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Here Come the Very Light Jets

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Cover photo: The seven-seat, all-composite Adam 700 has accumulated more than 260 flight hours. The company expects U.S. certification of the 340-knot airplane in 2006 and European certification soon thereafter. (Photo: Adam Aircraft Industries)

HERE COME THE

Very Light Jets

Unique training programs are being developed to meet the challenges of safely assimilating the forecast influx of VLJs, many of which will be flown by relatively inexperienced owner-pilots.

— FSF EDITORIAL STAFF

Wings were mated to three Eclipse 500s in fall 2004. The prototypes currently are undergoing flight tests. The company expects to obtain U.S. certification in March 2006 and European certification later that year. (Photo: Eclipse Aviation Corp.)

Very light jets (VLJs) — defined as turbofan-powered airplanes weighing 10,000 pounds (4,360 kilograms) or less and designed for single-pilot operation — are expected to enter the general aviation aircraft marketplace in 2006. The advent of VLJs (also called microjets, entry-level jets and personal jets) has prompted concerns about safety and air traffic control (ATC) system congestion in Europe and North America.

"We are watching the development of these airplanes with great interest," said Stuart Matthews, president and CEO of Flight Safety Foundation (FSF).[1] "Among our concerns are sales figures that, if true, will mean a significant increase in the number of airplanes with jet speed and jet-altitude capability that are not being flown by professional pilots."

A forecast by the U.S. Federal Aviation Administration (FAA) indicates that 4,500 VLJs will be part of the U.S. aircraft fleet by 2016.[2] Other forecasts indicate that the demand will be greater.

"Some forecasters place the VLJ market at roughly equal to the entire current fleet of traditional

Extensive use of VLJs in unscheduled commercial operations is predicted.

business jets — 6,000-plus aircraft," said Peter v. Agur Jr., president of the VanAllen Group, a business aviation consulting group, and a member of the FSF Corporate Advisory Committee.[3] "Based on what we have learned, I believe the need will be even greater."

Extensive use of VLJs in unscheduled commercial operations is predicted by the U.S. National Aeronautics and Space Administration (NASA).

"There may be as many as 5,000 microjets employed by on-demand air taxi services by 2010 and 13,500 by 2022," NASA said.[4] "Microjets, alone, may represent 40 percent of daily operations by 2025."

Among the leading drivers of the projected strong market for VLJs are their relatively low purchase prices and low costs of operation and maintenance.

"The prices being quoted are within the reach of the affluent middle class, not more expensive than a big boat," said Matthews.

Prices quoted by VLJ manufacturers range from about US$1 million to nearly $3 million. These prices are similar to those for some current-production single-engine turboprop airplanes (e.g., the Cessna Caravan, New Piper Malibu Meridian and Socata TBM 700) and for Raytheon's twin-reciprocating-engine Beechcraft Baron and twin-turboprop King Air C90. (Also within this price range is the $1.8 million special-edition Ferrari FXX.)[5] The least-expensive jet currently on the market is the Cessna CJ1+, which costs more than $4 million.[6]

Agur said that preliminary data indicate that VLJs likely will be less expensive to operate and maintain than some cabin-class piston twins.[7] He believes that a strong market will exist in Europe, where fuel prices typically are higher than in the United States.

In the Works

Among companies currently developing VLJs for certification and production are Adam Aircraft Industries, Aviation Technology Group (ATG), Cessna Aircraft Co., Eclipse Aviation Corp., Embraer and Excel-Jet.

Table 1 (page 3) includes preliminary specifications for the airplanes being developed by these companies. All the companies said that they will seek certification initially under U.S. Federal Aviation Regulations Part 23 and subsequently under European Joint Aviation Requirements Part 23, which prescribe airworthiness standards for airplanes with maximum certificated takeoff weights (MCTOWs) of 12,500 pounds/5,700 kilograms or less.

Media reports have discussed other VLJs. For example, Honda is flight-testing the HondaJet, a six-seat airplane with an MCTOW of about 9,200 pounds (4,173 kilograms) and with two Honda HF-118 engines mounted on overwing pylons. Nevertheless, the company has not taken a decision to proceed with certification and production of the airplane.

"The HondaJet is an experimental aircraft," said Jeffrey A. Smith, assistant vice president of corporate affairs and communications for American Honda Motor Co.[8] "We have no formal business plan at this time."

At press time, repeated requests for information had not been answered by Avocet Aircraft (Projet), Maverick Jets (Maverick Leader) and Safire Aircraft Co. (Safire Jet). Diamond Aircraft Industries declined to provide any information about the single-engine D-Jet. Spokesperson Cathy Wood said that Diamond will issue an update on its VLJ program in the next few months.[9]

A700 Reduces Parts Count

Adam Aircraft Industries is developing the A700, which has a twin-boom tail. The A700 is a derivative of the company's A500, a pressurized airplane with reciprocating engines mounted on the nose and the tail. Initial FAA certification of the A500 was awarded in May 2005.

Joe Walker, president of the company, said that the jet uses two-thirds of the A500's parts and that replacing the reciprocating engines with fuselage-mounted turbofan engines reduced the empty weight by 1,000 pounds (454 kilograms).[10]

Table 1
Preliminary Specifications for Very Light Jets

Manufacturer	Adam Aircraft Industries	Aviation Technology Group	Cessna Aircraft Co.	Eclipse Aviation Corp.	Excel-Jet	Embraer
Model	A700	Javelin Mk-10	Citation Mustang	Eclipse 500	Sport-Jet	NA
Seats	7	2	6	5–6	4	6–8
Engine(s)	2 Williams FJ-33	2 Williams FJ33-4-17M	2 Pratt & Whitney Canada PW610F	2 Pratt & Whitney Canada PW610F	1 Williams FJ33	2 Pratt & Whitney Canada PW617F
Thrust Rating	1,200 lb (544 kg)	1,700 lb (771 kg)	1,350 lb (612 kg)	900 lb (408 kg)	1,500 lb (680 kg)	1,615 lb (733 kg)
Length	40.8 ft (12.4 m)	36.0 ft (11.0 m)	39.9 ft (12.2 m)	33.1 ft (10.1 m)	30.0 ft (9.2 m)	41.0 ft (12.5 m)
Height	9.6 ft (2.9 m)	10.5 ft (3.2 m)	13.7 ft (4.2 m)	11.0 ft (3.4 m)	9.0 ft (2.7 m)	14.0 ft (4.3 m)
Wingspan	44.0 ft (13.4 m)	23.3 ft (7.1 m)	42.2 ft (12.9 m)	37.4 ft (11.4 m)	33.2 ft (10.1 m)	41.0 ft (12.5 m)
Cabin Length	16.0 ft (4.9 m)	10.0 ft (3.1 m)	14.5 ft (4.4 m)	12.3 ft (3.8 m)	10.4 ft (3.2 m)	NA
Cabin Height	52 in (132 cm)	51 in (130 cm)	54 in (137 cm)	50 in (127 cm)	48 in (122 cm)	59 in (150 cm)
Cabin Width	54 in (137 cm)	40 in (102 cm)	55 in (140 cm)	56 in (142 cm)	58 in (147 cm)	61 in (155 cm)
Empty Weight	NA	3,800 lb (1,724 kg)	NA	3,390 lb (1,538 kg)	2,700 lb (1,225 kg)	NA
Fuel Capacity	NA	1,876 lb (851 kg)	2,580 lb (1,170 kg)	1,540 lb (699 kg)	1,306–1,600 lb (592–726 kg)	NA
Maximum Takeoff Weight	NA	6,200 lb (2,812 kg)	NA	5,640 lb (2,558 kg)	4,900 lb (2,223 kg)	NA
Takeoff Distance	2,950 ft (900 m)	1,700 ft (519 m)	3,120 ft (952 m)	2,155 ft (657 m)	2,500 ft (763 m)	3,400 ft (1,037 m)
Rate of Climb	NA	10,000 fpm	NA	2,990 fpm	2,000–2,500 fpm	NA
Single-engine Rate of Climb	NA	2,200 fpm	NA	888 fpm	2,000–2,500 fpm	NA
Maximum Pressurization Differential	8.7 psi	8.3 psi	8.3 psi	8.3 psi	6.0 psi	NA
Optimum Cruise Altitude	FL 380	FL 350	FL 350	NA	FL 250	NA
Airspeed	340 kt	520 kt	340 kt	375 kt	350 kt	380 kt
Fuel Consumption	NA	496–730 lb/hr (225–331 kg/hr)	NA	NA	300 lb/hr (136 kg/hr)	NA
Maximum Operating Altitude	FL 410	FL 450	FL 410	FL 410	FL 250	FL 410
Maximum Operating Speeds	NA	NA/0.975 M	NA	285 kt/0.64 M	NA	NA/0.7 M
Maximum Landing Weight	NA	6,200 lb (2,812 kg)	NA	5,360 lb (2,431 kg)	4,400 lb (1,996 kg)	NA
Landing Distance	NA	1,550 ft (473 m)	NA	2,040 ft (622 m)	2,000 ft (610 m)	NA
Stall Speeds (V_s/V_{so})	NA	110 kt/100 kt	NA	NA/67 kt	70 kt/65 kt	NA
Price (U.S. dollars)	$2.1 million	$2.8 million	$2.4 million	$1.3 million	$1.2 million	$2.8 million
Expected Certification Date	2006	2007	2006	2006	2007	2008

cm = centimeters FL = flight level ft = feet fpm = feet per minute hr = hour in = inches kg = kilograms kt = knots lb = pounds
m = meters M = Mach NA = not available psi = pounds per square inch V_s = stall speed V_{so} = stall speed, landing configuration

Sources: Adam Aircraft Industries, Aviation Technology Group, Cessna Aircraft Co., Eclipse Aviation Corp., Excel-Jet, Embraer, *Jane's All the World's Aircraft*

Both airplanes are constructed primarily of composite materials. Walker said that the primary advantage of composites is ease of manufacturing.

"There has been a lot of conversation over the years about composites saving weight," he said. "In the aggregate, there probably are some weight-savings, but it's not significant — maybe 5 percent. What is significant is parts count. These airplanes are roughly the size of a Baron or a CitationJet, which have about 25,000 part numbers in them. In our A500 and A700, we have about 4,500 part numbers, about 20 percent of the parts count. There are fewer parts but bigger parts.

"That ripples through the whole business: By eliminating a part, you don't have to design the part, you don't have to manufacture it or stock it, you don't have to warranty it, and it never breaks on the customer."

An A700 prototype has accumulated about 260 flight hours, and another airplane was expected to be flying by November 2005. Walker said that 50 A700s have been ordered by owner-operators, most of whom are "stepping up from pressurized piston twins and single-engine turboprops." He declined to discuss air taxi fleet orders.

"The bad news about owner-operators is that you get their orders one at a time; the good news is that they cancel one at a time," Walker said. "My experience with fleet deals is that with one phone call, you get 50 or 100 orders, and with another phone call, you get a cancellation for that many."

Javelin Resembles Fighter

ATG is developing the Javelin Mk-10, a twin-tail, tandem-seat airplane that looks like a miniature fighter airplane. The company also is working with Israeli Aircraft Industries in the development of a military-trainer version, the Javelin Mk-20, said Sara Newton, ATG's communications manager.[11]

Newton said that the first flight of the Javelin Mk-10 prototype is expected in the summer of 2005. The company has about 100 orders for the airplane and is requiring that potential owner-pilots have at least 1,500 flight hours in turbine airplanes.

Near–Mach 1 speed and structural limits of +6 g and –3 g are planned for the Javelin, which has two engines, two seats and dual controls. (Photo: Aviation Technology Group)

The Javelin will be constructed primarily of composite materials. Engine modifications include an inverted oil system for aerobatic flight.

Mustang Joins Citation Line

Like the Cessna CitationJet/CJ series of light jets, the Citation Mustang will be certified under Part 23 but is being designed to meet the transport category airworthiness standards of Part 25, which requires two flight crewmembers, said Steve Saflin, program manager, Citation Mustang and Special Missions Sales and Marketing.[12]

Saflin said that all 500-series Citations, including the Bravo and Encore, can be flown single-pilot with proper authorization. The Bravo, which has as many as eight seats and an MCTOW of 14,800 pounds (6,713 kilograms), and the Encore, which has as many as 11 seats and an MCTOW of 16,630 pounds (7,543 kilograms), are certified under Part 25 and require an FAA waiver for single-pilot operation.

"Like the CJs, the Mustang will be certified to [Part 23] standards that allow them to be flown single-pilot with a type rating for single-pilot operation," Saflin said. "You won't have to worry about getting a waiver on an annual basis."

Cessna evaluated composite construction and metal construction for the Mustang, and decided to proceed with metal construction.

"Advanced construction techniques using metal alloys and metal-bonding processes were compared to composites in an exhaustive and ongoing research program," Saflin said.[13] "We determined that advanced-technology metal alloys and metal-bonding processes were far more advantageous. The evaluation considered safety, reliability, maintainability, repairability, corrosion factors, fatigue and other limiting factors."

At press time, the company had completed the first phase of pre-certification flight tests of the prototype. Saflin said that the flight tests comprised "two weeks of intensive flying to get a good idea of how the systems are operating and performing before we actually go into the certification-test program." The first production Mustang was expected to enter the certification program by the end of September.

Cessna has more than 230 orders for the airplane.

The prototype Citation Mustang lifts off on its first flight in April 2005. Certification flight tests are expected to begin later this year. (Photo: Cessna Aircraft Co.)

The Citation Mustang's fuselage is about five inches (13 centimeters) narrower than the CJ's fuselage. Looking forward from the Mustang's rear bench seat, the unbelted toilet can be seen in front of the right cockpit partition. (Photo: Cessna Aircraft Co.)

"Our customer profile is very broad," Saflin said. "We are seeing customers coming in from single-engine recip airplanes all the way up to turbojet airplanes."

Eclipse Orders Top 2,200

More than 2,200 orders from owner-pilots and air taxi operators have been placed for the Eclipse 500, said Andrew Broom, manager of public relations for Eclipse Aviation.[14] More than 200 orders have been placed by customers in Europe.

"Our first year of production is going to be primarily for owner-operators who will be buying the airplane," he said. "But that dramatically changes for subsequent years to the majority of production being for air taxi operators."

Broom said that the majority of owner-operators who have ordered Eclipse 500s currently are flying high-performance reciprocating-engine airplanes and turboprops.

"There also are customers who own or have owned jets," he said.

The airplane will be constructed primarily of aluminum alloys. Certification test flights currently are being conducted with four prototypes, and the company expects to obtain FAA certification in March 2006.

Embraer Announces VLJ

Embraer announced in May 2005 that it would develop a VLJ. Few details were available at press time, and the company had not yet named the airplane. Artists' renditions of the airplane indicate that it will have low, minimally swept wings, fuselage-mounted engines and a T-tail.

The company said that the airplane will enter service in mid-2008 and that it had selected Pratt & Whitney Canada (PWC) PW617F engines for the VLJ. PWC expects to obtain certification of the engine in 2007.

Sport-Jet Has One Engine

Robert Bornhofen, president of Excel-Jet, said that the first flight of the single-engine, four-seat Sport-Jet is expected to occur before the end of July 2005.[15]

"We're not taking any firm orders until the airplane is in the air," he said.

Bornhofen said that he expects most of the airplanes to be flown by owner-pilots.

"We worked with insurers on a set of conditions that would make the airplane more insurance-friendly," he said. "Operating at 25,000 feet and below eliminates some issues about pressurization. Having four seats limits exposure in an accident. Keeping it single-engine makes it easier to fly than a twin."

The cabin will be constructed of composite material. The wings and tail will be constructed of aluminum.

Taking a Huge Step

Many customers who purchase VLJs for private and/or business use are expected to contract with airplane-management organizations to maintain and crew the airplanes.

"There is no reason not to expect that the majority of VLJs will be flown by professional pilots," said Agur. "For the nonprofessional pilots currently operating reciprocating-engine airplanes and turboprops, it will be taking a huge step up in speed and capability."

Agur said, however, that the nonprofessional pilots (i.e., pilots who receive no salary or compensation for flying airplanes) typically will have had substantial experience in the highly integrated cockpits with which a number of reciprocating-engine airplanes and turboprops are equipped.

"We're apt to find that many will do a better job than high-time pilots currently flying airplanes with less-sophisticated cockpits, because they won't have the negative learning transfer that usually occurs when stepping up from steam gauges," he said.

Edward R. (Ed) Williams, president of The Metropolitan Aviation Group and chairman of the FSF Corporate Advisory Committee, agreed. [16]

"The people who can afford VLJs typically are very technically oriented and already have a good background with advanced avionics," he said. "The VLJs, from what information I've gathered, will be even easier to fly than earlier single-pilot business jets because of new advances in avionics technology just in the past five [years] to seven years."

All the VLJs listed in Table 1 will have "glass cockpits" (electronic flight instrument systems), automated flight-management systems and full-authority digital engine control (FADEC) systems.

The Avidyne FlightMax Entegra system has been selected for the Adam A700 and the ATG Javelin. Cessna has selected the Garmin G1000 system for the Mustang. The systems basically comprise two primary flight displays (PFDs) and a multifunction display (MFD). Information provided by the PFDs includes attitude, heading, airspeed, altitude, vertical speed and flight director command bars. Depending on the installation, the MFD provides a moving-map navigation display; weather, traffic and terrain information; and

N502EA, one of four Eclipse 500 prototypes currently involved in certification flight testing, made its first flight in April 2005. (Photo: Eclipse Aviation Corp.)

