon	substantial	2 none
The captain said that prior to takeoff, he closed the cargo door and the first officer confirmed that the door-warning light was out. A witness observed that the exterior door latch was not down as the airplane was taxied to the runway. After takeoff, at about 600 feet, the cockpit door opened and the cargo-door-warning light illuminated. The captain decided to return to the airport. The captain said that he requested repeatedly that the landing gear and the flaps be extended, but the first officer was late in doing so and it "caused us to overshoot the runway centerline." The first officer called for a go-around, retracted the landing gear and partially retracted the flaps. The first officer said that the captain continued to descend and deviated right of the runway centerline. The first officer then extended the landing gear. The nose gear extended prior to touchdown, but the main landing gear did not. The airplane touched down approximately halfway down the runway and traveled off the end.				
Oct. 8, 2001	Milan, Italy	Cessna Citation CJ2	destroyed	118 fatal
Visibility varied from 164 feet to 318 feet (50 meters to 100 meters) in fog when the Citation was taxied onto the active runway while a Boeing MD-87 was departing on the runway. After the collision, the MD-87 struck a baggage-handling building, killing four people inside the building.				
Oct. 26, 2001	Ciudad Victoria, Mexico	Learjet 25	substantial	6 none
Both main landing gear collapsed during the landing touchdown in nighttime VMC.				
Nov. 22, 2001	Pittsburgh, Pennsylvania, U.S.	Learjet 25B	destroyed	2 fatal
A commercial pilot who observed the airplane during takeoff said that it used "lots" of runway and that rotation was conducted "too early and way too slow." The airplane lifted off with a 45-degree nose-up pitch attitude. The airplane was airborne briefly before it descended, veered off the left side of the runway about 3,645 feet (1,112 meters) from the approach end and struck a chain-link fence. The report said there was no indication of a pre-impact mechanical malfunction.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Nov. 26, 2001	Mexico City, Mexico	Cessna Citation 550	substantial	6 none
The airplane overran the runway during a rejected takeoff in VMC at the Benito Juarez International Airport.				
Dec. 9, 2001	Boston, Massachusetts, U.S.	Rockwell Sabreliner 80	substantial	3 none
After touchdown, the pilot deployed the thrust reversers. Soon thereafter, the airplane yawed right violently. The pilot recovered directional control and stopped the airplane on the runway. The report said that the thrust-reverser assembly had separated from the left engine. Three attachment bolts had failed from fatigue; a fourth bolt was pulled out of the flange and was slightly bent.				
Dec. 10, 2001	Sierra Blanca, Mexico	Learjet 24	destroyed	2 fatal
The airplane struck terrain during an uncontrolled descent in VMC. The airplane was at FL 390 when the crew was cleared to descend to 10,000 feet. At about FL 220, the airplane began a climb that lasted about 20 seconds, then began to descend. ATC radar contact was lost about 18 seconds later. The report said that ATC received no distress radio calls from the crew.				
Dec. 20, 2001	Zurich, Switzerland	Cessna Citation 560	destroyed	2 fatal
At 2208 local time, the airplane traveled about 1,200 feet (366 meters) down the runway, lifted off with a right-wing-low bank and struck trees on initial climb in IMC. The report said that the airplane was not deiced prior to takeoff.				
Jan. 4, 2002	Birmingham, U.K.	Canadair Challenger 604	destroyed	5 fatal
Witnesses said that they observed frost or ice on the airplane's wings prior to departure. Other airplanes that had been parked overnight were deiced, and there were reports of moderate ice to severe ice accumulations and frost accumulations. The Challenger was not deiced. The takeoff appeared normal until lift-off, when the airplane began to bank left. The roll rate increased rapidly. The report said that the airplane was banked 80 degrees left when the left wing scraped the runway edge and fuel released from the ruptured wing tank ignited. The airplane then struck the ground.				
Feb. 7, 2002	Novato, California, U.S.	Cessna CitationJet	substantial	1 none
The pilot said that he had received a full weather briefing earlier in the day and an abbreviated briefing before departure. He said that the weather was "pretty miserable" and that it was a "hard IFR flight" to Novato. Nearing the airport, he heard the crew of an airplane that had been landed report that they had descended below the clouds at 1,200 feet. The accident pilot conducted a GPS approach to Runway 13. The automated surface observing system (ASOS) was reporting winds from 230 degrees at 11 knots with gusts to 17 knots. The pilot said that he began the descent from the final approach fix late and "used up most of the runway trying to get down." The airplane overran the runway and stopped in a ditch.				
Feb. 8, 2002	Broomfield, Colorado, U.S.	Gulfstream IV	none	1 serious, 3 none
ATC advised the flight crew of possible severe turbulence as they began the descent from cruise altitude. The captain said that she briefed the flight attendant about the possibility of turbulence and selected the "Fasten Seat Belts/No Smoking" sign and chime. Soon thereafter, the airplane encountered severe turbulence. The flight attendant said that he was out of his seat when he heard the chime. He returned to his seat but was unable to fasten his seat belt before the turbulence encounter. The report said that the flight attendant was "thrown about" and received an ankle-bone fracture.				
Feb. 10, 2002	Cleveland, Ohio, U.S.	Mitsubishi MU-300	substantial	2 none
The crew of another business jet reported braking action as poor. All runway surfaces were covered with a thin layer of snow. The Mitsubishi crew conducted the Runway 23 ILS approach in nighttime IMC. The airplane touched down hard with 2,233 feet (681 meters) of the 5,101-foot (1,556-meter) runway remaining. The airplane overran the runway, and the nose landing gear collapsed. The report said that the surface winds were from 330 degrees at 12 knots, gusting to 22 knots.				
Feb. 14, 2002	West Palm Beach, Florida, U.S.	Gulfstream V	substantial	2 none
Soon after departure, the pilot requested clearance to return to the airport because the landing gear did not retract on command. As the airplane was flared for landing, the ground spoilers deployed. The airplane landed hard, and the right-main landing gear collapsed. The report said that wooden tongue depressors were found in the weight-on-wheels switches for both main landing gear. A maintenance technician had used the tongue depressors to disable the weight-on-wheels system while the airplane was on jacks for a tire change, so that he could access the maintenance-data-acquisition unit to check an overspeed message. The tongue depressors were not removed after maintenance was completed.				
March 25, 2002	Anderson, Indiana, U.S.	Mitsubishi MU-300	substantial	6 none
Freezing rain and snow were reported in the area. The crew conducted an ILS approach to Runway 30, which was 5,401 feet (1,647 meters) long and had a grooved asphalt surface. The controller said that winds were from 050 degrees to 070 degrees at 10 knots, gusting to 20 knots, and that braking action had been reported as fair to poor by a snowplow operator. The controller told the crew that they had the option to conduct either a straight-in approach to Runway 30 or a circling approach to Runway 12. The captain said that they would land on Runway 30. Radar data indicated that the airplane's groundspeed was more than 200 knots between the FAF and the runway threshold. The airplane overran the runway.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
April 1, 2002	Lake in the Hills, Illinois, U.S.	Cessna Citation 551	substantial	2 none
The pilot said that during the takeoff roll, the copilot and he saw five deer on one side of the runway. The crew rejected the takeoff. During rollout, at 60 knots, the airplane struck another deer that had run into the airplane's path from the other side of the runway.				
April 25, 2002	Lake in the Hills, Illinois, U.S.	Cessna Citation 560	substantial	2 none
The first officer was flying the airplane from the left seat. The captain said that the approach to the 3,058-foot (933-meter) runway was normal and "on speed." During the flare, the first officer lowered the nose, and the airplane touched down on all three landing gear and bounced. The captain said that the bounce was not severe enough to warrant a go-around. After the second or third bounce, the captain took the controls but could not control the airplane. He said that the airspeed was too slow to attempt a go-around. The nose gear was damaged on the last bounce.				
May 1, 2002	Baltimore, Maryland, U.S.	Raytheon Beechjet 400A	substantial	6 none
The captain said that he was distracted by a flight-management-system problem during approach and did not hear their clearance to conduct a visual approach. As a result, the airplane was "high and fast" on final approach. The first officer called for a go-around, but the captain continued the approach. He said that airspeed was "V_{REF} plus 40" when the airplane was over the runway threshold. The first officer said that the airplane touched down about halfway down the runway. The airplane overran the runway and struck barriers and light poles.				
May 2, 2002	Leakey, Texas, U.S.	Cessna Citation 560	destroyed	6 none
The airplane overran the 3,975-foot (1,212-meter) runway and struck trees. A postimpact fire consumed the airplane after the occupants exited.				
May 8, 2002	Cleveland, Ohio, U.S.	Raytheon Beechjet 400	substantial	2 none
Soon after calling V_1 on takeoff, the copilot told the pilot that there were birds ahead. The pilot rejected the takeoff and stopped the airplane 100 feet (31 meters) from the end of the runway. Examination revealed that both engines had ingested birds.				
May 20, 2002	Oklahoma City, Oklahoma, U.S.	Cessna Citation 550	substantial	1 minor, 5 none
The pilot said that he did not observe any anomalies during the preflight examination of the airplane or while taxiing for takeoff. He said that a check of the flight controls indicated that they were "free and correct." During the takeoff roll on the 7,198-foot (2,195-meter) runway, the pilot began pulling back on the control column at V_1 (103 knots), but the nose landing gear did not lift off the runway. The pilot rejected the takeoff at about 120 knots and applied maximum wheel braking. The airplane veered off the right side of the runway, struck a fence, traveled across a road and stopped in a muddy field.				
June 17, 2002	Oxford, Connecticut, U.S.	Learjet 35A	substantial	2 none
The pilot was receiving an orientation flight in the airplane after completing ground school. When he applied power during a touch-and-go landing, the airplane became uncontrollable, veered off the left side of the runway and stopped in a grassy area. The flight instructor said that the thrust reversers would not always deploy or stow at the same time. The report said that the flight manual supplement for the thrust reversers, which said that they must not be used during a touch-and-go landing, was not in the airplane flight manual. The pilot said that he was not aware of the prohibition against the use of reverse thrust during a touch-and-go landing. The flight instructor said that he was aware of the prohibition but was not aware that the pilot had deployed the thrust reversers.				
Aug. 5, 2002	Jinzhou, China	Gulfstream IV	none	1 serious, 4 none
The pilot said that the airplane was descending through about FL 300 when it entered a layer of stratus clouds and encountered light chop, then severe turbulence. The captain said that the flight crew had been circumventing a line of scattered thunderstorms and that they had advised the flight attendant of possible turbulence ahead. The severe-turbulence encounter lasted about 90 seconds. After the turbulence subsided, a passenger advised the flight crew that the flight attendant had been injured. The airplane was landed about 15 minutes later, and the flight attendant was treated for a fracture of her left ankle.				
Aug. 10, 2002	Sandusky, Ohio, U.S.	Cessna Citation 500	substantial	2 none
The airplane was being rotated for a nighttime takeoff when a deer ran onto the runway and was struck by the nose landing gear. The crew continued the takeoff and diverted to a larger airport, where the airplane was landed with the nose gear partially extended.				