A mock-up of an Avidyne FlightMax Entegra panel planned for the Adam Aircraft A700 shows three flat-panel, liquid-crystal displays. (Photo: Avidyne Corp.)

engine indications. Both systems are available with three-axis autopilots.

Eclipse is developing an integrated avionics system called Avio, which will provide centralized management of all aircraft systems, including engine controls, fuel controls, cabin temperature, cabin pressure, anti-ice/deice equipment, and lights.

FADEC, which replaces electro-mechanical or hydro-mechanical fuel-control equipment, simplifies engine operation.

"When you move the throttle, you're telling a computer what you want," said Don Taylor, vice president of safety, training and flight operations for Eclipse.[17] "With a FADEC, you cannot hurt the engine."

FADEC prevents hot starts, hung starts and high-altitude surges, he said.

Saflin said that with the FADEC system in the Mustang, "the pilot simply places the throttles in detents on the throttle quadrant for takeoff, climb or cruise, and selects the throttle position appropriate for the airspeed in other phases of flight."

Entering an Unknown Area

The systems integration and automation characteristic of the VLJ designs are intended to reduce pilot workload. Nevertheless, single-pilot operation of the airplanes, especially by pilots with no previous experience in jets, will be challenging.

"Pilots have been operating aircraft solo for over 100 years," said Capt. Richard Walsh, vice president of flight operations and business continuity for Cardinal Health, and former director of operations and training for United Airlines.[18] "What's the big deal?

"The answer is speed, multi-function displays, advanced systems technology, complex airspace and operating rules, plus potential inexperience combined with an affordable jet. With VLJs — personal jets — we enter an area where no man has gone before."

Walsh said, "The VLJ will weigh less than many popular turboprop cabin-class twins yet will be capable of operating near the upper limits of civilian airspace as well as being integrated in the traffic pattern of America's high-density airports. … The question is whether or not the single pilot can remain concurrently engaged in all the tasks confronting him or her and achieve operational mastery in the high-speed world of turbojet flight."

Pitfalls of Going Solo

Training specialists agree that single-pilot operation of any high-performance airplane has few advantages compared to flying as a member of a trained and well-coordinated crew.

"I think that it's overall a better operation if you have two well-trained pilots in an aircraft," said

Greg McGowan, vice president of operations for FlightSafety International.[19] "If you are flying single-pilot, you must have self-discipline; you have to force yourself to use checklists and to do other things that you wouldn't have to force yourself to do if you knew that you were being observed by someone else, and both of you knew what the rules were. A two-pilot operation is a better operation."

Walsh said that crew resource management (CRM) research has indicated that the workload involved in single-pilot operation of a jet is three times to five times higher than the workload involved in a multi-crew operation.[20]

Ned Carlson, director of business aviation sales for CAE SimuFlite, said, "Especially for someone who does not have significant time in a jet, the ability to think out in front of the aircraft — to plan ahead, anticipate what's going to happen — can be a big task that really is going to be the key to single-pilot operation of a VLJ. The idea behind a crew is that you always have someone backing you up, double-checking you. You lose that in a single-pilot situation."[21]

Asked if there are any advantages to single-pilot operation, Carlson said, "From a safety standpoint, no. From a cost standpoint, yes. You're not paying for two crewmembers or for a professional pilot to accompany the owner-operator."

Williams said, "There are risks associated with both single[-piloted] and dual-piloted aircraft. Intuitively, we always hoped high-performance aircraft would be flown by two pilots in high-density-airport areas, especially in deteriorating weather conditions. Obviously, pilot workload increases considerably under these conditions. An individual pilot will need to learn to make more reasoned decisions to even attempt a flight with his VLJ into a high-density area with the weather going down at the time of arrival."

ALAs Top Single-pilot Jet Accidents

Available data indicate that 35 accidents and eight incidents occurred worldwide during single-pilot operation of jet airplanes from 1966 through 2004 (see appendix, page 28). Fifteen (43 percent) of the accidents involved fatalities.

"A two-pilot operation is a better operation."

Twenty-seven accidents (77 percent), including eight fatal accidents (53 percent of the fatal accidents), were approach-and-landing accidents (ALAs). Nine ALAs (33 percent) involved runway overruns; none was fatal. Eight ALAs (30 percent), including two fatal accidents, involved airplanes that were landed short of the runway.

Loss of control was involved in six accidents (17 percent), all of which were fatal.

The following reports to the NASA Aviation Safety Reporting System (ASRS), involving single-pilot operations in Cessna Citations, illustrate the disadvantages of not having another pilot aboard to help check and cross-check instruments:[22]

- The pilot's report on an altitude deviation said that a maintenance technician likely set the altimeter 1,000 feet high while replacing a transponder. The pilot did not notice the discrepancy before takeoff. "When one makes a mistake [while] setting an instrument, the chances are [that] they will misread it again when cross-checking it," the pilot said. "Our company policy has been changed to include a copilot on all possible flights to prevent something of this nature from happening again."[23]

- In a report on nonadherence to a published approach procedure, the pilot said that he misinterpreted a distance-measuring-equipment (DME) readout and did not observe indications that the airplane had crossed the initial approach fix during a nondirectional beacon (NDB) approach in daytime visual meteorological conditions. "The controller called to ask where we were going," the pilot said. "Though I am a firm believer in the safety of single-pilot Citation operations with a properly trained pilot, this incident points up the value of a second pilot to catch an error like this."[24]

- In a report on a route deviation, the pilot said that he was flying an assigned arrival route

Honda HF-118 engines are mounted on overwing pylons on the HondaJet. Flight tests have been conducted since December 2003, but the company at press time said that it had no plans to manufacture the airplane. (Photo: American Honda Motor Co.)

when ATC told him to fly a different route. "I rushed to set up the FMS [flight management system] and mistakenly set up for [an incorrect route]," he said. "This caused me to stray from my assigned route."[25]

- Distracted by a problem with an anti-ice system, the pilot did not reset the altimeter while descending through Flight Level (FL) 180 (approximately 18,000 feet; the transition level). During approach, a controller asked the pilot why the airplane was 600 feet above the assigned altitude.[26]

- The pilot was programming the FMS and the global positioning system (GPS) receiver when he inadvertently taxied the airplane off the side of a snow-covered apron. "I realized the situation when I observed a taxiway light pass inside the right main gear," the pilot said. "As a single-pilot operator, workload can be quite high [and must be] properly managed and, more importantly, prioritized."[27]

- During descent, the pilot set the assigned altitude, FL 240, in the altitude selector but did not arm the autopilot altitude-preselect mode. The pilot later observed that the airplane was descending 500 feet below the assigned altitude. "At the time, I was completing the descent checklist and listening to the ATIS [automatic terminal information system] information," the pilot said.[28]

- A report on an inadvertent entry into an instrument landing system (ILS) critical area said that the pilot had received two radio-frequency changes and four revised taxi clearances while taxiing the airplane at the unfamiliar airport. "Operating a single-pilot aircraft in a complex ground environment [while] trying to read the taxi map, make frequency changes and copy revised clearances while peering out a rain-soaked windshield presents a unique set of challenges," the pilot said.[29]

'Everyone Is Gearing Up'

Insurance underwriters are watching closely the development of VLJs, said Ed Bolen, president and CEO of the National Business Aviation Association (NBAA).[30]

"Although estimates vary, most industry forecasts suggest that the market for VLJs and other technically advanced aircraft will be strong over the next decade," Bolen said. "Because of their high performance, however, concerns have been raised about the safety measures in place for the pilots who will fly them. The insurance companies, in particular, have taken note."

Christopher A. (Chris) O'Gwen, senior vice president of United States Aviation Underwriters, said, "Everyone is gearing up for it. The idea of people transitioning to the next higher level of aircraft is not unique. We've been dealing with that for as long as aircraft have been in existence. What is unique is the possibility that there is going to be a much more significant number of people transitioning to VLJs. The economics of these VLJs clearly will allow more owners to purchase turbojet aircraft than we've seen in the past."[31]

O'Gwen said that the experience levels of the owner-pilots will vary widely.

"There will be people who have been flying jets already as the owners; they will have an easier time transitioning because they have the jet experience," he said. "In the middle will be individuals who have been operating turboprops for some years and who are going to step up to their first jet. That group is going to be a little more involved in transition training. Then, there will be the group that's been operating piston-powered airplanes; that's going to be the most complicated transition of all."

Jim Anderson, vice president of AIG Aviation's Light Aviation Division, said, "We're actually quite excited about what's going on with regard to the introduction of VLJs. We're working very closely with some leading manufacturers to adapt their training programs into our underwriting so that it takes away the quantitative measurement — how many flight hours you have and so forth — and takes more into effect the qualitative measurement — the multiple training operations involved."[32]

Williams said, "Each insurer that I'm aware of plans to evaluate each pilot individually by carefully learning about that pilot's experience in high-performance aircraft, how and where the individual plans to use the aircraft and whether that pilot will take advantage of the various after-sale, after-training mentor programs that the VLJ manufacturers are developing."

Mentoring is an element of recommended training guidelines developed by the NBAA Safety Committee's VLJ Working Group (see "NBAA Training Guidelines: Single Pilot Operations of Very Light Jets and Technically Advanced Aircraft," page 12).

Williams said that the NBAA guidelines are a foundation for tailoring training programs for individual pilots.

"The days of the rigid four-day or five-day ground school/flight simulator syllabus, check ride and handshake before the pilot is turned loose will be all but a memory," he said. "The process of decision making will be as much a part of the VLJ-pilot training syllabus as the aircraft's performance specifications and limitations, etc."

"The economics of these VLJs clearly will allow more owners to purchase turbojet aircraft."

Guidelines Seek Proficiency

Bolen said that the VLJ Working Group spent a year developing the training guidelines with input from FAA, aircraft manufacturers, insurance underwriters and flight-training providers.

The guidelines assume that a prospective VLJ pilot has at least the minimum credentials for a type rating — a private pilot certificate with a multi-engine rating and an instrument rating — and recommend the following training-program components:

- An initial evaluation that includes an in-flight examination of the candidate's instrument skills and airmanship, an oral examination of judgment skills and a written examination of aeronautical knowledge. "If deficiencies are detected, the manufacturer or training provider should arrange supplemental flight training to bring candidates up to the necessary flight-skills level," the guidelines said;

- A pre-training study package with information on several topics, including the VLJ's performance characteristics and systems, standard operating procedures, single-pilot resource

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NBAA Training Guidelines: Single Pilot Operations of Very Light Jets and Technically Advanced Aircraft

Introduction

This document provides the National Business Aviation Association's recommended training guidelines for the next generation of very light jets (VLJs). For the purpose of this document, VLJs are jet aircraft weighing 10,000 pounds (4,536 kilograms) or less (a distinction from the traditional definition of large aircraft as more than 12,500 pounds/5,700 kilograms, and light aircraft as 12,500 pounds or less) and certificated for single-pilot operations. These aircraft will possess at least some of the following features:

- Advanced cockpit automation such as moving-map global positioning system (GPS) displays and multifunction displays (MFDs);
- Automated engine and systems management; and,
- Integrated autoflight, autopilot and flight-guidance systems.

This document offers a training outline that represents the minimum curriculum necessary to satisfy a VLJ transition-training program.

These training guidelines do not mandate how VLJ training is to be implemented. Though the guidelines were developed with a simulator-based training program in mind, each training provider must best determine the most effective and efficient methods to meet the objectives in this document. All elements presented must be addressed in a training program for VLJs.

Background

The introduction of the VLJ into the general aviation community will mark the beginning of a new era in personal and business air travel. Applying what the industry has learned from the past, an extraordinary training process must be developed to ensure an orderly and safe transition for those who become owners or operators of this new generation of aircraft.

Traditionally, training has been conducted with the objective of passing the necessary practical test standards (PTS) without regard to obtaining proficiency. With the advent of next-generation VLJ aircraft, potential candidates will come from varied levels of experience ranging from the relatively inexperienced to the veteran professional aviator. It is imperative that all candidates successfully completing VLJ training demonstrate a level of proficiency and operational knowledge beyond that required to merely "pass the check ride." As a result, the concept of a mentor pilot is an integral part of the guidance contained within this document. Operators of VLJs are urged to utilize the resources of a mentor-pilot program until such time that they have acquired the necessary skills and proficiency for safe operation in all flight regimes.

Part of the challenge in developing these guidelines is defining what should be taught and how proficiency should be measured. To address this need, the NBAA Safety Committee formed a VLJ Working Group to formulate training guidelines.

To establish the necessary curriculum and criteria, input was received and reviewed from the following:

- NBAA Safety Committee;
- U.S. Federal Aviation Administration (FAA)/Industry training standards;
- Adam Aircraft;
- Cessna Aircraft Co.;
- Eclipse Aviation;
- Insurance underwriters; and,
- Training providers.

The final product reflects a compilation of identified areas of greatest risk associated with transitioning into VLJs and how best to mitigate these risks with an appropriate training curriculum.

VLJs will prove to be a dynamic force in the aviation community with the potential for thousands being delivered over the next decade. Safety is paramount, and all stakeholders agree that training must be thorough and properly conducted to maintain the exemplary safety record of the industry and to ensure the viability of the product. It is with this in mind that these guidelines are offered.

Scope

This document is applicable to training programs designed for VLJs. It is recognized, however, that many of these elements will overlap and apply to current single-pilot operations in any complex aircraft.

Industry-accepted terminology, abbreviations and acronyms have been used throughout this document. Realizing that aircraft manufacturers may use different acronyms, abbreviations or trade names to describe certain components, it may be desirable to substitute the manufacturer's terminology in specific curricula.

Prerequisite Knowledge/Certification

These guidelines assume the following prerequisite certification:

- Private pilot license;
- Multi-engine rating; and,
- Instrument rating.

In addition, preferred prerequisite knowledge and skill in the following areas:

- Basic autoflight procedures;
- Basic flight management system (FMS) procedures; and,
- Weather radar.

Information relating to automated flight decks, both training and operations, is available in NBAA Automated Flight Deck Training Guidelines, available on the NBAA Internet site at <www.nbaa.org/library>.

However, any knowledge and skill deficiency must be determined during initial candidate evaluation. Any deficiencies identified will need to be mitigated prior to manufacturer's training.

Definitions

Aircraft Automation Management — The demonstrated ability to control and navigate an aircraft by means of the automated systems installed in the aircraft.

Automation Competence — The demonstrated ability to understand and operate the automated systems installed in the aircraft.

Automation Bias — The relative willingness of the pilot to trust and utilize automated systems.

Candidate Evaluation — A system of critical thinking and skill evaluations designed to assess a training candidate's readiness to begin training at the required level.

Critical Safety Tasks/Event — Those mission-related tasks/events that, if not accomplished quickly and accurately, may result in damage to the aircraft or loss of life.

Data Link Situational Awareness Systems — Systems that feed real-time information to the cockpit on weather, traffic, terrain and flight planning. This information may be displayed on the primary flight display (PFD), MFD or on other related cockpit displays.

Large Aircraft — Aircraft weighing more than 12,500 pounds maximum certificated takeoff weight (MCTOW).

Light Aircraft — Aircraft of 12,500 pounds or less MCTOW.

Mission-related Tasks — Those tasks required for the safe and effective accomplishment of the mission(s) that the aircraft is capable of and required to conduct.

Multi-function Display (MFD) — Any display that combines primarily navigation, systems and situational awareness information onto a single electronic display.

Primary Flight Display (PFD) — Any display that combines the six primary flight instruments plus other related performance, navigation and situational awareness information into a single electronic display.

Operating Cycle — One complete flight, consisting of takeoff, climb, cruise, descent, approach and landing.

Proficiency-based Qualification — Aviation task qualification based on demonstrated performance rather than flight time or experience.

Scenario-based Training (SBT) — A training system that uses a highly structured script of real-world experiences to address flight-training objectives in an operational environment. Such training can include initial training, transition training, upgrade training, recurrent training and special training. The appropriate term should appear with the term "scenario-based" (e.g., "scenario-based transition training") to reflect the specific application.

Single-pilot Resource Management (SRM) — The process of managing resources available to the single pilot. These would include the pilot's resources of preflight planning, personal knowledge, materials and personnel aboard the aircraft, and additional resources beyond the cockpit.

Technically Advanced Aircraft — A general aviation aircraft that combines some or all of the following design features: advanced cockpit automation system (moving-map GPS/glass cockpit) for instrument flight rules (IFR) and/or visual flight rules (VFR) flight operations, automated engine and systems management, and integrated autoflight/autopilot systems.

Very Light Jet — Jet aircraft weighing 10,000 pounds or less MCTOW and certificated for single-pilot operations. These aircraft will possess at least some of the following features:

- Advanced cockpit automation, such as moving-map GPS displays and MFDs;
- Automated engine and systems management; and,
- Integrated autoflight, autopilot and flight-guidance systems.

Acronyms and Abbreviations

ACARS — Aircraft Communications Addressing and Reporting System

ADS-B — Automatic Dependent Surveillance — Broadcast

AFIS — Airborne Flight Information System or Automatic Flight Information System

ALAR — Approach-and-landing Accident Reduction

ATC — Air Traffic Control

CAT — Clear Air Turbulence

CFIT — Controlled Flight Into Terrain

CRM — Crew Resource Management

CTAF — Common Traffic Advisory Frequency

EFIS — Electronic Flight Instrument System

EGPWS — Enhanced Ground-proximity Warning System[1]

FBO — Fixed Base Operator

FGS — Flight Guidance System

FIS — Flight Information System

FITS — FAA/Industry Training Standards

FMA — Flight Mode Annunciator

FMS — Flight Management System

GPS — Global Positioning System

IOE — Initial Operating Experience

IRS — Inertial Reference System

LAHSO — Land and Hold Short Operation

LOFT — Line-oriented Flight Training

MSL — Mean Sea Level

PTS — Practical Test Standards

Radar — Radio Detecting and Ranging

SBT — Scenario-based Training or Simulator-based Training

SOP — Standard Operating Procedure

SRM — Single-pilot Resource Management

TCAS — Traffic-alert and Collision Avoidance System

VLJ — Very Light Jet

VOR — Very-high-frequency Omnidirectional Radio

Areas of Greatest Risk

Due to the operating regime of VLJs, an assumption must be made that very little distinction might exist between a VLJ weighing 10,000 pounds or less and heavier corporate jets. The VLJ will weigh less than many popular turboprop cabin-class twins yet will be capable of operating near the upper limits of civilian airspace as well as being integrated into the traffic patterns of America's high-density airports. The air traffic system and the owner-operators must recognize the vulnerability of these lightweight and high-performance aircraft.

The manufacturers of VLJs have started to look at the unique risks that exist for their products. Any training proposal put forth by the manufacturer or vendor must include an understanding of these potential problems and the intent to address them in all phases of the training plan. The following is a list of issues discussed and brought forward during VLJ manufacturer visits:

- Wake turbulence encounters:
  - At altitude and in the traffic pattern;
  - In-trail spacing and profile adjustments; and,
  - Best recovery configuration;
- Convective weather encounters:
  - Preflight weather analysis;
  - Alternate route identification;
  - Contract flight planning and/or dispatch interaction; and,
  - Circumnavigation fuel capability;
- Microburst/wind shear encounters:
  - Area entrance rules or philosophy;
  - Preflight weather analysis;
  - Condition definition;
  - Best recovery methods;
  - Alternate airport identification; and,
  - Alternate fuel capability;
- Clear air turbulence (CAT)/jet stream core or boundary encounters:
  - Preflight weather analysis;
  - Contract flight planning and/or dispatch interaction;
  - Aircraft configuration in various levels of turbulence;
  - Lower/higher altitude cruise capability; and,
  - Fuel-burn impact;
- High-altitude upset:
  - Performance capability;
  - Coffin corner[2] education;
  - Recovery methods from low-speed/high-speed stalls; and,
  - Straight/swept-wing aerodynamics, as appropriate;
- Mountain wave encounters:
  - Thrust and speed adjustments; and,
  - Preflight weather analysis;
- Inadequate knowledge of high-altitude weather:
  - Winds aloft (millibar) charts;
  - Tropopause levels;
  - K index and lifted index chart;[3]
  - CAT forecasts;
  - Icing levels; and,
  - Severe weather charts;
- Physiological effect of high-altitude operations:
  - Altitude-chamber or nitrogen-simulator[4] training;
  - Personal health issues; and,
  - Medication interaction;
- Jet-blast damage behind larger jets during ground operations:
  - Proper spacing on taxiways;
  - Advise/educate air traffic control (ATC); and,
  - Close-proximity operations in icing conditions;
- Low-fuel arrivals trying to stretch range:
  - Cruise-chart education;
  - Identification of maximum-range and maximum-endurance speeds;
  - Identification of suitable intermediate airports; and,
  - Altitude selection to reduce fuel consumption;

- Incorrect/less-than-optimum cruise-altitude selection:
  - Contract flight planning and/or dispatch interaction;
  - Cruise-chart education;
  - Wind/altitude-trade capability; and,
  - Rule-of-thumb or tool-kit approach to altitude/range/fuel-burn predictions;
- Inadequate preparation for high-rate/high-speed climbs:
  - Course/altitude overshoots;
  - Excessive airspeed below 10,000 feet mean sea level (MSL) or below Class B airspace;
  - High deck angles and reduced traffic vigilance;
  - Thrust-controlled vertical rate; and,
  - Tool-kit approach to thrust/speed/rate control;
- Inadequate crosswind takeoff/landing preparation:
  - Speed adjustments for steady-wind and gust components;
  - Roll and pitch airframe limits;
  - Flap selection criteria; and,
  - Maximum crosswind and gust limits;
- Inadequate preparation for land-and-hold-short operations (LAHSO);
  - Minimum pattern size and programmed drag profile; and,
  - Advise/educate ATC;
- VLJs misunderstood by ATC (pilot mitigations):
  - High speed in terminal airspace;
  - High speed to final approach fix;
  - Lack of respect for single-pilot operation and associated workload;
  - Improper spacing behind heavier traffic; and,
  - Unreasonable requests for configuration or climb/descent performance;
- Single pilot adherence to checklists:
  - Overcoming old habits;
  - Patterns of discipline not developed;
  - Complacency resulting from simplicity of VLJs; and,
  - Degradation of systems knowledge;
- FMS programming and autoflight vs. manual flight control:
  - Reluctance to abandon autoflight/reluctance to use autoflight;
  - Inadequate FMS and/or autoflight skills;
  - Inadequate manual flight skills; and,
  - Raw data/manual flight and FMS/autoflight training;
- Inadequate exercise of “command”:
  - Inclusion of captain-development training in program;
  - Inclusion of crew resource management (CRM)/single-pilot resource management (SRM) training in program;
  - Inclusion of line-oriented flight training (LOFT) or scenario-based training (SBT) in program;
  - Inclusion of judgment contrast debriefings in program; and,
  - Inclusion of command modeling in program;
- Recognizing single pilot “red flags” as an alternative to POPE, which stands for:
  - Psychological (overload, inexperience, emotional);
  - Operational (aircraft-mechanical, weather, fuel, performance);
  - Physiological (fatigue, medical, pharmaceutical); and,
  - Environmental (time, external pressure, business);
- Lack of pilot self-evaluations:
  - Use of available tools/personal minimums checklist;
  - PAVE, which stands for:
    - Pilot;
    - Aircraft;
    - Environment; and,
    - External pressure; and,
- Winter operations:
  - Airframe contamination;
  - Airport contamination;
  - Takeoff;
  - Landing; and,
  - Decision making.

Component Training Requirements

Initial Candidate Evaluation

VLJs appeal to a wide variety of pilots and operators — including those who are highly experienced and those relatively new to the aviation industry. A critical consideration in the candidate-evaluation process must be the availability of insurance and satisfying underwriting requirements. A candidate can invest significantly in both the planning and acquisition of a VLJ, but without the early input of the insurance underwriting community, the candidate may find that he or she is uninsurable when it comes time to take delivery of the aircraft.

Insurance underwriters have been keenly interested in the development of VLJs and have taken a proactive role in learning about the capabilities of these aircraft and the various markets for which they are intended. However, in spite of aircraft technology advances, unprecedented emphasis on proper training and the concept of mentor-pilots, the nature of aviation underwriting still does not lend itself to formulating universally accepted minimum candidate credential and experience levels for VLJ operations. There simply are too many variables to consider, and any minimum guidelines very well may be outdated by the time they are published due to the dynamic nature of aviation underwriting.

Each candidate therefore must engage the insurance community early in the purchase process with the goal of finding mutually agreeable terms and conditions for transitioning into the VLJ. These NBAA training guidelines are designed to provide a common denominator for the candidate, underwriter and manufacturer to collaboratively tailor a training course for each candidate, based upon that candidate's unique background, experience and intended operations. The training course will need to be tailored also for a specific aircraft type, panel layout and installed equipment.

Before enlisting in a VLJ training course, the candidate should have an initial evaluation to determine proficiency in a number of areas. These include but are not limited to a flight-skills assessment, including:

- Practical in-flight examination to test instrument skills and airmanship;
- Oral examination to evaluate judgment skills; and,
- Written examination to determine aeronautical knowledge.

If deficiencies are detected, the manufacturer or training provider should arrange supplemental flight training to bring candidates up to the necessary flight-skills level. The manufacturer should oversee this arrangement; however, the candidate may have the option of obtaining the supplemental flight training elsewhere provided a reassessment is undertaken.

In addition, the evaluation is to be used to determine those candidates most likely to succeed in the training program based upon experience and knowledge, recency of experience, background and type of experience.

Pre-training Study Package

Prior to arriving at a training facility, the candidate should become familiar with not only the specific aircraft on which they will train, but also all aspects of the new regime of flight they are about to undertake and ways in which they can operate safely. A pre-training study package is recommended to cover the following subject areas:

- Manufacturer's welcome to turbine-powered flight:
  - New horizons;
  - New challenges; and,
  - New responsibilities;
- Manufacturer's history and corporate mission;
- Aircraft specifications and mission capability:
  - Range;
  - Useful load;
  - Runway required;
  - Single-engine performance; and,
  - Comparison to cabin-class turboprops;
- The meaning of pilot-in-command (PIC):
  - Master of your fate;
  - Knowledge is power;
  - Nobody's perfect;
  - Learning never ends;
  - Achieve immortality — set a good example; and,
  - Becoming a captain;
- Professional aviator attitudes:
  - Safety;
  - Conservatism;
  - Discipline;
  - Currency;
  - Responsibility;
  - Decisions;
  - Fatigue; and,
  - Security;
- Armchair flight:
  - Phase of flight review; and,
  - Typical mission demonstration;
- U.S. Federal Aviation Regulations Part 91 and Part 91 Subpart K (plus Part 135 differences);
- Airspace — definition and usage;
- Instrument procedures review;
- High-altitude physiology;
- High-altitude aerodynamics:
  - Overspeeds;
  - Underspeeds;
  - Coffin corner;

- Wing loading; and,
- Straight wing vs. swept wing;
- Characteristics of high-speed aircraft;
- Operations in the high-speed regime;
- The VLJ and the ATC system;
- Flight-planning resources;
- Weight-and-balance computations;
- Takeoff and landing performance charts;
- Pinch-hitter[5] and passenger-briefing plans;
- Communication:
  - Common traffic advisory frequency (CTAF);
  - Unicom; and,
  - Fixed base operator (FBO);
- Introduction of tool kits:
  - Fly/no-fly:
    - Personal health (including fatigue);
    - Weather; and,
    - Time constraints;
  - Go/no-go:
    - Rejected takeoff decision; and,
    - Balanced field length awareness;
  - Self-dispatching:
    - Personal minimums checklist;
  - Dealing with emergencies and abnormalities
  - Performance:
    - Contaminated runways;
  - Briefings — self:
    - Departure; and,
    - Approach;
  - Weather:
    - Visibility;
    - Wind;
    - Turbulence;
    - Icing;
    - Convective activity; and,
    - Clutter;
- Elements of a diversion;
- Aircraft systems overview;
- Radar/weather data link basics;
- Autoflight systems introduction:
  - FMS;
  - Flight guidance system (FGS);
  - Flight mode annunciator (FMA);
  - Electronic flight instrument system (EFIS);
  - Airborne flight information system (AFIS)/aircraft communications addressing and reporting system (ACARS);
  - Navigation sources (IRS/GPS/VOR);
  - Traffic-alert and collision avoidance system (TCAS); and,
  - Enhanced ground-proximity warning system (EGPWS);
- Standard operational procedure overview;
- CRM/SRM elements:
  - Traditional; and,
  - Single-pilot differences;
- Advanced maneuvers:
  - Upset recovery;
  - Noise-abatement procedure; and,
  - Slam-dunk arrivals;[6]
- Wind shear elements — avoidance and recovery;
- Wake turbulence — recognition and avoidance;
- Meteorology for jets;
- Mountain flying;
- Reduced vertical separation minimum (RVSM);
- Maintenance:
  - Minimum equipment list (MEL);
  - Deferrals;
  - Placards;
  - Logbooks;
  - Documentation; and,
  - International issues;
- Accident/safety training:
  - Statistical review;
  - Case studies;
  - Flight Safety Foundation *Approach-and-landing Accident Reduction (ALAR) Tool Kit and Controlled Flight Into Terrain (CFIT) Checklist*; and,
  - Threat and error management;
- Runway incursion risks and airport signage;
- ATC phraseology;
- Collision avoidance:
  - Automatic dependent surveillance — broadcast (ADS-B); and,

– Flight information system (FIS);

- Review of PTS; and,
- Practical test expectations.

CRM/SRM. CRM principles apply to the PIC of a personal jet or any other single-pilot-certified aircraft. This is called SRM when applied to these types of operations. Pilots of these aircraft should be trained in, understand and apply CRM/SRM principles because accident/incident data have shown that CRM/SRM enhances the safety and efficiency of single-pilot operations.

Pilots, dispatchers, maintenance personnel and safety-related personnel should receive CRM/SRM training on an initial basis and recurrent basis in the following areas (see Table 1):

- CRM/SRM elements:
  - Communication;
  - Decision making;
  - Situational awareness;
  - Workload management; and,
  - Resource management;
- CRM/SRM SBT:
  - Domestic flight operations;
  - International flight operations;
  - Normal procedures; and,
  - Emergency and abnormal procedures;
- Personality grid training:
  - Personal management style recognition;
  - Identification of personality extremes; and,
  - Movement motivation toward norm;
- CRM/SRM tool kits:
  - Decision-making model;
  - Workload-management model;
  - Flight-safety model;
  - Self-briefing mechanisms; and,
  - Personal-limits model;
- Threat and error management:
  - Red flags of overload;
  - Red flags of weather encounters;
  - Red flags of inexperience;
  - Red flags of time pressure;
  - Red flags of mission focus; and,
  - Reversing adversity; and,
- Automation management:

Table 1
Recommended Elements of Crew Resource Management (CRM)/Single-pilot Resource Management (SRM) Pre-course Training and Post-course Training

CRM/SRM Training Guidelines	Pre-course Training	Post-course/Line-oriented flight training (LOFT)
CRM/SRM Role in Single-pilot Operations	1. CRM/SRM and safety 2. Professionalism 3. Standard operating procedures 4. Pilot-in-command 5. Precious cargo 6. Hostile environment	1. Threat and error management 2. Advanced autoflight
History of CRM/SRM	1. CRM/SRM beginnings 2. Five generations of CRM 3. Corporate 4. Airline 5. Military	1. LOFT role 2. Initial operating experience and CRM/SRM
CRM/SRM Elements	1. Communication 2. Decision making 3. Situational awareness 4. Workload management 5. Command	1. CRM/SRM tool kit 2. Decision making model 3. Automation as second-in-command 4. Technical tool kit 5. Regulatory requirements
Behavior Grid	1. Scenario review 2. CRM/SRM exercises 3. Situational awareness	1. LOFT CRM/SRM exercises
CRM/SRM Core Values	1. CRM/SRM definitions	1. Video CRM/SRM summary

Source: National Business Aviation Association

- Autoflight vs. manual flight philosophy;
- FMSs;
- EFIS displays and symbology;
- Autopilot modes;
- Flight-mode annunciations; and,
- FGSs.

Information on CRM/SRM can be found in:

- FAA Advisory Circular 120-51C, *Crew Resource Management Training*;
- International Civil Aviation Organization (ICAO) Human Factors Digest No. 2, *Flight Crew Training: Cockpit Resource Management (CRM) and Line Oriented Flight Training (LOFT)*;
- FAA/industry training standards (FITS), *Single Pilot Resource Management Guide*; and,
- Ashgate Publishing (www.ashgate.com) aviation psychology and CRM publications.

Manufacturer's Training

The manufacturer's training can be described as the "nuts-and-bolts" portion of the training. It is technical in nature and designed to instruct the student on the specific aircraft. Candidates should expect a manufacturer's course to include the following:

- Pre-training study package review and testing;
- Aircraft systems;
- Autoflight skills;
- Avionics and navigation;
- Maneuvers and profiles;
- Emergency and abnormal procedures;
- Limitations and specifications;
- MEL, placards and maintenance requirements; and,
- Aircraft servicing:
  - Fuel;
  - Oil;
  - Hydraulic fluid;
  - Tires;
  - Potable water;
  - Oxygen; and,
  - Lavatory.

Post-rating Training

A critical element for the safe operation of the VLJ will be in the experience gained in this section. Although technically trained on the aircraft, the candidate may lack the experience necessary for safe operation in a variety of scenarios. It is the intent of this portion of training to expose the student to many different situations in anticipation of what will be experienced as the pilot gains initial operating experience (IOE). Post-rating training should consist of the following:

- LOFT (SBT):
  - Domestic;
  - Winter operations — deicing/runway clutter (contamination) performance, such as Denver, Colorado, U.S., to Aspen, Colorado;
  - Summer operations — high elevation/terrain-critical performance, such as Jackson, Wyoming, U.S., to Boise, Idaho; and,
  - International:
    - Western Atlantic, such as Teterboro, New Jersey, U.S., to Bermuda; and,
    - Mexico, such as San Diego, California, U.S., to La Paz, Mexico;
- CRM/SRM applications;
- Establishing personal operating minimums; and,
- Fatigue.