Appendix
Business Jet Accidents, 1991–2002 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Aug. 13, 2002	Big Bear, California, U.S.	Cessna Citation 550	destroyed	7 none
On approach, the Citation crew radioed for traffic advisories. A flight instructor, who was conducting touch-and-go landings with a student, advised the Citation crew of wind shear near the approach end of Runway 26. The flight instructor extended his downwind leg to allow the Citation crew to land first. The flight instructor then observed that the windsocks and the AWOS indicated winds from about 060 degrees; he told the Citation crew about the wind change and that he would be landing on Runway 08. The Citation crew did not acknowledge the transmission. The Citation subsequently was landed on Runway 26 (5,260 feet [1,604 meters] usable) and overran the runway. The airplane penetrated the airport-perimeter fence, traveled across a road and stopped in a dry lake bed. The Citation captain said that the thrust reversers did not function during the landing.				
Aug. 30, 2002	Lexington, Kentucky, U.S.	Learjet 25C	destroyed	1 fatal, 4 serious, 1 minor
The captain said that during an emergency medical services flight, the airplane touched down about 1,000 feet to 1,500 feet (305 meters to 458 meters) from the threshold of the 7,003-foot (2,136-meter) runway. The thrust reversers were selected but did not deploy. The captain said that manual wheel braking "gave no indication of slowing the airplane." He told the first officer to apply his wheel brakes but felt no deceleration. He then told the first officer to engage the emergency-braking system. The airplane overran the runway at 70 knots to 80 knots, struck ILS ground equipment and slid across a highway. One passenger (the patient) was killed; the two pilots, a flight nurse and a passenger received serious injuries; and a truck driver received minor injuries. The report said that the thrust reversers had come out of the stowed position but had not deployed.				
Oct. 7, 2002	Dexter, Maine, U.S.	Cessna CitationJet	substantial	2 serious, 2 minor
The pilot said that the approach was stabilized and that the airplane touched down in the first quarter of the 3,400-foot (1,020-meter) runway slightly above V_{REF}. The pilot selected ground flaps and applied the wheel brakes. He could feel the anti-skid braking system pulsating through the brake pedals, but the airplane did not decelerate as expected. With approximately 1,500 feet (458 meters) of runway remaining, he rejected the landing, but the airplane did not accelerate as expected. The airplane overran the runway.				
Nov. 8, 2002	Taos, New Mexico, U.S.	Israel Aircraft Industries 1124A	destroyed	2 fatal
The report said that the crew was conducting a VOR/DME-B approach in IMC. The airplane crossed the initial approach fix at 15,000 feet (minimum crossing altitude is 12,000 feet; airport elevation is 7,091 feet). Soon thereafter, controllers heard a "mayday" radio call and a loss of radio contact and radar contact with the airplane occurred. A witness said that he heard "distressed-engine noises overhead" and observed a small jet flying overhead. "The engine seemed to be cutting in and out," the witness said. The airplane then descended behind a ridge, and the witness heard an explosion and saw a large cloud of smoke. The report said that the airplane had encountered mountain-wave conditions, resulting in a loss of control.				
Dec. 3, 2002	Astoria, Oregon, U.S.	Learjet 36A	substantial	4 none
The pilot said that at approximately V_1 during takeoff, the airplane struck an elk. The pilot applied the wheel brakes and deployed the drag chute, but the airplane overran the runway and stopped in a bog.				
Dec. 16, 2002	Seattle, Washington, U.S.	Hawker Siddeley HS-125	substantial	3 none
The first officer was flying the approach. The captain stated that he extended the flaps and the landing gear. The first officer said that she did not check the landing-gear indications before landing. The airplane touched down with the landing gear retracted. The report said that the landing gear position-indicator lights were functional but that the landing gear warning horn did not function with the landing gear retracted, the flaps fully extended and the throttle levers at idle. Further examination disclosed a "bad" set of contacts in the landing gear warning-horn circuit.				