Initial Operating Experience

Determining how much operating experience a pilot needs to be considered qualified will be at the discretion of the individual insurance company. The pilot may require differing amounts of operating experience, based on prior experience levels, recency of experience and previous types of training he/she has received. In addition, it may be determined that utilizing a mentor is necessary. These variables are combined into the IOE categories and requirements shown in Table 2 (page 20), which prepare the pilot for single-pilot VLJ operations and are considered to be recommendations in the absence of specific insurance company requirements. The categories in and of themselves do not guarantee proficiency; regardless of the amount of operating experience and cycles employed, the IOE must yield candidates that are proficient.

At a minimum, the following should be addressed during IOE:

- Standard operating procedures (SOPs);
- Procedures vs. techniques;
- Ground-handling issues:
  - Aircraft geometry[7]; and,
  - Jet blast;
- Cabin features;
- Exit operation;
- Emergency equipment;
- Aircraft servicing;
- IOE checklist to be determined:
  - Minimum IOE time regardless of performance;
  - Established by experience level;

Table 2
Recommended Initial Operating Experience (IOE)

Category 1	Category 2	Category 3	Category 4
Pilots transitioning from left seat of previous jet aircraft	Pilots transitioning from left seat of turboprop or cabin-class twin	Pilots transitioning from single-engine turboprop or pressurized single-engine aircraft	Pilots transitioning from single-reciprocating-engine aircraft or as determined by insurance company
25 hours IOE	35 hours IOE	50 hours IOE	100 hours IOE
Minimum of 5 operating cycles*	Minimum of 8 operating cycles	Minimum of 10 operating cycles	Minimum of 25 operating cycles

*An operating cycle is one complete flight, consisting of takeoff, climb, cruise, descent, approach and landing.

Source: National Business Aviation Association

- Set by underwriter;
- End-level proficiency criteria; and,
- End-level proficiency areas:
  - Flight planning;
  - Performance;
  - Taxi;
  - Takeoff and climb;
  - Cruise management;
  - Descent and approach;
  - Landing;
  - Autoflight systems;
  - Exterior inspection; and,
  - Aircraft-geometry awareness.

An operating cycle is one complete flight, consisting of takeoff, climb, cruise, descent, approach and landing. At the completion of any category (see Table 2 for definitions), it is expected that proficiency is required in the following areas:

- Flight planning;
- Performance;
- Taxi;
- Takeoff and climb;
- Cruise management;
- Descent and approach;
- Landing;
- CRM;
- Autoflight;
- Basic FMS tasks;
- Systems;
- Exterior inspection; and,
- Geometry demonstration.

Mentor Program. Upon successful completion of the manufacturer's training program, the need for a mentor-pilot must be determined. The decision should be collaborative with the pilot, training provider and insurance underwriter. Should a mentor be deemed necessary, the duration may be derived from the individual's progress, but it must be recognized that the mentoring period for each individual may be different. The goal is to use a mentor-pilot until such time that the single-pilot operator acquires the necessary skills and proficiency for safe operation in all flight regimes. The categories listed in Table 2 are solely a guide for the mentor in the absence of formal insurance provider guidance. It is important that the pilot is exposed to a variety of environments during the mentoring period, including traffic, weather, airspace and terrain. It is possible that a mentor may be utilized on specific flights throughout a calendar year to have the candidate experience all climatic conditions. Mentors are not meant to instruct on the specific aircraft, but to act as a coach. The mentor should not fly as a crewmember but observe the pilot's aircraft handling, automation use and SRM, and provide feedback to the pilot.

However, it is indeed possible that operational intervention by the mentor might become necessary. This intervention may come in a verbal form or physical form, and there must be an understanding between the mentor and his/her client regarding intervention.

If it is deemed by the underwriter that a VLJ buyer will need a mentor following IOE, then that mentor will most likely report when the buyer, in the opinion of the mentor, no longer requires an escort. That point usually occurs when the mentor does not feel compelled to intervene.

Mentors also will have a role in recurrent training by providing recommendations, if applicable, for specific areas of emphasis.

Mentors should be selected from experienced pilots that have airline transport pilot (ATP) licenses and are type-rated in jet aircraft that have technically advanced systems similar to the VLJ in which they will mentor. The prospective mentor needs to be recognized by both the aircraft manufacturer and the insurance underwriter as meeting these criteria. In addition, it is recommended that a training program

Table 3
Recommended Curriculum for Recurrent Training

Day 1	Day 2	Day 3	Day 4
Emergency Procedures Training • Exits • Ditching • Evacuation • Emergency equipment • Crew resource management/single-pilot resource management	Segmented Line-oriented Flight Training • Autoflight • Cold-weather operations • Wind shear • Diversion • Holding • Flap irregularities systems review	Maneuvers Training • Crosswind takeoffs and landings • High-altitude decompression • Steep turns • Rejected takeoff • V_1 and V_2 cuts • Nonprecision approaches • Single-engine instrument landing system approaches • Visual approaches	Line-oriented Evaluation • Systems evaluation • Operational evaluation • Spot training
4 hours classroom	2 hours brief 4 hours simulator	2 hours brief 4 hours simulator	2 hours brief 4 hours simulator

Source: National Business Aviation Association

on the specific aircraft in which they will mentor be completed.

Annual Recurrent Training

In addition to the initial training, there will be a requirement for recurrent training (Table 3). Although individuals may elect to reduce the interval between recurrent training sessions, it is recommended that training be conducted on a yearly basis, as a minimum.

Recurrent training should include the following:

- Pre-training study package review;
- Mentor recommendations, if applicable;
- Incident review and industry events;
- Review of manufacturer's maintenance bulletins and operations bulletins;
- Recurrent critical maneuvers training;
- Review operating minimums;
- Practical application of CRM/SRM;
- LOFT (SBT) format;
- Unsatisfactory result criteria; and,
- Additional training plan. ■

[FSF editorial note: To ensure wider distribution in the interest of aviation safety, this document has been reprinted by permission from the National Business Aviation Association. Some editorial changes were made by FSF staff for clarity and for style.]

Notes

1. *Enhanced ground-proximity warning system (EGPWS)* is a term used to describe terrain awareness and warning system (TAWS) equipment. TAWS is the term used by the European Joint Aviation Authorities and the U.S. Federal Aviation Administration (FAA) to describe equipment meeting International Civil Aviation Organization standards and recommendations for GPWS equipment that provides predictive terrain-hazard warnings.

2. *Coffin corner* is a term used to describe the range of airspeed between an airplane's stall speed (at which low-speed buffet occurs) and maximum operating speed (beyond which high-speed buffet can occur); the range of airspeed between stall speed and maximum operating speed decreases with altitude.

3. FAA Advisory Circular 00-45D, *Aviation Weather Services*, says that when used on composite moisture and stability charts, the *lifted index* indicates the stability of the air at a specific location and, hence, the severity of any thunderstorms that might occur; the *K index* is primarily a meteorologist's tool for examining the temperature and moisture profile of the air at a specific location.

4. A nitrogen simulator is a portable device that induces hypoxia by increasing the nitrogen content of the air inhaled by the subject.

5. *Pinch hitter* is a term used to define a non-pilot-rated passenger who has received general familiarization training on airplane operation and can assist the pilot with specific tasks (e.g., selecting a radio frequency, adjusting the environmental-control system).

6. *Slam-dunk* is an informal term used to describe a situation in which air traffic control issues descent instructions that require a higher-than-normal descent rate into a terminal area.

7. Awareness of airplane *geometry* — wingspan and turning radius — is an important element in maneuvering the airplane on the ground.

> **"The mentor has to be an educator and able to deal with a Type A owner personality."**

management (SRM), high-altitude physiology, high-altitude aerodynamics, hazards (e.g., wind shear, wake turbulence), reduced vertical separation minimum, and collision avoidance. The FSF *Approach-and-landing Accident Reduction (ALAR) Tool Kit* and *Controlled Flight Into Terrain (CFIT) Checklist* are recommended elements of the package;

- Training for the type rating;

- Post-rating training on the application of CRM/SRM principles, establishment of personal operating minimums and fatigue countermeasures. Also recommended is line-oriented flight training (LOFT), to provide the pilot with experience in winter operations, operating at high-elevation airports and airports near high terrain, and international operations. "It is the intent of this portion of the training to expose the student to many different situations in anticipation of what will be experienced as the pilot gains initial operating experience [IOE]," the guidelines said;

- Supervised IOE, varying from a minimum of 25 hours for a pilot with previous experience as a jet captain, to 35 hours for a pilot transitioning from a cabin-class twin or turboprop, to 50 hours for a pilot transitioning from a pressurized single-reciprocating-engine airplane or single-engine turboprop, and to 100 hours for a pilot transitioning from a nonpressurized single-reciprocating-engine airplane. The pilot might be required to receive IOE with a mentor pilot aboard the airplane; and,

- Recurrent training at least annually.

Walsh, who headed the VLJ Working Group, said that mentoring is a critical part of the training guidelines. Mentors must be selected and trained carefully, and they must fly with the owner-operator until he is proficient.

"The judgment made by the mentor regarding a trainee's release from supervision will be the most important decision made during the training process," he said.

McGowan said that the role of a mentor will be different than that of a flight instructor.

"The mentor will be along primarily as a safety pilot but also will have to complete the pilot's experience base," he said. "I think we are going to have to put together a training program for mentor-pilots because a lot of pilots with a lot of experience might have to learn how to do the job of a mentor as opposed to an instructor."

O'Gwen said, "Being a professional pilot doesn't qualify you to be a mentor. The mentor has to be an educator and able to deal with a Type A owner personality. The way we envision a successful mentor program is not just having a guy in the right seat; it should truly be a transfer of knowledge and experience. The mentor should be involved in everything from trip planning to trip execution."

O'Gwen said that an ideal situation would be one in which an owner-pilot continues his relationship with a mentor.

"We can envision a point in time when the owner becomes qualified to go out and fly 70 percent of his trips alone, but for the other 30 percent — whether it be for weather or a long day — he is accompanied by the mentor. We've seen a lot of that already, where an owner-pilot will take a professional with him for whatever reason. It should be an evolving relationship, not one in which the owner flies with the mentor only for a required amount of time. It could be a relationship that is perpetuated indefinitely."

Simulator Training Promoted

The training guidelines are being used for the development of training programs by all the companies in Table 1. Representatives of CAE SimuFlite, FlightSafety International and SimCom said that the guidelines are a good basis for the development of a VLJ-pilot training program.

Carlson said that CAE SimuFlite is studying the market.

"It is an interesting market, in that VLJ manufacturers have many deliveries forecast," he said. "It's also a very challenging market, in that transitioning owner-operators into the single-pilot jet environment, where they will have to make the proper decisions in an aircraft that will be flying in the same airspace as the commercial jets and business jets, will be a big challenge. It is, however, an unproven market."

CAE SimuFlite currently provides single-pilot training in Citations and CJs. Asked what special considerations would be involved in developing a training program for VLJ owner-pilots, Carlson said, "It's a very unique individual that has the ability to run a business and earn enough to support a small jet. The individual tends to be very driven, very accomplished, used to having his own way. … These individuals sometimes say, 'I want to get in and out as quickly as I can. I want to do the four-day program in two days, or initial training in a week.' There are times when we can accommodate that with a recurrent situation; but with initial training, typically we cannot."

The initial training course for a CJ type rating is two weeks, and initial training for single-pilot authorization is an additional eight days. Carlson said that training a VLJ owner-pilot might require up to four more days.

"What we typically recommend for someone coming in for his first type rating and for single-pilot authorization is that he come in for the type rating, go fly the airplane for at least six months with an instructor pilot and then come back for his single-pilot authorization," he said.

Tracy Brannon, senior vice president and managing director of SimCom, said that the company has discussed training with several VLJ manufacturers.[33]

"Developing a training program usually is not inexpensive, and what we are hearing from the industry is that the insurance underwriters are pushing hard for full-motion simulation," he said. "Development of a VLJ full-motion simulator is going to be a multi-million-dollar project. So, any training provider is going to want to have an exclusive training arrangement."

SimCom currently provides Citation single-pilot training. Prerequisites for the training include a type rating in the airplane, a commercial pilot certificate with multi-engine and instrument ratings, and at least 1,000 flight hours.

"I would expect these same requirements for single-pilot operation of a VLJ aircraft," Brannon said. "In practice, it will be the underwriting industry that sets the minimum experience requirements for each insured. Despite the advertised safety and simplicity of the proposed VLJ aircraft, underwriters as a whole are not likely to deviate from experience requirements associated with similar light turbine-powered equipment."

McGowan said that FlightSafety International has been developing a VLJ-pilot training program.

"From a training standpoint, the challenge is that in 95 percent of our training programs, we have people with a good deal of flying experience when they transition from a multi-engine turboprop into a jet," he said. "So, there's a core of experience we can expect when we develop a program, and that expected core of experience helps us design a program that makes the most benefit from the time that you have.

"With any of the VLJs, we're going to see a broader range of experience. We're going to see some very high-time pilots as well as some pilots with perhaps as little as a couple hundred hours."

Simulating the ATC Environment

Among the elements that FlightSafety is developing for VLJ-pilot training is a simulated ATC environment, McGowan said.

"Operating in a busy ATC environment, where the whole world seems to be talking at once and where things are happening fast, could be a problem for some of these pilots," he said. "One of the areas of simulation that has not been very realistic is the ATC environment; it is simulated by the instructor playing the role of controller. Having no extraneous communications — ATC instructions to other flight crews and their responses — and having the same voice for every communication is not realistic."

The simulated ATC environment will be based on electronic voice-processing (EVP) technology.

"FAA uses EVP to train controllers," McGowan said. "Our goal is to simulate the ATC environment from the beginning of a flight to the end. … We may only be able to simulate an ATC environment for a flight from, say, Wichita [Kansas] to Chicago [Illinois] to New York and back to Wichita, and we may have very narrow corridors. But, if the learning objective is to familiarize the pilot with a rapid-pace ATC environment, we can achieve that."

FlightSafety also will use its "short, narrow runway model" for VLJ-pilot training. McGowan said that the model for VLJ-pilot training will be a runway that is 3,000 feet (915 meters) long and 50 feet (15 meters) wide.

"With most of our runway models, if you go off the end of the runway, it's like being on the runway; it has no impact," he said. "With the short, narrow runway model, if the airplane runs off the edge of the runway or the end of the runway, a landing gear shears, and the pilot gets a very rough ride. It has impact; you're going to remember it."

The object is to instill the importance of conducting a stabilized approach or conducting a go-around when an approach is not stabilized.

"Operating in a busy ATC environment could be a problem for some of these pilots."

"A lot of pilots get used to landing on long, wide runways, and they carry extra speed on the approach," McGowan said. "There are times, however, when a pilot will land on a marginal runway because 'the book' [airplane flight manual] says he can do it. When a pilot lands 700 feet [214 meters] down a 3,000-foot runway while carrying 10 knots of extra speed, bad things are going to happen. The time to recognize that is when you're still 500 feet to 1,000 feet in the air and you're high on altitude and fast on airspeed, not when you're flaring to land or are on the brakes, hoping you can get it stopped."

McGowan said that his greatest concern about VLJ-pilot training is time.

"Most of our type-rating courses are two or three weeks long," he said. "Whether it's a professional pilot, who flies for a living, or a pilot who flies for business or as an avocation, there are some who will fuss about a training program that takes more than two weeks. My concern is whether the people will be willing to put the time in to get to the level of proficiency that is needed."

Adam to Conduct In-house Training

Adam Industries will train A700 pilots in-house, said Walker. The program, at least initially, will not include simulator training.

"We'll just have our customers use their own airplanes for pilot training," he said. "Our training program includes mentoring, and we'll supply, on a daily-fee basis, the mentor-pilots. We are overrun with mentor candidates. There's a ton of retired or semi-retired airline pilots who have a wealth of experience and would like to get out of the house."

Cessna and Excel-Jet plan to contract with training partners. Eclipse has selected United Airlines' United Flight Training Center (UFTC) as its training partner.

Eclipse Program Has Six Phases

The Eclipse 500 pilot-training program begins with a review of the pilot's qualifications.

"It's a fairly simple two-part procedure, beginning with a thorough, interactive ground-school presentation on SRM that takes the better part of an afternoon," said Taylor. "The next day begins with a briefing for a simulator evaluation. The customer-pilot then goes into a Boeing 737-300 procedures trainer with an instructor. The 'airplane' already is in flight at 10,000 feet, and the pilot does some airspeed changes, climbs and descents, tracking of a radial, holding patterns — nominal airwork that you would expect an instrument-rated pilot to be able to do."

If the review shows that training is required to improve the pilot's proficiency, UFTC will tailor the training to the pilot's needs.

"However, if the customer wants to improve his instrument-flying skills elsewhere, that's certainly an option, but he would have to come back to take a second review at United," Taylor said.

The second phase of training is a self-study course on compact disc, which already has been sent to customers who have placed orders for the Eclipse 500.

"The course include basics of jet engines, high-altitude meteorology, high-altitude aerodynamics, flight planning, etc.," Taylor said. "It's a generic program; it's not Eclipse-specific. The purpose is to bring our customers up to a level of understanding about a jet airplane that they may not have if they have not flown one."

The third phase includes hypoxia training in a hypobaric (altitude) chamber or with a mixed-gas breathing system — in which an emergency medical technician controls the amount of oxygen inhaled by the trainee through a mask — and upset-recovery training in an Aero Vochody L-39 military jet trainer.

"Our upset-recovery training will comprise two brief flights and is designed to familiarize the customer with what it's like to be upside down, in a 60-[degree] or 90-degree bank or in an extreme nose-up or nose-low attitude, and how to recover from upsets," Taylor said. "The training also will include lectures on aerodynamics, high-speed stalls and upset-recovery techniques."

The first three phases of training do not have to be completed in order, but all three phases must be completed before the pilot begins the fourth phase: the type-rating transition course. The pilot will be tested on his knowledge of the self-study topics before beginning the training.

"We'll start off with a Level 6 flight-training device — a fixed-base device with a good visual system and full replication of the Eclipse aircraft cockpit," Taylor said. "An aircraft flight will be required upon completion of the training in the non-motion simulator. We will be going to full-motion simulation, but that probably won't happen until the end of 2006."

After earning an Eclipse 500 type rating, the pilot either will be certified for single-pilot operation or will be required to fly with a mentor.

"A lot of our customers, by virtue of the fact that they have not flown a jet airplane or do not have a previous type rating in a jet airplane, will be required to have a certain amount of mentor time after they get the type rating," Taylor said. "We will develop a pool of mentor-pilots who will be required to receive the same training as our customers, plus a day or two of additional training on standardization and the expectations we have of our mentor-pilots — sort of an Eclipse charm school, so that they understand our customer service."

Taylor said that there is no shortage of mentor candidates.

"I probably have 150 applications on file already from very-well-qualified people who would like to participate," he said. "Primarily, they are people, like me, who have been chronologically retired from an airline, don't want to quit flying and see this as a nice opportunity. That's exactly the type of person we're looking for: a very highly experienced jet aviator who's 'been there and done that.'"

What happens if a prospective owner-pilot cannot complete the training?

"There may be some customers who will not be able to complete the training," Taylor said. "They will not have to accept delivery of the aircraft if they don't want to; we will give them their money back. A customer who still wants the airplane probably can hire someone to fly it for them, and we'll be happy to train that person."

The last phase is recurrent training, which also will be conducted by UFTC.

"We are anticipating that any customers who need mentoring will be required to come back for a six-month recurrent check," Taylor said. "Those who do not require mentoring, which will probably be a very small minority, we would like to see in a year. After that, it will depend on the pilot's performance. There may be some we will want to see every six months and some we will want to see every year."

Taylor said that the company will collect and analyze data recorded during flights conducted in customers' airplanes.

"We are going to implement a program similar to the FOQA [flight operational quality assurance] program that the airlines use," he said. "The program will help us identify trends — such as unstabilized approaches, high-speed touchdowns and long landings — and to make repairs."

Resale Raises Concerns

A perplexing question about VLJs is what happens after the original owner sells the airplane.

"The manufacturers are developing pilot-training programs, but what happens when the original customer sells?" said Matthews. "I would imagine that the insurance companies will have a say in this, but what about the possibility of an affluent person self-insuring — that is, not contracting with an underwriter for coverage?"

John D'Angelone, executive vice president of Global Aerospace, voiced similar questions.[34]

"If all the training that's being proposed — and that includes the mentoring and the follow-up recurrent training — is conducted, the concept will work," he said. "If I have one concern, it would be about resales. We will be insuring the pilot who does all the right things, but when he sells the airplane to somebody else, then what happens? The new owner is not beholden to the manufacturer at that point. We might have a bunch of owner-pilots out there who are not getting any training at all. That could turn into a situation in which losses begin to mount and VLJs get a bad record."

ATC Congestion Anticipated

Forecasts of thousands of VLJs entering service over the next few years have raised concerns about increased ATC congestion.

"Upper airspace flight levels are already congested," said Mike Ambrose, director general of the European Regions Airline Association and vice chair–Europe of the FSF Board of Governors.[35] "VLJs will make a difficult situation worse. Furthermore, increasing environmental awareness means that regulatory authorities are paying more attention to upper-airspace pollution."

Eurocontrol has launched a study of the potential impact of VLJs, said Tzvetomir Blajev, coordinator of safety improvement initiatives for the organization.[36]

"Eurocontrol has observed both a recent strong growth in business aviation (business-jet flight movements were up 11 percent in 2004) and the potential for this to accelerate due to new aircraft types (VLJs) and new operating models [which include aircraft performance characteristics and preferred cruise altitudes, routes and airports]," he said. "As no forecasts for this sector exist for Europe, Eurocontrol identified it as an important area to analyze.

"Consequently, we have launched a business aviation study to help the air traffic–management industry in Europe anticipate and prepare for the business-aviation growth and to assess when and where the traffic growth will come, and what the impact will be on air traffic management in terms of delays, traffic complexity, safety and environmental issues."

Blajev said that among the questions being asked are the following:

- "When will controllers see increases in traffic — and how many more flights will there be to control?
- "How will growth in the market sector affect current en route traffic flows? What are the economical cruise levels for business aviation, and will this change?
- "Which airports or airport types will be most affected? How will this affect airports that are already short of capacity?
- "What effect will this growth have on our ability to continually improve

safety and to reduce environmental impacts? [and,]

- "What effect might growth in the sector have on the income from route charges?"

Eurocontrol plans to complete the study in spring 2006, Blajev said.

Delays in U.S. Could Triple

A draft report on a study by FAA indicates that if VLJs enter the U.S. National Airspace System (NAS) at the predicted levels, and no changes are made to accommodate them, flight delays would increase by more than 300 percent by 2010.[37]

Doug Fralick, director of safety and technology for the National Air Traffic Controllers Association, and a former controller, said that the relatively low cruising speeds of VLJs likely will be the greatest problem for controllers.

"The biggest impact most likely will be in the en route environment," he said. "They will fit in fine with traffic below 10,000 feet, where maximum speed is 250 knots. In the upper flight levels, speed will be an issue. The larger business jets are not an issue; they can charge right along with the 'big guys' [airliners].

"The early Citations already are an issue for us. As a controller, you have to be aware of their slower speeds so that you don't run them down. The very light jets are going to create the same issue *if* they're put into the same flow with commercial aircraft. … I don't think the VLJs will mix in well with the flow that we have today. A solution is going to have to be found."

Fralick said that a possible solution is to segregate slower aircraft in required navigation performance (RNP) routes that parallel the routes typically flown by faster traffic.

"It makes sense to put these airplanes in their own traffic flow because, then, they'd be compatible; they wouldn't interfere with the higher-speed jets," he said.

FAA defines RNP as "a navigation system that provides a specified level of accuracy defined by a lateral area of confined air-space in which an RNP-certified aircraft operates."[38] Factors included in the RNP certification of an aircraft include on-board avionics equipment and database, pilot training, operating procedures and maintenance. An aircraft certified for RNP 1.0, for example, is capable of tracking within 1.0 nautical mile (1.9 kilometers) either side of the flight-path centerline. RNP 1.0 accuracy is required for departures and arrivals; RNP 2.0 accuracy is required for en route operations; and RNP 0.3 accuracy is required for approaches.

Fralick said that *any* increase in air traffic will increase congestion at the major airports.

"Volume is an issue," he said. "Congestion is going to get worse. I don't know of any quick fix in the works. But, whatever you throw up there, we're going to figure out a way to make it work. That's our job. We'll make it work." ■

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    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 interval of several or more years will reflect patterns that are broadly representative of the total universe of aviation safety incidents of that type."

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Appendix

Accidents and Incidents Involving Single-pilot Operation of Civilian Jets, 1966–2004

Date	Location	Airplane Type	Airplane Damage	Injuries
Sept. 26, 1966	North Platte, South Dakota, U.S.	Aero Commander 1121 Jet Commander	destroyed	5 fatal

The ceiling was at 500 feet and visibility was two statute miles (three kilometers) or less with rain showers when the pilot conducted a takeoff from his ranch airstrip and a low pass over his house. The aircraft then was observed descending through the clouds in an inverted attitude. The instrument-rated private pilot, 49, had 5,200 flight hours, including 200 flight hours in type. The U.S. National Transportation Safety Board (NTSB) said that the probable cause of the accident was "loss of control for undetermined reasons." The report indicates that the accident occurred during single-pilot operation of the airplane; the U.S. Federal Aviation Administration (FAA) type certification data sheet for the Jet Commander shows that it was certified for a minimum crew of two (pilot and copilot).

Date	Location	Airplane Type	Airplane Damage	Injuries
Nov. 22, 1966	near Freeport, Bahamas	Hawker-Siddeley DH-125	destroyed	1 fatal, 1 serious

The airplane, which was not certified for single-pilot operation, reportedly was flown from Miami, Florida, U.S., to Freeport at night by a 33-year-old pilot who held an airline transport pilot (ATP) certificate and had 6,300 flight hours, including 152 flight hours in type. The NTSB report did not specify the weather conditions. The pilot was cleared to conduct a straight-in approach. The airplane was in controlled flight when it struck the water about 4.5 nautical miles (8.3 kilometers) offshore. The passenger was missing and presumed to be dead. The report said that the probable causes of the accident were that the pilot misjudged altitude, failed to follow approved procedures and directives, and misread or failed to read the airplane's instruments.

Date	Location	Airplane Type	Airplane Damage	Injuries
Feb. 22, 1978	Rome, Italy	Learjet 35	destroyed	3 fatal

Airclaims said that the airplane "went missing while approaching to land." The airplane was not certified for single-pilot operation.

Date	Location	Airplane Type	Airplane Damage	Injuries
Aug. 2, 1979	Canton, Ohio, U.S.	Cessna Citation 501	destroyed	1 fatal, 2 serious

The pilot was Thurman L. Munson, a professional baseball player. He held a private pilot certificate and a Citation type rating, and had 516 flight hours, including 34 flight hours in type. Both passengers were certificated pilots, but neither held a type rating. The front-seat passenger had instructed the pilot during his training for an instrument rating. The pilot conducted a takeoff from a 5,598-foot (1,707-meter) runway and two touch-and-go landings. The NTSB report said, "The first two touch-and-goes were normal, except both passengers were in agreement that pattern altitude was flown higher than normal (2,700 feet) and airspeeds were fast." The front-seat passenger told investigators that the pilot then invited him to conduct a no-flap landing. The airplane was observed to touch down at midfield. The pilot assumed control and conducted the takeoff. He then was told by the tower controller to fly a right downwind pattern to another runway, which was 6,398 feet (1,951 meters) long. "The passengers again reported a high downwind [at] about 3,500 feet [and] at about 200 knots," the report said. The pilot reduced power to near idle on the downwind leg; the landing-gear-warning horn sounded, and the pilot manually silenced the horn. The controller told the pilot to extend the downwind leg for traffic spacing. "Neither passenger started to become apprehensive about the aircraft operation until beginning the turn onto final approach," the report said. The front-seat passenger observed that the airplane was below the visual approach slope indicator (VASI) glide path and descending with the landing gear and flaps retracted. The passenger said, "I don't think you want to land this airplane with the gear still up." The pilot extended the landing gear, moved the throttle levers forward slightly and then moved them full forward. A motor-vehicle driver on a highway about 3,300 feet (1,007 meters) from the runway threshold observed the airplane cross the highway at about 50 feet to 75 feet, descending and "going very slowly." The airplane then struck terrain about 870 feet (265 meters) from the runway, and a fuel-fed fire erupted. The passengers received second-degree burns while evacuating the airplane. "The pilot [who was not using his shoulder harness] received various head and body injuries that evidently rendered him incapable of exiting the aircraft and died of asphyxiation," the report said. The probable cause of the accident was "the pilot's failure to recognize the need for, and to take action to maintain, sufficient airspeed to prevent a stall into the ground during an attempted landing." The report said, "The pilot also failed to recognize the need for timely and sufficient power application to prevent the stall during an approach conducted inadvertently without flaps extended. Contributing to the pilot's inability to recognize the problem and to take proper action was his failure to use the appropriate checklist and his nonstandard pattern procedures which resulted in an abnormal approach profile."

Date	Location	Airplane Type	Airplane Damage	Injuries
Oct. 1, 1980	St. Peters, Jersey, England	Cessna Citation I	destroyed	1 fatal

Visibility was restricted and the ceiling was low when the pilot discontinued a nighttime instrument approach at about 200 feet. The report said that the pilot probably experienced spatial disorientation during the attempted missed approach. The airplane continued to descend, banked right and struck the roof of a house about 623 feet (190 meters) right of the runway threshold. One of the occupants of the house received serious injuries and two occupants received minor or no injuries while escaping from the post-impact fire.

Date	Location	Airplane Type	Airplane Damage	Injuries
Dec. 16, 1980	Santa Ana, California, U.S.	Learjet 24	minor	1 none

During the landing roll in daylight visual meteorological conditions (VMC), the nosewheel turned 90 degrees and caused a loss of directional control. The pilot held an ATP certificate and a Learjet type rating, and had 3,000 flight hours, including 400 flight hours in type. The airplane was not certificated for single-pilot operation.

Date	Location	Airplane Type	Airplane Damage	Injuries
Jan. 30, 1981	London, England	Cessna Citation	substantial	4 none

Runway visual range (RVR) was less than 150 meters(/500 feet) when the airplane struck a radar reflector and two approach lights during an approach to London Stansted Airport. The airplane came to a stop on the runway, 650 meters (2,133 feet) from the threshold.

Appendix

Accidents and Incidents Involving Single-pilot Operation of Civilian Jets, 1966–2004 *(continued)*