AGL = Above ground level ATC = Air traffic control ATIS = Automatic terminal information service AWOS = Automated weather-observing system CVR = Cockpit voice recorder DME = Distance-measuring equipment FAF = Final approach fix FL = Flight level GPS = Global positioning system IFR = Instrument flight rules ILS = Instrument landing system IMC = Instrument meteorological conditions MDA = Minimum descent altitude NDB = Nondirectional beacon NOTAM = Notice to airmen VASI = Visual approach slope indicator VFR = Visual flight rules VMC = Visual meteorological conditions VOR = Very-high-frequency omnidirectional radio V_1 = Takeoff decision speed V_{REF} = Landing reference speed

Source: Patrick R. Veillette, Ph.D., from Airclaims and accident/incident reports by the Australian Transport Safety Bureau, Transportation Safety Board of Canada, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

Number of Serious Incidents of Passenger Disruptive Behavior on U.K. Airlines Decreases

The U.K. Department for Transport said that the likelihood of a passenger boarding a flight on which a serious disruptive-behavior incident took place was extremely small. Nevertheless, the department said, airline employees working aboard flights were more at risk than passengers.

— FSF EDITORIAL STAFF

From April 2002 through March 2003, U.K.-based airlines reported 648 incidents of disruptive behavior by passengers. Of those incidents, the U.K. Civil Aviation Authority (CAA) categorized 613 as "significant" incidents and the remaining 35 as "serious."[1] That represented a decline from 52 serious incidents in the April 2001–March 2002 period, and a further decline in the number of serious incidents from the two previous one-year reporting periods, beginning in April 1999 (Table 1, page 49).

The 613 significant incidents were more than in any of the previous three one-year reporting periods. That increase could be a statistical anomaly, however.

"The CAA classified incidents according to their actual [threat] or potential threat to flight [safety] and personal safety, taking into account consequences such as aircraft diversions," said the report.

Beginning June 1, 2002, to reduce the reporting burden on flight crewmembers and to concentrate on incidents that might involve risk, airlines were asked to report only incidents that CAA would be expected to categorize as serious or significant. Previously, there had been a third category: "other." CAA also made minor changes to the criteria for classifying incidents as significant. Therefore, some of the apparent increase in significant incidents might have resulted from the inclusion of incidents that would previously have been classified as "other." The criteria for serious incidents did not change, so comparisons across one-year periods in that category are valid.

The report on the four years of reported incidents, published by the U.K. Department for Transport, included statistics that offered further details of the reported incidents in the April 2002–March 2003 period.

"Some 74 percent of all incidents involved male passengers," the report said. "The majority of offenders were in their 30s or 40s, and about [25 percent] of incidents involved people traveling alone. Whereas last year [April 2001–March 2002] 21 incidents involved groups of 10 or more, this

Table 1

Severity of Disruptive Behavior Aboard U.K. Aircraft, April 1999–March 2003

	April 1999–March 2000	April 2000–March 2001	April 2001–March 2002	April 2002–March 2003
Serious	74	63	52	35
Significant	519	595	528	613[1]
Other	612	592	475	—
Total incident reports	**1,205**	**1,250**	**1,055**	**648[2]**

[1]The increase in significant incidents may be accounted for by a change in the classification of some types of incidents.

[2]Beginning June 1, 2002, airlines were asked to report only incidents that were likely to be classified as serious or significant.

Source: U.K. Department for Transport

year only nine incidents involved large groups of disruptive passengers. About 4 percent of incidents occurred in business[-class seating] or first-class seating, in common with previous years."

Violence was involved in 90 of the 648 total reported incidents, and the violence was directed toward crewmembers in 48 reported incidents (Table 2). Those 90 incidents represented a reduction from 157 incidents involving violence in the first reporting period, April 1999–March 2000.

Most incidents could be described as "general disruptiveness," the report said, with "verbal abuse" to cabin crewmembers or other passengers accounting for 44 percent of incidents. About 25 percent of incidents involved disobeying airline staff.

"Dissatisfaction with the level of service and smoking restrictions were common triggers for unruly or aggressive behavior, while arguments between passengers often stemmed from domestic disputes, arguments over allocation of seats or the effect of reclining a seat on the person behind," said the report.

The most common form of misbehavior among incidents classified as significant was smoking in an aircraft toilet, the report said.[2]

"There were also several cases of aggressive or abusive behavior, of repeated refusal to follow instructions — often regarding the use of seat belts, of intoxication and of passengers exhibiting signs of personality disorder," the report said. "The number of violent incidents continued the downward trend from previous years."

The 35 incidents categorized by CAA as being serious included "several in which passengers were acting extremely irrationally and [were] strongly suspected of being, or known to be, under the influence of drugs," said the report. "Many involved excessive consumption of alcohol. Nearly all the remainder involved varying degrees of violent, abusive or unacceptable behavior, on a few occasions including damage to the interior of the aircraft."

In most incidents, the misbehaving passenger was given a warning. The report said, "The evidence from the reports suggests that the warning was effective in 28 percent of cases and ineffective in 30 percent of cases (in the remainder, the degree of effectiveness of the warning was not reported)."

In six incidents, a passenger had to be physically restrained using handcuffs, a

Table 2

Incident Details of Disruptive Behavior Aboard U.K. Aircraft, April 1999–March 2003

	April 1999–March 2000	April 2000–March 2001	April 2001–March 2002	April 2002–March 2003
Violence involved	157	139	101	90
Violence toward crewmembers	83	71	49	48
Alcohol involved	607 (50%)	533 (43%)	472 (45%)	271 (42%)
Alcohol — preboarding	66[1]	198	198	121
Alcohol — airline's	234	165	92	63
Alcohol — passenger's own	283	214	182	88
Smoking involved	449 (37%)	408 (33%)	385 (36%)	260 (40%)
Smoking in toilet	240	350	306	221

[1]Not included as a specific category on the reporting form until April 2000.

Source: U.K. Department for Transport

strap or both (compared with 16 such incidents in the April 2001–March 2002 reporting period). In seven incidents, other forms of restraint — such as having a cabin crewmember or another passenger sit next to the disruptive passenger for the remainder of the flight — were used. On five occasions, the aircraft was diverted because of passenger disruption, and there were two instances when taxiing or takeoff procedures were discontinued and the aircraft was returned to the gate.

"There were 132 incidents reported where passengers were offloaded (either after boarding, after pushback or at a stopover)," said the report. "Since cabin crew would not necessarily know at the time of reporting an incident whether further action was taken, there are no reliable figures on how many incidents led to arrest or other police action. However, police or security attended 191 incidents involving disruptive behavior on board U.K. aircraft during the 12 months to [March 31,] 2003 (very similar to the previous year)."[3]

The report examined factors related to disruptive behavior. As in the earlier one-year reporting periods, alcohol and smoking ranked the highest.

Alcohol was identified or suspected of being a contributing factor in 42 percent of incidents, and smoking in 40 percent.

"Around 32 percent of the alcohol-related incidents involved passengers drinking their own alcohol, and 45 percent involved passengers drinking alcohol before boarding," the report said.

Smoking or a desire to smoke played a part in 260 incidents (40 percent of the total), with 85 percent of smoking-related incidents involving smoking in the toilets, the report said.

The numbers of reported incidents should be viewed in the context of the number of flights operated by U.K. airlines and the number of passengers carried, the report said (Table 3).

"During the 12-month period covered by the data, U.K. airlines operated about 1.2 million passenger flights and carried about 118 million passengers," the report said. "In this period, only 35 serious incidents were reported. This means that the chance of an individual passenger boarding a flight on which a serious incident took place was around one in 36,000, and that only one [passenger] in every 3 million passengers was the cause of a serious disruptive incident."

The figures show that "air rage" is not a widespread phenomenon, the report said. "However, there remains a low level of anti-social behavior, which on occasions escalates into serious incidents which could pose a threat to the safety of the aircraft and/or its occupants," said the report. "The Department [for Transport] is also conscious that airline employees working [aboard] aircraft are more at risk of harm than the average passenger by virtue of flying more frequently and the nature of their responsibilities."■

[FSF editorial note: This article is adapted from *Disruptive Behaviour on Board UK Aircraft: April 2002–March 2003*, available on the U.K. Department for Transport Internet site at <www.dft.gov.uk/stellent/groups/dft_aviation/documents/page/dft_aviation_022936.hcsp>.]

Table 3
Context of Disruptive Behavior Aboard U.K. Aircraft, April 1999–March 2003

	April 1999–March 2000	April 2000–March 2001	April 2001–March 2002	April 2002–March 2003
Number of flights per serious incident	15,000	17,000	22,000	36,000
Number of passengers carried per serious incident	1,300,000	1,700,000	2,000,000	3,000,000

Source: U.K. Department for Transport

Notes

1. The definitions used were the following:

   Serious: Serious and very serious incidents that actually threatened flight safety or personal safety, or had the potential for doing so if the situation had escalated (e.g., the incident might have resulted in a diversion, or in cabin crew receiving injury or in a passenger being physically restrained).

   Significant: Incidents that were not trivial and that caused concern but that did not cause a major threat to the safety of the aircraft or its occupants (e.g., smoking in the toilets, a passenger displaying irrational and unpredictable behavior that did not escalate, or using mobile phones contrary to instruction).

2. A spokeswoman for the U.K. Department for Transport said, "For the purposes of analysis, incidents involving smoking in the toilet are classed as significant rather than serious due to the fact that there are so many of them that they would obscure the fewer serious incidents involving other causes." McColl, Lis, press officer, U.K. Department for Transport. E-mail communication to Darby, Rick. Alexandria, Virginia, United States. April 14, 2004. Flight Safety Foundation, Alexandria, Virginia, United States.

3. A spokeswoman for the U.K. Department for Transport said, "Unless other information is specified, incidents involving police action are classed as significant instead of serious, as the policy can differ between companies (e.g., some companies call the police to all incidents involving smoking in the toilets whereas others only call the police to very serious incidents)." McColl, Lis, press officer, U.K. Department for Transport. E-mail communication to Darby, Rick. Alexandria, Virginia, United States. April 14, 2004. Flight Safety Foundation, Alexandria, Virginia, United States.

System Designed to Classify Human Error in Aviation Accidents

Human Factors Analysis and Classification System is a comprehensive framework for investigating, studying and recording human-error factors in aviation accidents, designed to avoid both academic abstraction and, at the other extreme, "pop psychology."

— FSF LIBRARY STAFF

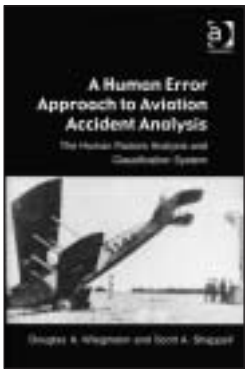
Books

A Human Error Approach to Aviation Accident Analysis: The Human Factors Analysis and Classification System. Wiegmann, Douglas A.; Shappell, Scott A. Aldershot, England: Ashgate Publishing, 2003. 165 pp. Figures, tables, photographs, references, index.

As aircraft generally have become highly reliable, the role of human error in accident causation has become a more prominent factor. Accordingly, aviation safety managers of flight organizations have increasingly emphasized the assessment of human error in accident and incident investigation, and the development and use of programs to counteract human error.

Unfortunately, the book says, aviation safety personnel are faced with a bewildering variety of "models" (intellectual conceptions) for understanding human error. "Even worse, most error models and frameworks tend to be either too 'academic' or abstract for practitioners to understand or are too simple and 'theoretically void' to get at the underlying causes of human error in aviation operations," the book says.

Without a basis in adequate guidance through the various ideas for classifying and understanding human error, many accident-investigation and error-management programs are derived from intuition or "pop psychology," rather than on theory and empirical data, the book says. The authors write, "The result has been accident analysis and prevention programs that, on the surface, produce a great deal of activity (e.g., incident reporting, safety seminars and 'error awareness' training), but in reality only peck around the edges of the true underlying causes of human error."