<table>
<tr><th>Date</th><th>Location</th><th>Airplane Type</th><th>Airplane Damage</th><th>Injuries</th></tr>
<tr><td>Sept. 20, 1982</td><td>Crystal City, Texas, U.S.</td><td>Cessna Citation 501SP</td><td>substantial</td><td>6 none</td></tr>
<tr><td colspan="5">The airplane touched down 10 feet (three meters) from the runway threshold. The right main landing gear failed when it struck the raised end of the runway, causing a loss of directional control. The airplane then struck fence posts. The NTSB report said that the probable cause was that the "proper touchdown point [was] not attained."</td></tr>
<tr><td>Nov. 12, 1982</td><td>Wichita, Kansas, U.S.</td><td>Cessna Citation 501</td><td>substantial</td><td>1 none</td></tr>
<tr><td colspan="5">A maintenance technician employed by the aircraft manufacturer taxied the aircraft rapidly to the active runway and conducted a takeoff without clearance. Witnesses said that the aircraft appeared to stall during a very steep climb. "The nose was lowered, and the aircraft turned left and entered a downwind leg to Runway 01R," the report said. The aircraft was low on the base leg and, on final approach, touched down 557 feet (170 meters) from the end of the runway and struck approach-light stanchions. The maintenance technician was not a certificated pilot and was not authorized by the manufacturer to operate the airplane. "The mechanic had been, and was at the time of the accident, under psychiatric care (schizophrenia)," the report said.</td></tr>
<tr><td>Nov. 18, 1982</td><td>Mountain View, Missouri, U.S.</td><td>Cessna Citation 551</td><td>destroyed</td><td>3 fatal</td></tr>
<tr><td colspan="5">The ceiling was at about 100 feet, and visibility was about 1.0 statute mile (1.6 kilometers) in fog. The pilot had obtained an instrument flight rules (IFR) departure clearance that was valid until 0930 local time. He arrived at the airport between 0920 and 0925, boarded the passengers and started both engines. Witnesses said that the takeoff was begun about two minutes later. "The takeoff appeared to be normal," the report said. "However, the airplane crashed less than three minutes later, 1.75 miles [3.24 kilometers] due north of the airport." Pitch attitude was 30 degrees nose-down, and the airplane was banked 90 degrees left on impact. The NTSB report said that the probable cause of the accident was "the loss of control of the airplane following the takeoff in instrument meteorological conditions [IMC] as a result of the pilot's use of attitude and heading instruments which had not become operationally usable and/or his partial reliance on the copilot's flight instruments, which resulted in an abnormal instrument-scan pattern leading to the pilot's disorientation. Contributing to the accident was the pilot's hurried and inadequate preflight procedures." The pilot was president of the company that owned the airplane. Although the company employed a chief pilot, the pilot generally flew the Citation without a copilot. He had about 3,350 flight hours, including 1,750 flight hours in type. The chief pilot had conducted a preflight inspection of the airplane while the pilot was en route from his home to the airport.</td></tr>
<tr><td>Dec. 5, 1983</td><td>near Kalgoorlie, Western Australia, Australia</td><td>Cessna Citation</td><td>substantial</td><td>6 minor/none</td></tr>
<tr><td colspan="5">The airplane was being descended through clouds when the pilot observed a visual warning that the fuel supply was low. Soon thereafter, the right engine flamed out. The pilot was unable to restart the engine. The airplane descended below the clouds at 1,000 feet above ground level (AGL). The left engine then flamed out, and the pilot conducted a gear-up landing on a firebreak (a strip of land cleared to prevent the spread of a fire). The report said that the engine failures were caused by fuel exhaustion. The report said that the winds aloft were almost twice the velocity that the pilot had assumed while planning the flight; the pilot selected a lower-than-planned cruise altitude to increase groundspeed in an attempt to arrive at the destination on schedule. "This was achieved to some degree but at the expense of increased fuel consumption," the Airclaims report said.</td></tr>
<tr><td>Sept. 10, 1984</td><td>Chesterfield, Missouri, U.S.</td><td>Learjet 24D</td><td>substantial</td><td>1 none</td></tr>
<tr><td colspan="5">The airplane was landed in a thunderstorm and with a 16-knot left-quartering tail wind. The report said that the pilot knew of an area on the runway where water tended to collect; nevertheless, because of heavy precipitation, the pilot could not observe the area. The left main gear began to hydroplane in this area; the airplane veered 90 degrees right and overran the runway onto rough terrain. The NTSB report said that the probable cause of the accident was that the pilot's "in-flight planning/decision [was] improper."</td></tr>
<tr><td>Oct. 2, 1989</td><td>Sedona, Arizona, U.S.</td><td>Cessna Citation 501</td><td>destroyed</td><td>1 none</td></tr>
<tr><td colspan="5">The pilot said that he encountered strong turbulence and a strong downdraft on final approach. He increased power to maintain the landing reference speed and the VASI glide path. "Turbulence and a downdraft were reported to be exceptionally strong over the [runway] threshold," the report said. The airplane touched down on all three landing gear, bounced and entered pitch oscillations that increased in amplitude. After the second touchdown, the airplane veered off the side of the runway and came to a stop in a wooded area. The NTSB report said that the probable cause of the accident was "improper in-flight planning/decision by the pilot, which resulted in his inability to flare the aircraft and/or recover from a bounced landing."</td></tr>
<tr><td>Nov. 5, 1990</td><td>near Mareeba, Queensland, Australia</td><td>Cessna Citation 501</td><td>destroyed</td><td>11 fatal</td></tr>
<tr><td colspan="5">While inbound to the Mareeba airport on a charter flight, the pilot was told to descend to, and maintain, 10,000 feet. Soon thereafter, the pilot reported that he had visual contact with Mareeba. He again was instructed to maintain 10,000 feet. "The pilot reportedly queried this instruction and some time later was cleared to descend to 7,000 feet," the Airclaims report said. "This transmission was not acknowledged." The airplane was in a wings-level, slightly nose-down attitude when it struck Mount Emerald near its summit at 3,688 feet.</td></tr>
<tr><td>Sept. 16, 1990</td><td>Morristown, Kentucky, U.S.</td><td>Learjet 24</td><td>minor</td><td>4 none</td></tr>
<tr><td colspan="5">The FAA incident report said, "[The] pilot admitted he operated [the] stolen aircraft under [the influence of] alcohol." After flying the airplane over the city, the pilot landed at Moore-Murrell Airport. The airplane overran the runway and struck approach lights. The pilot held an ATP certificate and had 6,000 flight hours, including 2,000 flight hours in type. The report said that his ATP certificate was revoked after the incident.</td></tr>
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Appendix
Accidents and Incidents Involving Single-pilot Operation of Civilian Jets, 1966–2004 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Jan. 5, 1993	Canefield, Dominica	Cessna Citation 550	NA	1 minor/none
After a visual approach, the airplane was landed hard on its nose gear, which collapsed.				
July 26, 1995	Minneapolis, Minnesota, U.S.	Cessna Citation 550	substantial	3 none
After conducting a maintenance test flight in daytime VMC to check the operation of the airplane's air-conditioning system, the pilot allowed a maintenance technician, who held a commercial pilot certificate, to land the airplane from the right front seat. The pilot said that the maintenance technician allowed the airplane to float too far down the 3,909-foot (1,192-meter) runway. The pilot called for a go-around and then took control of the airplane. During the subsequent landing, the pilot deployed the thrust reversers and applied the wheel brakes. He said that the wheel brakes had no effect. The maintenance technician also applied the wheel brakes but found no braking action. The airplane overran the runway, and the nose landing gear collapsed. The NTSB report said that the probable causes of the accident were "failure of the landing gear braking system for undetermined reasons and the pilot's failure to perform the emergency procedure of operating the emergency brake system."				
Jan. 1, 1996	Greensboro, North Carolina, U.S.	Cessna Citation 550	minor	2 none
During a nighttime visual approach to the Charlotte, North Carolina, airport, the pilot observed no indication that the landing gear was extended. He flew the airplane near the airport control tower and was told that the landing gear was not extended. The pilot diverted to the Greensboro airport and attempted to extend the landing gear with the emergency-extension system. He flew the airplane near the control tower and was told that only the nose gear appeared to be extended. The flaps and the fuselage were damaged when the airplane was landed on a runway. The FAA incident report said that a hydraulic-valve cannon plug was found loose and that the emergency-extension system was not rigged properly.				
June 30, 1996	Carpi, Italy	Cessna Citation 500	substantial	1 minor/none
The Airclaims report said that airplane was substantially damaged when it "undershot on approach."				
Jan. 24, 1997	Washington, Indiana, U.S.	Cessna Citation 500	minor	4 none
Daytime VMC prevailed when the airplane was landed on an ice-contaminated, 4,621-foot (1,409-meter) runway. The nose gear collapsed when the airplane slid off the end of the runway into a ditch and came to rest on a taxiway. The pilot held an ATP certificate and a type rating, and had 12,000 flight hours, including 5,000 flight hours in type.				
March 13, 1997	Uvalde, Texas, U.S.	Cessna Citation 500	minor	1 none
After a maintenance test flight in daytime VMC, the airplane was landed with the nose gear retracted. The FAA incident report said, "Investigation revealed that the right nose-gear door was left disconnected from the rear hinge attach point and taped in the closed position. Preflight inspection failed to observe this function." The pilot held an ATP certificate and type rating, and had 8,500 flight hours, including 1,100 flight hours in type.				
June 11, 1997	Berry Island, Bahamas	Cessna Citation 501	substantial	8 none
The pilot said that he landed the airplane at Chub Cay International Airport at the landing reference speed (V_{REF}), extended the speed brakes, selected the anti-skid brake system and applied wheel brakes. He observed that the airplane was not decelerating and applied full power for a go-around. "The airplane failed to clear a grove of trees past the departure end of the runway and came to rest upright," the report said. The accident occurred in daylight VMC. The pilot held an ATP certificate.				
March 19, 1998	Portland, Oregon, U.S.	Aerospatiale SN-601 Corvette	substantial	4 none
The pilot was unable to start the right engine and attempted to take off for a visual flight rules (VFR) flight in daytime VMC with the right engine inoperative. Witnesses said that the nose landing gear lifted off about 4,100 feet (1,251 meters) down the 8,000-foot (2,440-meter) runway; the airplane became airborne with its wings rocking and then settled onto the runway. The airplane veered off the right side of the runway and slid for about a half mile. The pilot held a commercial pilot certificate and a type rating, and had 4,500 flight hours, including 125 flight hours in type. "The aircraft has a minimum crew requirement of two," the report said. "The copilot's-seat occupant, a private pilot–rated passenger, did not hold a multi-engine rating and thus was not qualified to act as second-in-command of the aircraft." The report said that the probable cause of the accident was "the pilot-in-command's decision to attempt takeoff with the right engine inoperative, resulting in his failure to maintain directional control or attain adequate airspeed during the takeoff attempt."				
April 4, 1998	Marietta, Georgia, U.S.	Cessna 525 CitationJet	destroyed	5 fatal
Daytime VMC prevailed when the CitationJet collided with a Cessna 172 at 3,400 feet. The CitationJet pilot was conducting a climb to the north and was communicating with a terminal approach controller, who did not observe the 172's primary radar target. The 172 pilot was southbound and communicating with a military-airport controller when the collision occurred. "A cockpit visibility study indicated that from a fixed eye position, the 172 was essentially hidden behind aircraft structure of the 525 for the 125 seconds before impact," the report said. "The 172 could be seen by shifting the pilot's eye position. The 525 was viewable in the left lower section of the 172's windscreen." The 172 was destroyed, and the pilot was killed. The 172's transponder switch was found in the "OFF" position. The report said that the probable causes of the accident were "the failure of both pilots to see and avoid conflicting traffic, and the failure of the 172 pilot to operate the transponder as required by current regulations." The CitationJet pilot held an ATP certificate and type rating, and had 1,824 flight hours, including 86 flight hours in type.				

Appendix

Accidents and Incidents Involving Single-pilot Operation of Civilian Jets, 1966–2004 *(continued)*

<table>
<tr><th>Date</th><th>Location</th><th>Airplane Type</th><th>Airplane Damage</th><th>Injuries</th></tr>
<tr><td>Sept. 28, 1998</td><td>Pueblo, Colorado, U.S.</td><td>Cessna Citation 551</td><td>substantial</td><td>4 none</td></tr>
<tr><td colspan="5">The pilot said that after a normal touchdown on the 10,496-foot (3,201-meter) runway in daytime VMC, he pushed the control column forward to lower the nose and began to deploy the thrust reversers; the airplane then began to "veer and oscillate up and down." The airplane became airborne, touched down again and veered off the side of the runway onto rough terrain. Airport control tower personnel told an FAA investigator that the airplane appeared to have been landed hard. The NTSB report said that the probable causes of the accident were "the pilot's delayed flare, improper recovery from a bounced landing and failure to maintain directional control."</td></tr>
<tr><td>Dec. 2, 1998</td><td>Umpire, Arkansas, U.S.</td><td>Cessna Citation 501</td><td>destroyed</td><td>1 fatal</td></tr>
<tr><td colspan="5">Daytime VMC prevailed when the pilot departed from the Mena (Arkansas) airport to fly his newly repainted airplane back to his home base, about 67 nautical miles (124 kilometers) away. Witnesses about 17 nautical miles (31 kilometers) south of the airport heard the airplane fly past them from the north; the airplane then turned and flew toward the north. The witnesses observed the airplane in a 90-degree right bank; it then rolled inverted and entered a near-vertical descent. The witnesses said that the engine sound was "constant and never changed." Investigators found no indication of pilot incapacitation, an in-flight fire or explosion, or an in-flight mechanical malfunction or flight-control malfunction. The report said that the probable cause of the accident was "the pilot's in-flight loss of control for undetermined reasons." The pilot, 57, held a commercial pilot certificate and a type rating. The pilot's logbooks were not found; an application for an airman medical certificate in July 1997 indicated that the pilot had 3,700 flight hours.</td></tr>
<tr><td>Dec. 21, 1999</td><td>Cordele, Georgia, U.S.</td><td>Cessna Citation 551</td><td>destroyed</td><td>1 fatal</td></tr>
<tr><td colspan="5">The nighttime weather conditions included a 300-foot overcast and 1.25 statute miles (2.01 kilometers) visibility when air traffic control (ATC) cleared the pilot to conduct a localizer approach. Recorded ATC radar data indicated that the airplane descended to the published minimum descent altitude (MDA) and flew over the airport. "The controller stated that he was waiting for the missed-approach call [from the pilot] as he observed the airplane climb to 700 feet MSL [mean sea level]," the report said. "The airplane then descended back to 600 feet MSL and disappeared from radar." A witness said that he heard the airplane fly over the airport but did not see the airplane because of haze and fog. The airplane struck trees and terrain about two nautical miles (three kilometers) from the airport. The report said that the probable causes of the accident were "the pilot's failure to follow the published missed-approach procedures and to maintain proper altitude." The pilot held a private pilot certificate and a Cessna 551 type rating, and had more than 4,230 flight hours, including 958 flight hours in type.</td></tr>
<tr><td>March 26, 2000</td><td>Buda, Texas, U.S.</td><td>Cessna 525 CitationJet</td><td>destroyed</td><td>1 fatal</td></tr>
<tr><td colspan="5">IMC prevailed at 0830 local time when the pilot conducted a visual approach to a 3,800-foot (1,159-meter) runway at a private airport that had no published instrument approach procedure or lights. Local residents said that heavy fog and heavy drizzle were in the area. A weather-observation facility 16 nautical miles (30 kilometers) from the airport was reporting a 400-foot overcast ceiling and four statute miles (six kilometers) visibility in mist. The pilot told ATC that he had the airport in sight and canceled his IFR flight plan. Recorded ATC radar data indicated that the airplane descended at 1,900 feet per minute from 2,400 feet to 1,000 feet, where radar contact was lost. The airplane was 4,000 feet (1,220 meters) from the airport when it struck a tree in a wings-level attitude and then struck the ground inverted. "The pilot had filed an alternate airport (with a precision instrument approach)," the report said. "However, he elected not to divert to the alternate airport." The report said that the probable cause of the accident was "the pilot's inadequate in-flight decision to continue a visual approach in [IMC], which resulted in his failure to maintain terrain clearance." The pilot held an ATP certificate and a Cessna 525 type rating, and had 5,887 flight hours, including 154 flight hours in type.</td></tr>
<tr><td>May 2, 2000</td><td>Orlando, Florida, U.S.</td><td>Cessna Citation 501</td><td>substantial</td><td>2 none</td></tr>
<tr><td colspan="5">The pilot said that he silenced the landing-gear-warning horn during a visual approach in daytime VMC and then forgot to extend the landing gear until just before touchdown. The airplane touched down with the gear in transit, and the right main landing gear collapsed. The airplane slid about 2,500 feet (763 meters) before coming to a stop on the runway. The report said that the probable cause of the accident was "the pilot's failure to follow the landing checklist, [which] resulted in the delay of lowering the landing gear before touchdown."</td></tr>
<tr><td>March 8, 2001</td><td>Hamburg, Germany</td><td>Cessna 525 CitationJet</td><td>substantial</td><td>1 none</td></tr>
<tr><td colspan="5">Nighttime VMC prevailed when the pilot conducted a go-around and told the airport tower controller that the airplane had landing gear problems. He then flew the airplane near the control tower, and the controller told the pilot that the landing gear appeared to be extended. Nevertheless, unsafe-landing-gear warnings continued in the cockpit. The report said that the pilot did not conduct the emergency landing-gear-extension procedure. Aircraft rescue and fire fighting vehicles and personnel were present when the aircraft was landed. The right main landing gear collapsed on touchdown, and the airplane veered off the runway. The German Federal Bureau of Aircraft Accidents Investigation report said that the causes of the accident were that "the hydraulic system failed as a result of a defective valve, [and] the pilot did not accomplish the procedure recommended by the manufacturer in case the landing gear is not positively locked." The pilot held German and U.S. commercial pilot certificates and a Cessna 525 type rating, and had 5,350 flight hours, including 700 flight hours in type.</td></tr>
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Appendix

Accidents and Incidents Involving Single-pilot Operation of Civilian Jets, 1966–2004 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
April 2, 2001	Ashwaubenon, Wisconsin, U.S.	Cessna 501 Citation I	destroyed	1 fatal, 3 serious, 4 minor
Weather conditions included a 200-foot broken ceiling, an 800-foot overcast, 0.5 statute mile (0.8 kilometer) visibility in fog and snow, and temperature and dew point both at 32 degrees Fahrenheit (zero degrees Celsius) when the pilot conducted a takeoff from Runway 18 at the Green Bay (Wisconsin) airport. When the tower controller told the pilot to establish radio communication with the departure controller, the pilot said, "We have a little problem here. We're going to have to come back." When asked what type of approach he would conduct, the pilot said, "Like to keep the vis[ual]." The controller said, "Like the contact approach, [is] that what you're saying?" There was no response from the pilot. The last recorded radar data indicated that the airplane's heading was 091 degrees, airspeed was 206 knots and altitude was 160 feet AGL. A witness observed the airplane in a 90-degree left bank before it struck a warehouse. The pilot was killed, and the seven passengers were injured. The NTSB report said that the probable causes of the accident were "the pilot not maintaining aircraft control while maneuvering after takeoff and the pilot's inadequate preflight planning and preparation." The pilot held an ATP certificate and a Cessna 500 type rating, and had 4,548 flight hours, including 206 flight hours in type.				
Jan. 30, 2002	Kingman, Arizona, U.S.	Cessna 550 Citation II	minor	2 none
Both engines flamed out because of fuel exhaustion during an approach in daytime VMC. The pilot conducted an emergency landing on a highway about 0.5 statute mile (0.8 kilometer) from the runway. The pilot held an ATP certificate and a Cessna 550 type rating, and had 25,000 flight hours, including 400 flight hours in type.				
Feb. 7, 2002	Novato, California, U.S.	Cessna 525A CJ2	substantial	1 none
Nighttime IMC prevailed when the pilot conducted a global positioning system (GPS) approach to Runway 13, which was 3,300 feet (1,007 meters) long and had an asphalt surface. Light rain was falling, and the surface winds were from 230 degrees at 11 knots, gusting to 17 knots. The airplane touched down about one-third of the way down the runway; the pilot extended the ground flaps and spoilers, and applied wheel braking. The airplane did not decelerate normally, and the pilot rejected the landing. He applied full power but did not retract the ground flaps and spoilers. The airplane overran the runway and came to a stop in a ravine. After the accident, surface winds were reported from 290 degrees at 20 knots, gusting to 27 knots. The NTSB report said that the probable causes of the accident were "the pilot's failure to achieve the proper touchdown point and his failure to retract the flaps and spoilers during an attempting landing abort, which resulted in a landing overrun. Also causal was the pilot's decision to attempt a landing in wind conditions that exceeded the landing-performance capability of the airplane for the runway selected."				
May 20, 2002	Bethany, Oklahoma, U.S.	Cessna 550 Citation II	substantial	1 minor, 5 none
The pilot began to rotate the airplane for takeoff at 103 knots (V_1) in daytime VMC, but the nose gear did not come off the runway. He rejected the takeoff at 120 knots by reducing power to idle and applying maximum wheel braking. "Upon seeing the localizer antennas approaching the airplane at the departure end of the runway, the pilot veered the airplane to the right of centerline," the report said. The airplane overran the 7,198-foot (2,195-meter) runway, struck two fences and came to a stop in a muddy field. The elevator-trim wheel was positioned to the takeoff setting, but the elevator-trim system was found to be 12 degrees out of trim in the nose-down direction. "The aircraft's flight manual informs the pilot that the right elevator and trim tab should be inspected during the exterior inspection to ensure the elevator-trim-tab position matches its indicator," the report said. The probable causes of the accident were "the anomalous elevator-trim system and the pilot's failure to note its improper setting prior to takeoff," the report said. The pilot held an ATP certificate and several type ratings, and had about 13,000 flight hours, including 150 flight hours in type.				
Oct. 7, 2002	Dexter, Maine, U.S.	Cessna 525A CJ2	substantial	2 serious, 2 minor
Daytime VMC prevailed when the pilot conducted a visual approach with a seven-knot tail wind to a 3,009-foot (918-meter) runway. The report said that V_{REF} was 108 knots and that the airplane's groundspeed was about 137 knots nine seconds before touchdown and about 130 knots on touchdown 642 feet (196 meters) from the runway threshold. "After touchdown, the pilot selected ground flaps, which moved the flaps from 35 degrees to 60 degrees, the spoilers auto-deployed and the speed brakes were extended," the report said. "The pilot said that after applying the [wheel] brakes, he felt the brake pedals pulsing and did not think the airplane was slowing." He released the brakes and then reapplied them. "Again, he felt the pulsing in the pedals, but the airplane was not slowing as he expected," the report said. The airplane was halfway down the runway when the pilot released the brakes, reset the flaps to the takeoff position and applied power to reject the landing. The airplane overran the runway and traveled 300 feet (92 meters) before coming to a stop. Examination of tire marks on the runway indicated that the airplane bounced (touched down and became airborne) four times. "Tire marks on the last half of the runway were consistent with brakes applied and anti-skid operative," the report said. The probable causes of the accident were "the pilot's improper decision to land with excessive speed and his delayed decision to perform an aborted landing, both of which resulted in a runway overrun," the report said. The pilot held an ATP certificate and several Citation type ratings, and had 2,450 flight hours, including 763 flight hours in type.				