The book is an attempt to remedy the situation by presenting a "comprehensive, user-friendly framework" that can be applied to investigating and analyzing human error in aviation. That framework — originally developed for and adopted by U.S. military organizations and by the U.S. Federal Aviation Administration — is called the Human Factors Analysis and Classification System (HFACS). It is based on James Reason's "Swiss cheese" model of accident causation, according to which accidents occur when a number of systemic latent failures, active failures and failed or absent defenses ("holes" within different layers of the system) happen to "line up" like the holes in slices of Swiss cheese.

The book says, "In essence, HFACS bridges the gap between theory and practice in a way that helps improve both the quantity and quality of information gathered in aviation accidents and incidents."

To that end, the authors provide a historical overview of the role of human error in aviation accidents; the prominent human-error perspectives that have been advanced in the literature; a review of Reason's model; a full description of HFACS; case studies of how HFACS can be applied to explain human-error causal factors in certain actual aviation accidents; the use of HFACS to analyze existing accident databases; a set of design criteria and validation processes that organizations can use to evaluate whether HFACS would be a useful tool for them; and answers to common questions and concerns that are raised in connection with the HFACS model.

Commercial Aviation Safety. Fourth edition. Wells, Alexander T.; Rodrigues, Clarence C. New York, New York, U.S.: McGraw-Hill, 2003. 399 pp. Figures, tables, references, index.

This book is designed as a thorough review of the principles and regulatory practices of commercial aviation safety in the United States today.

"Today's aviation safety practitioner has to contend with more than just the safety dictates of [the U.S. Federal Aviation Administration] and [the U.S. National Transportation Safety Board]," the book says. "OSHA [the U.S. Occupational Safety and Health Administration] and EPA [the U.S. Environmental Protection Agency] also have regulatory jurisdiction over the aviation sector. It is therefore important that today's aviation safety professional gain a broad understanding of relevant OSHA and EPA regulations. Failure to do so could lead to unsafe operating conditions and regulatory violations that could result in millions of dollars in fines."

This latest edition updates and revises the aviation safety information in previous editions; establishes changes in the format, content and order of the chapters to make the flow of information progressive and logical; and broadens the field to include regulatory information on OSHA and EPA.

The book includes a section about Flight Safety Foundation. "Through the years, [the Foundation] has been responsible for the development of many aviation safety improvements that are taken for granted," it says. "As an apolitical, independent, nonprofit and international organization, [the Foundation] benefits from a nonofficial status because it avoids a great many of the postured responses that many businesses are obliged to present to their peers, governments and media. Because it has no enforcement authority, its task is friendly persuasion. Several aviation leaders have described [the Foundation] as the 'safety conscience' for the industry. [The Foundation] has the support from major manufacturers and airlines (which have a sense of responsibility as well as an enlightened self-interest) to make the skies as safe as possible."

Fly the Wing. Third edition. Webb, Jim; Walker, Billy. Ames, Iowa, U.S.: Blackwell Publishing, 2004. 237 pp. Figures, photographs, index.

Fly the Wing, updated to include discussion of modern cockpit automation, provides pilots (particularly commercial pilots) with tools and techniques for all flight operations. This latest edition also includes a compact disc containing a glossary of flight terms, printable quick reference handbooks and supporting graphics.

Although not intended to replace training manuals, the book is designed as a course in advanced aviation. It is directed to "pilots desiring additional knowledge in the fields of modern flight deck automation; high-speed aerodynamics; high-altitude flying; speed control; and takeoffs and landings in heavy, high-performance aircraft."

Despite its substantial technical content, the book is written in an informal, personal style. For example, in discussing the importance of the pilot being seated correctly during landing for the proper eye reference — the plane of vision from the cockpit position — the book says, "I have found that most instructors do not go any further than merely telling their students [that] 'eye position is important' and not explaining why. Seat and eye position *are* important, but I have found that teaching *why* is equally so. The pilot who *knows* why certain things are taught has a greater tendency to make correct seat and eye position an ingrained habit."

The Art of the Helicopter. Watkinson, John. Oxford, England: Elsevier Butterworth-Heinemann, 2004. 390 pp. Figures, photographs, index.

The capabilities, technologies and inherent limitations of the helicopter are unique to this form of aircraft. Its ability to hover, which sets the helicopter apart, also "dooms it forever to vibration, poor performance and [poor] economy in forward flight," says the preface to the book. The helicopter's typical characteristics have given rise to such descriptions as "a mechanical engineer's dream and an aerodynamicist's nightmare" and "a collection of vibrations held together by differential equations." Nevertheless, the rotary-wing aircraft's ability to operate in terrain that would be dangerous or impossible for an airplane, to land where there is no room for an airstrip (such as on an offshore oil-drilling platform) and to hover make it the preferred aircraft for certain kinds of transportation and, above all, ideal as a rescue vehicle.

Although the complexity of helicopters fascinates and appeals to some pilots, it also makes understanding their theory, mechanics and flight controls challenging. *The Art of the Helicopter* is designed to de-mystify the complexity as it examines helicopter aerodynamic theory, design and performance. The book aims to discuss its subjects readably, begin each subject from first principles and build on those in a "clearly explained logical sequence using plain English and clear diagrams, avoiding unnecessary mathematics," the author said.

Chapters are devoted to technical background; rotors; the tail; engines and transmissions; control; and performance. The book is written, the publisher says, for "pilots and trainees, introductory level engineering students and all helicopter enthusiasts."

Crafting Flight: Aircraft Pioneers and the Contributions of the Men and Women of NASA Langley Research Center. Schultz, James. Washington, D.C., U.S.: U.S. National Aeronautics and Space Administration (NASA), 2003. 215 pp. Photographs, references, index, bibliography. Available from GPO.*

This book describes the contributions to aviation's development of NASA Langley Research Center. Langley, located at Hampton, Virginia, U.S., was established in 1917 as the nation's first government-sponsored civilian aeronautical research laboratory. It was originally called the Langley Memorial Aeronautical Laboratory in honor of Samuel Pierpont Langley, formerly of the Smithsonian Institution and an aeronautical researcher.

The book traces the evolution of the research that took place at Langley, from pioneering wind tunnels through work for the military in World War II to support for NASA satellite launchings and space flight.

Langley's history is thoroughly documented with photographs from all periods since its beginning. Both the researchers who contributed the ideas and developed the technology, and the aerospace vehicles that were tested and developed there, are given their due in pictures and text.

"As industries go, aerospace does not require much in the way of materials," says the introduction. "The real expense in aerospace is human resources. There are not many pounds of aluminum in even the largest of aircraft or spacecraft, but the human effort required to design, construct and operate an air transportation system or a satellite communication system is immense." The book shows how NASA Langley Research Center has, throughout its history, combined the functions of an "idea mine" with those of practical development.

Waterproof Flight Operations: A Comprehensive Guide for Corporate, Fractional, On-demand and Commuter Operators Conducting Overwater Flights. A special issue of *Flight Safety Digest* (September 2003–February 2004). Alexandria, Virginia, U.S.: Flight Safety Foundation, 2004. 664 pages. Figures, tables, photographs, references, bibliography. Available on compact disc or in print from Flight Safety Foundation.**

"The unthinkable happens," is the rationale for this comprehensive resource — the "unthinkable" being the ditching of transport category airplanes. In spite of a widespread belief that ditchings are a phenomenon of aviation's past and not a realistic prospect today, the book presents recent examples showing that controlled ditchings as well as uncontrolled water-contact accidents continue to occur. When they do, aircraft occupants who survive the accident must then confront other challenges that their training and experience may scarcely have prepared them for: exiting a water-filled aircraft, deploying a life raft and staying

alive in a water environment, possibly for days and with no readily available means of rescue.

The FSF publications staff studied the literature on ditching and post-ditching survival, helped conduct an in-the-water life raft evaluation, visited survival-equipment manufacturers, and examined safety-related equipment. They interviewed specialists in safety, survival and training; manufacturers of aircraft and equipment; regulatory authorities; and many others. They pored over regulations and official recommendations related to overwater flight and water-survival equipment.

The resulting book-length *Flight Safety Digest* examines every aspect of the subject. Some highlights include the following:

- The best piloting techniques for a survivable ditching;
- How to plan for a helicopter ditching;
- How the worldwide search-and-rescue system works, and what survivors must do to ensure maximum response by the system;
- A guide to emergency radio beacons (what type of beacon is carried can make a critical difference in the likelihood of rescue and the time required for rescue);
- Requirements for survival aboard a life raft, including who is in command, survival equipment, drinking water, first aid and avoiding injury by marine predators;
- A guide to the designs, construction and features of life rafts;
- The results of in-water testing of life rafts from seven manufacturers, with evaluations of the designs and features of each life raft model;
- Maintenance guidelines for life rafts and life vests;
- Correct use of life vests (inflating a life vest at the wrong time can turn it into a life-threatening hazard rather than a survival aid);
- Regulations and recommendations, including technical standard orders (TSOs) on which designs for equipment approved by civil aviation authorities are based;
- A statistical analysis of water-contact accidents; and,
- Useful references.

The size of the issue required by its extensive content made general distribution in print form impractical (although the issue is available in book format by special order from the FSF Internet site). Presenting the information on compact disc proved more manageable and allowed liberal use of color in a fresh design. A built-in search engine enables navigation through nearly 700 pages packed with facts, and links connect to a variety of relevant Internet sites.

Reports

Aviation Safety Management in Switzerland: Recovering From the Myth of Perfection. Amsterdam, Netherlands: National Aerospace Laboratory (NLR)–Netherlands, 2003. 266 pp. Figures, tables, appendixes, references. Available from NLR.***

Concerned that its national air transportation system might have structural deficiencies leading to adverse safety trends, the Swiss Department for Environment, Traffic, Energy and Communication commissioned NLR to conduct an extensive evaluation of the safety of air transportation in Switzerland.

"The main finding of the study is that in Switzerland a number of essential safety management processes and associated responsibilities has been institutionalized such that effective safety management is not achieved," says the report. "The study has also established that public air transport remains extremely safe and Swiss aviation is no exception. … Nevertheless, this study has found that the policy outcome, as reflected in the safety statistics of Swiss aviation over the last decade, is unsatisfactory, as the safety performance of Swiss aviation is declining whereas that of the comparable European states is improving."

Steps for creating an effective public safety policy, the report says, fall into the following categories:

- Setting the policy;
- The implementation of the policy;

- The outputs of the policy;
- The impacts of these outputs on the relevant operators;
- The policy outcomes; [and,]
- Feedback of the outcomes to the policy.

The report offers a number of recommendations based on the premise that "a well functioning safety management system will identify and correct the deficiencies that lead to unsatisfactory safety performance."

Wakefulness on the Civil Flight Deck: Evaluation of a Wrist-worn Alertness Device. U.K. Civil Aviation Authority (CAA), Safety Regulation Group. Paper 2003/14. November 2003. 32 pp. Figures, tables, references. Available on the Internet at <www.caa.co.uk/docs/33/CAPAP_14. pdf>.

The report describes the findings of a study to evaluate the effectiveness and crewmember acceptance of a wrist-worn alertness device, designed to minimize unauthorized sleep in the cockpit. The device is based on the principle that sustained periods of sleep are associated with wrist inactivity of more than five minutes, and is designed to sound an alarm following such a period. Besides anticipated use under conditions where cockpit napping is unauthorized, the device is also seen to have potential value when one flight crewmember is permitted a period of sleep on the flight deck, so as to ensure that the other flight crewmember remains awake.

In the study, 21 pilots wore the alertness device during the cruise phase of flights between Auckland, New Zealand, and Perth, Australia. They were asked to assess the device subjectively, and their sleep and sleepiness during the trial period were determined by recording brain electrical activity and eye movements. The effectiveness of the device at detecting and preventing sleep was analyzed.

"The study demonstrated that the device is capable of awakening pilots from sleep on the flight deck, and also highlighted problems with the current design," the report said. Practical problems included accidental switching on and off and the necessity for crewmembers to wear a second "wristwatch." The report offers recommendations for improvement to the design.

Regulatory Material

Operations Circular no. 1 of 2003: ALAR India Training Tool Kit. Office of the Director General of Civil Aviation (DGCA), New Delhi, India. May 2003. Available on the Internet at <dgca.nic.in/circular/opc-ind.htm>.

Citing the work of the Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force, this circular describes the formation of an ALAR India Task Force to recommend means of reducing approach-and-landing accidents in India. The ALAR India Task Force produced an ALAR training tool kit, containing video clips, a PowerPoint presentation and briefing notes on compact disc (CD).

Topics included in the training kit are stabilized approach, adherence to standard operating procedures, the approach briefing, horizontal and vertical situational awareness, respect for enhanced ground-proximity warning system (EGPWS) warnings, go-around decisions, controlled flight into terrain (CFIT) risk assessment, crew coordination, and approach-and-landing techniques.

The circular says, "The [India] Flight Inspection Directorate has also released a complimentary CD on adverse weather operations. As most accidents take place in bad weather, special precautions are to be taken during adverse weather conditions. These aspects are covered in the Adverse Weather Operations CD."■

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*** National Aerospace Laboratory
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Internet: <www.nlr.nl>

100-foot Separation Recorded Between DC-9, Floatplane at Airport in Canada

The flight crew of the airliner received clearance and began their takeoff as the pilot of the floatplane began a go-around in response to indications that his airplane's landing gear was not fully extended.

— FSF 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

Cessna Pilot Planned to Land, Hold Short of Intersecting Runway

McDonnell Douglas DC-9. No damage. No injuries. Cessna TU206G. No damage. No injuries.

About one minute after the pilot of the float-equipped Cessna received clearance to land his airplane on Runway 5 and hold short of the intersecting Runway 33L at an airport in Canada, the crew of the DC-9 was authorized to taxi into position for departure from Runway 33L. Day visual meteorological conditions prevailed.