Appendix
Accidents and Incidents Involving Single-pilot Operation of Civilian Jets, 1966–2004 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
Jan. 24, 2003	Melbourne, Florida, U.S.	Bornhofen Twinjet 1500	destroyed	1 fatal

VMC prevailed when the experimental airplane departed for a test flight. After takeoff, the pilot told the airport control tower that he had a problem with the landing gear and asked the controller to check the position of the gear. "On the first pass, the gear was partially extended," the report said. "On the second pass, the gear appeared to be fully retracted." The pilot told the controller that he would conduct a gear-up landing on the grass between the runway and the taxiway. The pilot overshot the intended landing area and conducted a go-around. "All the witnesses interviewed agreed that the aircraft was never higher than 200 [feet] to 300 feet, more like treetop level, and was pitching and banking very steeply in turns," the report said. "On the final circuit, the pilot reported that he was having trim problems and that he would now land on Runway 9L." The airplane was being turned from base leg to final approach when it struck trees and the ground. "Examination of the wreckage after the crash revealed no discrepancies," the report said. "The pilot was reported to have been sick with flu-like ailments for at least a week prior to the accident." Toxicological tests found salicylate (aspirin) and pseudoephedrine (an over-the-counter decongestant) in the pilot's urine. The report said that the probable cause of the accident was that "the pilot-in-command failed to obtain sufficient altitude to clear obstacles at the approach end of the airport, which resulted in an in-flight collision with trees."

Date	Location	Airplane Type	Airplane Damage	Injuries
March 15, 2003	Carey, Idaho, U.S.	Cessna 501 Citation	destroyed	3 fatal

After beginning a descent from Flight Level (FL) 350 (approximately 35,000 feet), the pilot asked if any aircraft had landed at the destination, Hailey, Idaho, U.S. The controller said that the last airplane to land had conducted the RNAV (area navigation) approach to "bare minimums" and that weather conditions at Hailey were "getting worse." The pilot later read back an instruction to descend to, and maintain, 15,000 feet. Recorded ATC radar data indicated, however, that the airplane remained at FL 190 for four minutes. The controller told the pilot to expedite the descent through 16,000 feet because of traffic. The pilot did not respond. Radar data indicated that the airplane had climbed to 20,300 feet and then had entered a descending right turn, followed by a descending left turn. The controller made 10 attempts to contact the pilot by radio and then told the pilot to "ident" (select the identification mode on his transponder) if he could still hear her. "The controller received an ident from the aircraft and instructed the pilot to descend and maintain 15,000 feet," the report said. "The controller [then] cleared the aircraft for the GPS approach and to acknowledge with an ident. There was no response." Radar contact was lost when the airplane descended through 15,900 feet. The airplane was in a 40-degree nose-down attitude when it struck terrain at 5,630 feet about 15 nautical miles (28 kilometers) from the Hailey airport. The report said that "pilot impairment for undetermined reasons" was the probable cause of the accident. The pilot was taking medications for high blood pressure and for high cholesterol, and had a family history of heart disease. "It is possible that the pilot experienced an event such as a stroke or heart attack," the report said. "It is also possible that he became hypoxic as a result of a decompression event without using supplemental oxygen. There is insufficient information to conclude any specific cause for the pilot's impairment or incapacitation." The pilot held an ATP certificate and a Cessna 500 type rating, and had more than 14,000 flight hours, including 1,382 flight hours in type.

Date	Location	Airplane Type	Airplane Damage	Injuries
March 31, 2003	Wilmington, North Carolina, U.S.	Cessna 500 Citation I	minor	2 none

Surface winds were from 310 degrees at 12 knots, gusting to 22 knots, when the airplane was landed on Runway 35. "Following approximately 1,000 feet [305 meters] of ground roll, the right main landing gear actuator failed to remain extended," the FAA incident report said. The pilot held an ATP certificate and a Citation type rating, and had 14,600 flight hours, including 100 flight hours in type.

Date	Location	Airplane Type	Airplane Damage	Injuries
April 7, 2003	Zürich, Switzerland	Cessna 500 Citation I	substantial	3 minor/none

After an instrument landing system (ILS) approach, the airplane was landed short of the runway, and the landing gear separated. The report said that the accident occurred in daylight but in reduced visibility with heavy snow showers.

Date	Location	Airplane Type	Airplane Damage	Injuries
April 26, 2003	Loma Alta, Texas, U.S.	Sino-Swearingen SJ30-2	destroyed	1 fatal

While conducting flutter tests during a certification test flight, the pilot initiated a descent from FL 390 to attain a target speed of Mach 0.884. "The airplane (a unique test bed) had a known speed-dependent tendency to roll right, which was attributed to wing and aileron twist deviations," the report said. "As the speed increased during the accident flight, the pilot had to apply full left aileron to be able to maintain airplane control." The airplane was banked 30 degrees right when airspeed increased to Mach 0.884; the airplane then began to roll right. "Lateral control was lost … and the airplane rolled about seven times during a 49-second time frame, from about 30,500 feet until a near-vertical ground impact," the report said. The probable cause of the accident was "the manufacturer's incomplete high-Mach design research, which resulted in the airplane becoming unstable and diverging into a lateral upset," the report said. The pilot held an ATP certificate and several type ratings, and had more than 12,000 flight hours and 13 years of flight-test experience. The report said that after the accident, the manufacturer completed flutter tests with an airplane equipped with vortex generators and thicker trailing-edge ailerons.

Appendix

Accidents and Incidents Involving Single-pilot Operation of Civilian Jets, 1966–2004 *(continued)*

Date	Location	Airplane Type	Airplane Damage	Injuries
July 22, 2003	Coupeville, Washington, U.S.	Cessna 525 CitationJet	destroyed	2 none

The pilot was flying the airplane on autopilot through 14,000 feet in daytime VMC when he observed a decrease in the rate of climb. He disengaged the autopilot, and the airplane pitched down about 10 degrees below the horizon. The pilot was not able to achieve level flight with increased back pressure on the control column. He reduced power to idle and attempted to re-trim the airplane. "He reported that the elevator-trim indicator was in the full-forward (nose-down) position and that the electric trim would not respond to inputs via the control wheel trim switch," the report said. The passenger assisted the pilot in applying back pressure on the control column, but the nose-down pitch attitude increased and airspeed neared the maximum operating speed. "[The pilot] reported that at one point, the aircraft's descent rate had reached approximately 2,000 feet per minute and the nose of the airplane was about 40 degrees below the horizon," the report said. "The pilot attempted to re-trim via the manual trim wheel; however, the wheel would not move." The pilot flew the airplane toward Whidbey Island, where a U.S. Navy airfield was located; however, after reaching the island, the pilot decided to ditch the airplane in Penn Cove. The landing gear were retracted, and the flaps were extended to the landing position (35 degrees) when the airplane touched down at 100 knots on the water about 900 feet (275 meters) from shore. "The pilot stated that the airplane began to sink shortly after the water landing," the report said. The pilot and passenger exited through the main cabin door and began swimming toward shore. They were rescued by a boater about 10 minutes later. The pilot held a commercial pilot certificate and a Citation type rating, and had 8,500 flight hours, including 2,689 flight hours in type. The probable cause of the accident had not been determined as of June 15, 2005. As a result of the accident, FAA in October 2003 issued Airworthiness Directive (AD) 2003-21-07, which required disengagement of the pitch-trim circuit breaker and the autopilot-servo circuit breaker because of the possibility of an electrical short circuit or failure of a relay in the electric pitch-trim system that could cause a trim runaway and prevent disconnection of the pitch-trim system using the disconnect switch. The AD was superseded in August 2004 by AD 2004-14-20, which required replacement or modification of the trim printed circuit board.

Date	Location	Airplane Type	Airplane Damage	Injuries
July 24, 2003	Albuquerque, New Mexico, U.S.	Eclipse 500	minor	1 none

Daytime VMC prevailed when the right main landing gear failed soon after the airplane was landed at the conclusion of a production test flight. "Examination of the aircraft revealed a cast fitting on the main-gear actuator had failed at the airframe attach point," the report said. "It was the second failure of this type [of] actuator, and the aircraft manufacturer had recently decided to change actuator manufacturers due to production problems. Additionally, as a result of this incident, the aircraft manufacturer is considering a landing gear design change to compensate for actuator failure." The pilot held an ATP certificate and had 8,034 flight hours, including 13 flight hours in type.

Date	Location	Airplane Type	Airplane Damage	Injuries
April 7, 2004	Camberley, Hampshire, England	Raytheon 390 Premier I	destroyed	1 none

After departing from Kirmington, North Lincolnshire, for a private flight with six passengers to Dublin, Ireland, the pilot was unable to retract the landing gear and observed a "LIFT DUMP FAIL" indication and an "ANTI SKID FAIL" indication. The pilot diverted the flight to Farnborough and landed without incident. A maintenance technician inspected the weight-on-wheels switches and checked the lift-dump spoiler control system and the anti-skid system, but found no faults. He told the pilot that he should ferry the airplane to Camberley. The pilot arranged alternate transportation for the passengers and flew the airplane to Camberley with the landing gear extended. Surface winds were from 350 degrees at 10 knots to 15 knots when the pilot landed the airplane on Runway 26, which had an available landing distance of 1,065 meters (3,494 feet). "The runway was predominantly dry with a few dark patches indicating damp areas, and there were isolated, small puddles of standing water," the report said. Witnesses said that the airplane appeared to touch down about 100 meters (328 feet) beyond the displaced threshold. The pilot applied wheel braking but perceived no discernible braking effect. "Conscious of the poor overrun for Runway 26, the pilot decided to initiate a takeoff and applied power, but the engine response felt slow, and he decided that there was now insufficient runway remaining to achieve rotation speed," the report said. The pilot closed the throttle levers and applied wheel brakes, but perceived no braking effect. He steered the airplane off the runway onto a grassy area. The airplane yawed left and skidded sideways into an embankment protecting a fuel-storage area; both wings separated from the airplane. The pilot, 39, held a private pilot license and type ratings for the Citation and Premier; he had 4,511 flight hours, including 413 flight hours in type.

Date	Location	Airplane Type	Airplane Damage	Injuries
May 27, 2004	North Las Vegas, New Mexico, U.S.	Raytheon 390 Premier I	substantial	2 none

The surface winds were reported from 160 degrees at 15 knots, gusting to 20 knots, when the airplane overran the runway while being landed on Runway 07 at 1557 local time. A special weather report issued at 1613 said that a wind shift had occurred at 1553, and the winds were from 190 degrees at 15 knots.

AGL = Above ground level ATC = Air traffic control ATP = Airline transport pilot FAA = U.S. Federal Aviation Administration FL = Flight level
GPS = Global positioning system IFR = Instrument flight rules ILS = Instrument landing system IMC = Instrument meteorological conditions
MDA = Minimum descent altitude MSL = Mean sea level NTSB = U.S. National Transportation Safety Board RNAV = Area navigation
RVR = Runway visual range VASI = Visual approach slope indicator VMC = Visual meteorological conditions V_{REF} = Target landing speed

Sources: Accident/incident reports by Airclaims, German Federal Bureau of Aircraft Accidents Investigation, Swiss Aircraft Accident Investigation Bureau, U.K. Air Accidents Investigation Branch, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board.

Canadian Incidents Up, Accidents Down in 2004

Improvement for 2004 occurred in the number of accidents, the number of airplanes involved in accidents, the number of helicopters involved in accidents and the aircraft accident rate. Data for the first five months of 2005 showed similar results.

— FSF EDITORIAL STAFF

The number of Canadian-registered-aircraft accidents and the accident rate were lower in 2004 than in 2003 and lower than the annual average in the previous five years, 1999–2003, data compiled by the Transportation Safety Board of Canada show. (Data for 2004 are preliminary.)

There were 252 accidents involving Canadian-registered aircraft in 2004, compared with 295 in 2003 and an average of 305 per year in the 1999–2003 period (Table 1, page 36). At 6.6 accidents per 100,000 flight hours, the 2004 accident rate was lower than the accident rate of 7.8 for 2003 and the annual average accident rate of 7.9 in the 1999–2003 period. The number of accidents involving non-Canadian-registered aircraft in Canada also decreased in 2004.

Reportable incidents in Canada involving all aircraft increased from 834 in 2003 to 906 in 2004. The 1999–2004 average was 795 per year. Reportable incidents were categorized by type, and the greatest number of reportable incidents in 2004 were in the "declared emergency" category, followed in number by "risk of collision/loss of separation."

Fatal accidents involving Canadian-registered aircraft decreased to 24 in 2004 from 32 in 2003 and from the annual average of 33 in the 1999–2003 period (Table 2, page 37). The 37 fatalities in the 2004 accidents were less than the 59 recorded in 2003 and the five-year average of 60. Serious injuries also decreased in 2004.

Continued on page 37

Table 1
Canadian Aircraft Accidents and Reportable Incidents, 1999–2004

	2004[1]	2003	1999–2003 Annual Average[2]
Canadian-registered-aircraft accidents[3]	**252**	**295**	**305**
Airplanes involved	206	242	248
Airliners	3	7	7
Commuter aircraft	1	9	8
Air taxi	43	35	46
Aerial work	8	17	17
Corporate	2	3	3
State	4	2	4
Private/other[4]	145	169	164
Helicopters involved	41	44	49
Other aircraft involved[5]	9	12	12
Flight hours (thousands)[6]	**3,809**	**3,782**	**3,860**
Accident rate (per 100,000 flight hours)	**6.6**	**7.8**	**7.9**
Non-canadian-registered-aircraft accidents in Canada	**20**	**30**	**22**
Fatal accidents	3	6	5
Fatalities	10	8	9
Serious injuries	2	3	2
Reportable incidents, all aircraft	**906**	**834**	**795**
Risk of collision/loss of separation	222	154	176
Declared emergency	276	292	252
Engine failure	143	132	157
Smoke/fire	94	103	96
Collision	21	16	14
Other incidents	150	137	100

1. Data for 2004 are preliminary as of Jan. 10, 2005.
2. All yearly averages in the five-year average have been rounded. The five-year average might not coincide with the sum of yearly averages.
3. Some accidents involve multiple aircraft; therefore, the number of aircraft involved might differ from the total number of accidents. Ultralight aircraft are excluded.
4. The category "Other" contains, but is not limited to, organizations that rent aircraft (e.g., flying schools and flying clubs).
5. "Other aircraft involved" include gliders, balloons and gyrocopters. The accident rate excludes these aircraft.
6. Transport Canada is the source of flight hours. Flight hours for 2004 are estimated.

Source: Transportation Safety Board of Canada

Table 2
Canadian Fatal Aircraft Accidents, 1999–2004

	2004[1]	2003	1999–2003 Annual Average[2]
Fatal accidents	**24**	**32**	**33**
Airplanes involved	18	26	25
Airliners	0	0	0
Commuter aircraft	0	0	1
Air taxi	3	5	5
Aerial work	0	3	1
Corporate	0	0	1
State	0	0	1
Private/other[3]	15	18	16
Helicopters involved	4	3	7
Other aircraft involved[4]	2	4	3
Fatalities	**37**	**59**	**60**
Serious Injuries	**26**	**43**	**43**

1. Data for 2004 are preliminary as of Jan. 10, 2005.
2. Some accidents involve multiple aircraft; therefore, the number of aircraft involved might differ from the total number of accidents. Ultralight aircraft are excluded.
3. The category "Other" contains, but is not limited to, organizations that rent aircraft (e.g., flying schools and flying clubs).
4. "Other aircraft involved" include gliders, balloons and gyrocopters.