During final approach, the pilot of the Cessna — which was being flown on a visual flight rules charter flight — moved the landing gear lever down; the green light that would have indicated that the right-main landing gear was locked in position did not illuminate. The pilot continued the approach as he recycled the landing-gear lever.

"Upon completion of the landing-gear recycling, the aircraft was in the landing flare, and the pilot again observed an inappropriate landing-gear [light] indication for landing," the accident report said. "The aircraft voice [landing]-gear advisory system also sounded."

The Cessna touched down briefly on Runway 5, about 3,350 feet (1,022 meters) before the intersection with Runway 33L; the air traffic controller observed the touchdown, assumed that the airplane had landed, told the pilot to continue taxiing on Runway 5 and reminded him to hold short of Runway 33L. Eight seconds later, the pilot said that he was conducting a go-around because of a landing-gear problem.

"The controller immediately instructed the Cessna pilot to commence a hard left turn to a heading of 290 degrees," the report said. "During the go-around, the Cessna 206 passengers observed the

McDonnell Douglas DC-9 aircraft on its takeoff run, and the front-seat passenger alerted the pilot to the conflict."

The crew of the DC-9 had received a takeoff clearance and had begun the takeoff for their flight to the United States less than 30 seconds before the Cessna's brief touchdown. As the DC-9 became airborne, the first officer (the pilot flying) observed that the Cessna was in the air and began a steep right turn.

Recorded radar data showed that the two aircraft were about 100 feet (31 meters) apart, both vertically and laterally.

After the incident, the pilot of the Cessna received vectors for landing at a nearby airport, and the flight crew of the DC-9 continued their flight.

The report said that the Cessna pilot's "decision making and airmanship, as well as the controller's use of ad-hoc procedures, were significant factors contributing to this occurrence."

The report said that the controller's decision to expedite departures by using land and hold short operations (LAHSO) "ultimately resulted in a near collision." The controller used LAHSO procedures between aircraft on a pair of runways for which the procedures were not authorized. The report said that the controller also did not tell the Cessna pilot that the DC-9 was departing, did not tell the pilot about conflicting traffic when he issued evasive instructions for the go-around and did not tell the pilot to remain clear of Runway 33L.

"The controller did not accurately assess the possibility of a go-around when planning the use of simultaneous (runway) procedures," the report said.

The report said that the Cessna pilot did not tell the controller about his airplane's landing-gear problem or about the possibility that he might not be able to land the airplane on Runway 5 and hold short of the intersecting runway.

The report also said that the airport chart used by the DC-9 flight crew did not "specifically identify LAHSO terminology in the depiction of LAHSO data for [the airport], and as a result, the flight crew may not have been aware of which LAHSO operations were authorized."

Lockup of Aileron, Flight-spoiler Controls Reported During Final Approach

Boeing 737-300. No damage. No injuries.

The airplane was being flown in day visual meteorological conditions on final approach to an airport in the United States when the captain and first officer experienced a "momentary lockup" of aileron and flight spoiler controls.The captain said that when the airplane was about 0.25 nautical mile (0.46 kilometer) from the runway threshold, he applied right aileron to correct for a crosswind and had to use excessive pressure before the control yoke responded. He said that the control yoke "felt like it had bound up."

After landing, he cycled the yoke left and right, and after a few cycles, the yoke "seemed to free up," the report said. The flight crew shut down the no. 2 engine before taxiing the airplane to parking; the captain said that during a sharp left turn, the tiller wheel "seemed to bind up."

Maintenance personnel conducted several tests and found no discrepancies that might have caused the problem. An analysis of data recorded by the digital flight data recorder also revealed no information that would explain the event. No discrepancies were observed during a test flight, and the airplane was returned to service.

AIR TAXI/COMMUTER

Faulty Drive Shaft Prevents Extension of Landing Gear

Beech Super King Air 200. Substantial damage. No injuries.

After departure from an airport in Australia, the left-main landing gear of the emergency medical services airplane failed to retract, and the pilot continued the flight with the landing gear extended.

At the destination airport, the pilot told air traffic control that the green light had not illuminated to indicate that the landing gear had extended and had locked in position. He declared an emergency.

As the airplane touched down, the left-main landing gear collapsed, and the airplane rolled off the runway.

An examination of the airplane by maintenance personnel showed that the left-main landing gear drive shaft had been severed after repeated rubbing against a bleed-air-duct clamp tail. The bleed-air duct clamp had been installed in the airplane six months before the incident.

Engine Stops After Takeoff

Cessna U206G. Minor damage. No injuries.

Visual meteorological conditions prevailed for the afternoon charter flight in New Zealand. After takeoff, as the pilot flew the airplane through 600 feet, the engine stopped. The pilot turned the airplane back toward the airport and landed on the reciprocal runway.

The accident report said that investigators determined that the engine had stopped because two connecting rods broke and punctured the engine casing. The investigation did not determine the cause of the failure of either of the connecting rods. The report said that the damage might have occurred over a long period of time and that "technical analysis of the oil might have identified the progressive deterioration of the bearings and prevented the engine failure."

Turbulence Injures Two Cabin Crewmembers

De Havilland DHC-8 Dash 8. No damage. Two minor injuries.

The flight crew was receiving radar vectors for a mid-afternoon approach to an airport in Scotland. The crew had intermittent visual contact with the ground and the weather radar had been turned off. The "seat belts" sign was on, and cabin crewmembers had been told that the airplane would land in 10 minutes.

As the flight crew flew the airplane through 7,000 feet on a descent and turned the airplane onto a base leg, the airplane entered clouds and "was shaken by a significant jolt," followed by further turbulence and the sounding of the overspeed warning horn, the incident report said. The captain reduced power, but the overspeed warning horn sounded again; the captain increased propeller speed to slow the airplane.

Thirty seconds later, the airplane was flown out of the clouds, and the crew conducted the landing. Two cabin crewmembers received minor injuries because of the turbulence.

CORPORATE/BUSINESS

Airplane Strikes Sign During Runway Excursion

Lancair LC42-550FG. Substantial damage. No injuries.

Visual meteorological conditions prevailed for the 10-minute business flight and subsequent landing at an airport in the United States. A commercial pilot occupied the left seat and operated the flight controls for the landing, with a flight instructor in the right seat and two passengers.

The pilot said that the approach was normal and that when the airplane was about four feet above the runway, he "chopped the power." The airplane descended rapidly to the runway and touched down left of the centerline in a nose-high attitude. After touchdown, the pilot applied full power, the airplane veered left, and the flight instructor used the rudder pedals to try to regain control of the airplane. The flight instructor also told the pilot to reduce power. The airplane departed from the runway onto gravel and snow. During the landing roll, the right wing struck a taxiway sign.

Airplane Strikes Ground After Pilot Reports Icing

Cessna 414. Destroyed. Four fatalities, one serious injury.

Day visual meteorological conditions prevailed and an instrument flight plan had been filed for the business flight in the United States. As the pilot prepared for the approach to land, an air traffic controller told him to expect light icing during the descent from 6,000 feet to the surface. The pilot confirmed that he had listened to information from the automated weather observing system (AWOS) and that he wanted to fly a localizer approach.

The pilot acknowledged his clearance to descend the airplane to 3,600 feet and maintain that altitude until the airplane was established on the localizer course and, seconds later, acknowledged

that he would change to the airport advisory frequency and "advise his cancellation down time." There were no further recorded communications from the pilot.

Witnesses said that they heard the pilot ask on the airport's advisory radio frequency for information about local weather, which included an overcast ceiling at 900 feet and winds from 260 degrees at 12 knots, with gusts to 16 knots. Later, the pilot said on the same radio frequency that he was flying the airplane on the localizer approach to Runway 23 and that he planned to circle and land the airplane on Runway 5.

Witnesses said that the airplane appeared to be lower than normal in the airport traffic pattern and closer to the runway than normal on the downwind leg.

"The airplane continued on the downwind until it was out of their line of sight," the report said. "About 10 [seconds] to 15 seconds later, both witnesses heard a garbled transmission on the [advisory] frequency. The pilot stated, 'Emergency, engine, ice.' They both went outside on the parking ramp and observed smoke about 1.5 [nautical] miles [2.8 kilometers] north-northeast of the airport."

Both witnesses said that, while on the parking ramp, they had observed two airplanes that had arrived earlier and that both had ice on the leading edges of the wings.

Another witness said that he had observed the airplane, with the landing gear extended, in straight-and-level flight about 200 feet to 250 feet above ground level and that he initially believed that the airplane was departing from the airport. Then he observed the airplane in about a 60-degree left bank just before it struck trees and the ground.

OTHER GENERAL AVIATION

Fuel Exhaustion Suspected in Airplane's Disappearance

Piper PA-31 Navajo. Destroyed. Two missing.

The airplane was being flown between two islands in the Caribbean, and the pilot had descended to 2,300 feet in preparation for the approach to the destination airport. About 16 minutes later, pilots of a commercial aircraft in the area relayed a mayday (distress) call from the pilot to air traffic control; the pilot's message was that one of the airplane's engines had failed, that the airplane appeared to be losing fuel and that the pilot believed that he could not fly the airplane to his destination.

About 3 1/2 minutes later, pilots of the commercial aircraft relayed a second message in which the pilot said that he intended to ditch his airplane. The final radar return showed that the airplane had been at 600 feet about 55 nautical miles (102 kilometers) from the destination airport. A review of fuel receipts and airplane flight times indicated that the airplane might have run out of fuel.

The accident report said that the airplane was equipped with a life raft and enough life vests for "a full complement of crew and passengers." The life raft's static line, which should have been attached to the fuselage to prevent the life raft from drifting away from the airplane before passengers could board, had not been reattached after a search of the airplane by customs authorities and excise-tax authorities. The report said that the pilot's operating handbook for the accident airplane did not contain an emergency checklist for ditching. The report included a recommendation that the manufacturer develop advice on ditching and ditching checklists for inclusion in future aircraft flight manuals and pilot operating handbooks.

Error Cited in Pilot's Departure With Inadequate Fuel

Aviat Pitts 2-SB. Substantial damage. No injuries.

Visual meteorological conditions prevailed for the afternoon flight from an airport in the United States. The pilot said that fuel had been ordered after an earlier flight but had not been delivered. The refueling error was not detected during the preflight inspection before the accident flight.

The pilot flew the airplane to a practice area to perform aerobatics, and as he rolled the airplane

inverted to begin the practice session, the engine hesitated. The pilot said that he "immediately … recognized that the airplane had not been refueled after the previous flight." He estimated that he had begun the flight with about six gallons (23 liters) of fuel, instead of the 23 gallons (87 liters) that the airplane usually held for aerobatics sessions. When the engine hesitated, about two gallons (eight liters) of fuel remained.

The pilot said that, rather than fly the airplane over populated areas to return to the airport, he conducted a precautionary landing on a dirt road near the practice area. During the rollout, saw grass struck the left wing, and the airplane veered off the dirt road, nosed over and stopped in a canal.

ROTORCRAFT

Accident Prompts Recommendation on Safety Restraints

Bell 206L LongRanger. Destroyed. Two minor injuries.

The pilot was conducting a return flight to the helicopter's base in Scotland when he turned south to fly around low clouds. As the pilot turned the helicopter east at 70 knots, about 500 feet above ground level, toward the intended landing area, he encountered more low clouds at the opening to a valley and conducted a descent to maintain visual contact with the ground.

The pilot then observed power cables in front of the helicopter and began an immediate climb. The helicopter struck a cable, rotated right and landed hard on an upward-sloping field. The accident report said that the tail rotor/fin assembly had separated from the helicopter when the helicopter struck the top cable of a set of cables about 120 feet above the valley floor.

The report said that the accident occurred near the pilot's home base, where "he should have been aware of the local geography, together with any hazards," and that his "sudden confrontation with the cables … indicated that he had lost awareness of his exact geographical position."

The pilot's shoulder harness failed during the hard landing, and the report said that all restraint harnesses in the helicopter had been replaced about two years before the accident when the interior was refurbished. The specialist company that did the work on the interior had obtained the restraints from a "small company of aircraft furnishers who said that they could do such work," the report said. "The specialist company stated that the belts had been supplied with documentation to the effect that they had been manufactured in compliance with applicable [U.S. Federal Aviation Administration] standards, but they were no longer able to locate any related documents. The company that manufactured the belts is no longer trading."

In a test of the front-seat passenger upper-torso restraint system, the system failed at the same location that the pilot's restraint system failed in the accident, at a load of about 900 pounds of force (4,004 newtons). An examination of a similarly designed system made by an original equipment manufacturer and installed in another Bell 206 helicopter found that the label said that the system had a rated strength of 1,500 pounds of force (6,672 newtons).

The report included a recommendation that the U.K. Civil Aviation Authority re-emphasize "to the aeronautical community in general and licensed engineers in particular the importance of ensuring that any occupant restraint systems already fitted, or to be replaced, on an aircraft or helicopter comply with the relevant airworthiness requirements."

Main-rotor Blades Strike Tree During Logging Operation

Sikorsky S-64 Skycrane. Substantial damage. No injuries.

Visual meteorological conditions prevailed for the long-line logging operation in Malaysia. The flight crew was conducting a descent while operating with a 275-foot (84-meter) long line and a hydraulic grapple and was preparing to secure a log, when the helicopter's main-rotor blades struck a tree.

The pilot flew the helicopter back to the landing zone for a safe landing.■

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