Source: Transportation Safety Board of Canada

Preliminary data for the first five months of 2005 showed a decrease in the number of Canadian-registered-aircraft accidents: 73, compared with 80 in the equivalent period in 2004 and the annual average of 92 in the equivalent periods in 2000 through 2004 (Table 3, page 38). The numbers of airplanes and helicopters involved in accidents decreased. The number of fatal accidents in the 2005 five-month period was lower than the equivalent period in 2003 and the annual average of equivalent periods in 2000 through 2004. Fatalities also decreased in the 2005 five-month period from those of the 2004 and the 2000–2004 annual average equivalents.

Reportable incidents in the first five months of 2005 were lower than in the equivalent period in 2004 and lower than the annual average of the equivalent periods in 2000 through 2004 (Table 4, page 38). The largest number of incidents were categorized as "declared emergency," followed in number by "risk of collision/loss of separation" and "other."

Table 5 (page 39) shows the types of operations in which accidents occurred in the first four months of 2005. The greatest number of airplanes involved in accidents was in "pleasure/travel" operations, followed in number by "air transport." The greatest number of helicopters involved in accidents was in "other/unknown" operations, followed in number by "air transport" operations. Fatal accidents and fatalities decreased in the first five months of 2005 compared with the equivalent period in 2004 and in the equivalent 2000–2004 annual average.

Canadian-registered aircraft involved in selected reportable incidents in January through May 2005 were classified by the first event in the incident (Table 6, page 40). The greatest number of first events fell into the category "risk of collision/loss of separation," a number that was lower than in the equivalent period in 2004 and the equivalent 2000–2004 annual average. The second-greatest number were categorized as "declared emergency," followed by "engine failure."

The data are available on the Internet at <www.tsb.gc.ca/en/stats>. ■

Table 3
Canadian Aircraft Accidents, Five-month Periods, 2000–2005[1]

	January–May		
	2005	**2004**	**2000–2004 Average[2]**
Canadian-registered-aircraft accidents[3]	**73**	**80**	**92**
Airplanes involved	66	68	75
Airliners	4	2	2
Commuter airplanes	2	0	2
Air taxi	13	21	14
Aerial work	2	0	2
State	0	1	1
Corporate	2	2	2
Private/other[4]	43	42	51
Helicopters involved	10	14	17
Other aircraft involved[5]	0	2	2
Fatal Accidents	**5**	**10**	**10**
Airplanes involved	3	7	7
Airliners	0	0	0
Commuter airplanes	0	0	0
Air taxis	1	2	1
Aerial work	0	0	1
State	0	0	0
Corporate	0	0	0
Private/other[4]	2	5	5
Helicopters involved	2	2	3
Other aircraft involved[5]	0	1	1
Fatalities	**7**	**22**	**17**
Serious injuries	**3**	**5**	**10**

1. Data are preliminary as of June 14, 2005.
2. All yearly averages in the five-year average have been rounded. The five-year average might not coincide with the sum of yearly averages.
3. Some accidents involve multiple aircraft; therefore, the number of aircraft involved might differ from the total number of accidents. Ultralight aircraft are excluded.
4. The category "Other" contains, but is not limited to, organizations that rent aircraft (e.g., flying schools and flying clubs).
5. "Other aircraft involved" include gliders, balloons and gyrocopters.

Source: Transportation Safety Board of Canada

Table 4
Canadian Reportable Incidents, All Aircraft, Five-month Periods, 2000–2005[1]

	January–May		
	2005	**2004**	**2000–2004 Average[2]**
Reportable incidents, all aircraft	**338**	**389**	**356**
Risk of collision/loss of separation	68	81	75
Declared emergency	89	136	120
Engine failure	61	55	63
Smoke/fire	49	38	43
Collision	3	15	8
Other incidents	68	64	46

1. Data are preliminary as of June 14, 2005.
2. All yearly averages in the five-year average have been rounded. The five-year average does not coincide with the sum of yearly averages.

Source: Transportation Safety Board of Canada

Table 5
Canadian-registered Aircraft Involved in Accidents, Five-month Periods, 2000–2005, by Type of Operation[1]

	January–May		
	2005	2004	2000–2004 Average[2]
Canadian-registered-aircraft accidents[3]	**73**	**80**	**92**
Airplanes involved	66	68	75
Training	9	11	12
Pleasure/travel	31	34	37
Business	3	2	2
Forest-fire management	0	0	1
Test/demonstration/ferry	1	2	3
Inspection	1	0	1
Air transport	15	18	15
Air ambulance	0	1	1
Other/unknown	6	0	3
Helicopters involved	10	14	17
Training	1	3	4
Pleasure/travel	1	1	0
Forest-fire management	0	0	1
Test/demonstration/ferry	0	2	1
Inspection	0	1	0
Air transport	3	6	5
Other/unknown	5	1	4
Fatal accidents	**5**	**10**	**10**
Airplanes and helicopters involved	5	9	9
Training	0	2	2
Pleasure/travel	3	3	3
Test/demonstration/ferry	0	0	1
Inspection	0	1	1
Air transport	2	3	1
Other/unknown	0	0	1
Fatalities	**7**	**22**	**17**
Serious injuries	**3**	**5**	**10**

1. Data are preliminary as of June 14, 2005.
2. All yearly averages in the five-year average have been rounded. The five-year average might not coincide with the sum of yearly averages.
3. Some accidents involve multiple aircraft; therefore, the number of aircraft involved might differ from the total number of accidents. Ultralight aircraft are excluded.

Source: Transportation Safety Board of Canada

Table 6
Canadian-registered Aircraft Involved in Incidents, Five-month Periods, 2000–2005, Selected Reportable Incident Types by First Event[1]

	January–May		
	2005	**2004**	**2000–2004 Average[2]**
Risk of collision/loss of separation	**96**	**116**	**102**
Air proximity	29	31	25
Air traffic services event	55	68	60
Altitude-related	6	2	3
Runway incursion	2	6	8
Other	4	9	7
Declared emergency	**58**	**98**	**94**
Landing gear failure	13	14	16
Hydraulic failure	11	9	12
Electrical failure	2	4	4
Other component failure	23	24	31
Other	9	47	32
Engine failure	**50**	**45**	**51**
Power loss	20	15	22
Component failure	28	29	25
Other	2	1	4
Smoke/fire	**43**	**35**	**37**
Fire/explosion	34	26	27
Component failure	9	9	10
Other	0	0	1
Difficulty in controlling aircraft	**17**	**21**	**13**
Component failure	10	12	6
Weather-related	4	3	3
Other	3	6	4

1. Data are preliminary as of June 14, 2005.
2. All yearly averages in the five-year average have been rounded. The five-year average does not coincide with the sum of yearly averages.

Source: Transportation Safety Board of Canada

STATS

Airline Industry Must Accommodate Diverse Work Force

Today's airlines may employ personnel from many cultural and linguistic backgrounds. Almost every aspect of operations can be affected by such differences, and aviation organizations must develop strategies in response.

– FSF LIBRARY STAFF

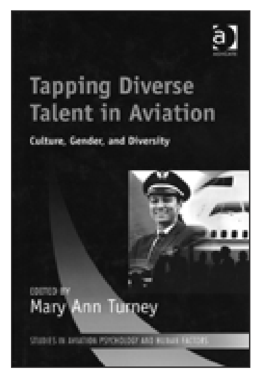
Books

Tapping Diverse Talent in Aviation: Culture, Gender, and Diversity. Turney, Mary Ann (ed.). Aldershot, England: Ashgate Publishing, 2004. 247 pp. Figures, tables, references, index.

"Future aviation employees will tend to be more divergent in their thinking than they were in the past, when the talent pool consisted of individuals with very similar backgrounds and when national aircrews were more the norm than international crews," says the editor. "The new diversity invites us to consider the influences of a variety of cultures, belief systems and values as we design effective and efficient training programs for multi-national, multi-ethnic and two-gender crews."

The papers collected in the book are divided into three sections. The first presents the concept of diversity from several perspectives; the second focuses on issues related to language; the third section presents papers related to the aviation environment.

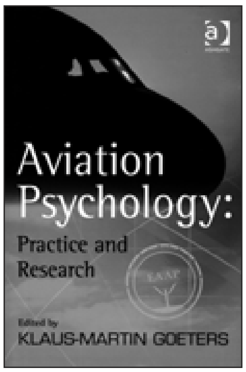
Contributors address such subjects as "Values and Orientation Differ in Mixed Crews"; "Women's Learning and Leadership Styles: Implications for Air Crews"; "The Efficacy of Standard Aviation English"; "Nonverbal Cues 'Speak' Volumes"; "Inclusive Versus Exclusive Exchange Strategies in Aviation Training"; and "Making Everyone Part of the Team."



Capt. Neil Johnston of the Aerospace Psychology Research Group based at Trinity College, Dublin, Ireland, says in his foreword, "In keeping with the origins and pioneering spirit of the early days of aviation, the general orientation was masculine, Western and unreflectively self-confident. It took quite a few years for us to realize, not to mention accept, that culturally mediated operational differences in aviation were a reality — rather than an unfortunate departure from the unarticulated normative standard rooted in the masculine Western model."

Airlines employing personnel from many cultures and varied linguistic backgrounds are growing in number, Johnston says.

"These organizations meet, daily, the challenges that face those who would wish to integrate, develop and optimize diversity," says Johnston. "For these and other reasons, we are ever more conscious of the need to achieve an appropriate 'accommodation' or 'fit' between individuals, technology, culture, work groups and organizational practices. We are ever more sensitive to the fact that diversity brings strengths and weaknesses that often vary relative to specific tasks or activities."



Aviation Psychology: Practice and Research. Goeters, Klaus-Martin (ed.). Aldershot, England: Ashgate Publishing, 2004. 396 pp. Figures, tables, references.

Many of the papers in this anthology were presented at recent conferences of the European Association for Aviation Psychology. The editor, head of the Department of Aviation and Space Psychology at the German Aerospace Center, says that the book "gives a good overview with respect to aviation psychology activities in Europe."

Sections, most comprising several papers, are devoted to human engineering; occupational demands; selection of aviation personnel; human factors training; clinical psychology (discussing psychological evaluation of pilots and treatment of post-traumatic stress disorder); and accident investigation and prevention.

Report

The Air Traffic Control Operational Errors Severity Index: An Initial Evaluation. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine, Civil Aerospace Medical Institute (CAMI). DOT/FAA/AM-05/5. Final report. April 2005. Bailey, Larry L.; Schroeder, David J.; Pounds, Julia. Figures, tables, references. 16 pp. Available through the Defense Technical Information Center* or on the Internet through National Technical Information Service (NTIS).**

CAMI's Aerospace Human Factors Research Division conducted an initial evaluation of the FAA Operational Error (OE) Severity Index (SI). The SI is computed largely from data that can be objectively determined after OEs have occurred. Point values are assigned for varying levels of vertical separation, horizontal separation, closure rate, direction of flight paths and the degree of controller awareness at the time of the OE. Based on the total point values, OEs are classified as low, low moderate, high moderate and high severity. OEs are also divided into components of vertical separation, horizontal separation, closure rate, flight paths and air traffic control (ATC) factors.

The review described in this report focused on three key issues: the distributional characteristics of operational errors; the margin of safety from collision associated with SI point values; and the objectivity of SI classifications of high-moderate and high-severity OEs.

"This evaluation of the [SI] revealed that the SI provides a rational approach for categorizing the severity of ATC [OEs]," says the report. "Although questions remain as to the SI cut scores [that differentiate between high-moderate and high-severity OEs], it is recommended that they not be changed unless objective measures can be developed that support those changes. With the exception of the ATC control component, the remaining four components are objective and are derived from performance characteristics of the aircraft involved in the OE."

Regulatory Materials

Guidance Material for 14 CFR Section 33.75, Safety Analysis. U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 33.75-1. March 4, 2005. References, glossary. 10 pp. Available from FAA.***

Federal Aviation Regulations (FARs) Part 33.75, *Safety Analysis*, concerns qualitative analysis or quantitative analysis of engines. Part 33.75 says, "It must be shown by analysis that any probable malfunction or any probable single or multiple failure, or any probable improper operation of the engine, will not cause the engine to:

- "Catch fire;
- "Burst (release hazardous fragments through the engine case);

- "Generate loads greater than those ultimate loads specified in [FARs Part] 33.23(a); or,
- "Lose the capability of being shut down."

This AC offers updated guidance about acceptable methods for demonstrating compliance with Part 33.75 "to reflect current FAA and industry practices concerning safety analyses."

The AC says, "The ultimate objective of a safety analysis is to ensure that the risk to the aircraft from all engine-failure conditions is acceptably low."

The AC is directed to engine manufacturers and modifiers, FAA engine-type-certification engineers and their designees, and non-U.S. regulatory authorities.

[A portion of this AC replaces Paragraph 52 (Section 33.75, "Safety Analysis") of AC 33-2B, *Aircraft Engine Type Certification Handbook*.]

Fuselage Doors and Hatches. U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 25.783-1A. April 25, 2005. 19 pp. Available from FAA.***

"There is a history of incidents and accidents in which doors, fitted in pressurized airplanes, have opened inadvertently during pressurized and unpressurized flight," says the AC. "Some of these inadvertent openings have resulted in fatal accidents." Part 25.783, *Fuselage Doors*, of the U.S. Federal Aviation Regulations (FARs) provides the airworthiness standards for doors installed on transport category airplanes.

The nonmandatory AC, directed to airplane manufacturers, modifiers, non-U.S. regulatory authorities, and FAA transport airplane type-certification engineers and their designees, describes an acceptable means for showing compliance with Part 25.783.

Guidance is given for provisions in Part 25.783 such as general design considerations; door opening by persons; pressurization-prevention mechanisms that operate if any door is not fully closed, latched and locked; latching and locking; warning, caution and advisory indications; visual inspection; and structural requirements.

[This AC cancels Advisory Circular 25.783-1, *Fuselage Doors, Hatches and Exits*, dated Dec. 10, 1986, except for airplanes with older certification bases.]

North American Route Program (NRP). U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 90-91J. July 30, 2005. Appendixes. 14 pp. Available from FAA.***

The NRP is a joint FAA and Nav Canada program whose objective is to harmonize and adopt common procedures where feasible to random-route flight operations at and above Flight Level 290 (about 29,000 feet) between the United States and Canada.

Flights may participate in the NRP under specific guidelines and filing, departure and destination requirements. NRP aircraft are not subject to route limitations such as published preferred instrument flight rules routes beyond a 200-nautical-mile radius of their point of departure or destination. This AC describes the procedures for NRP flights on routes that can be conducted using the communication and navigation equipment aboard the aircraft.

[This AC cancels Advisory Circular 90-91H, *North American Route Program*, dated July 30, 2004.] ■

Sources

* Defense Technical Information Center
Fort Belvoir, VA 22060 U.S.
Internet: <www.dtic.mil>

** National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161 U.S.
Internet: <www.ntis.gov>

*** U.S. Federal Aviation Administration
800 Independence Ave. SW
Washington, DC 20591 U.S.
Internet: <www.faa.gov>

Burning Odor Prompts Evacuation of B-747 During Boarding

A report by the Australian Transport Safety Bureau said that insulation had been rubbed off wires in a wiring loom that had been 'pinched' between a stowage bin and an adjacent structural frame. The result was electrical arcing.

— 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

Insulation Blankets Charred by Arcing

Boeing 747. Minor damage. No injuries.

The airplane was being boarded for a flight from Japan to Australia, and the crew was conducting pre-departure checks when the flight crew observed that a circuit breaker tripped for a "No Smoking/Fasten Seat Belt" sign when the sign was selected "ON." Cabin crewmembers said that they observed a flash and smelled a burning odor. Passengers and crewmembers disembarked.

When ground personnel examined the affected section of the airplane, they found that the sign's circuit wires were damaged with other wires in the same wiring loom. The wiring loom was "pinched between the outboard corner of the stowage bin and the adjacent structural frame," the report said. "The wiring loom had chafed against the structural frame, and the wiring insulation had been progressively abraded until the conductors made contact with the metal frame. Electrical arcing resulted in localized damage to the wiring loom and the structural frame, extensive charring of the two adjacent insulation blankets and the tripping of the 'No Smoking/Fasten Seat Belt' sign circuit breaker."

There was no fire.

The report said that the pinching of the wiring loom probably occurred during the previous "D" maintenance check, when stowage bins were installed.

"Neither the aircraft maintenance manual nor the operator's task card detailing installation of the overhead bins [required] inspection of the wiring looms and other components in the area of the stowage bins to ensure their adequate clearance from the bins," the report said.

After the incident, the operator modified task cards to require inspections of wiring looms and other components near the stowage bins to ensure adequate clearance.

Runway Lights Damaged During Turn at Threshold

Boeing 767-300. Minor damage. No injuries.

After a flight from Scotland and a morning landing at an airport in the Netherlands, a visual inspection of the airplane's tires revealed scuffing and embedded fragments of glass.

An inspection of Runway 24 at the departure airport revealed damage to four runway lights near the threshold. The previous two sectors flown by the airplane had involved a nighttime landing on Runway 06 and a takeoff at dawn from Runway 24; each time, a clockwise turn at the threshold of Runway 24 was required.

The captain said that he "had made an error of judgment concerning the lateral displacement of the left [main landing] gear from the edge of the runway during a 180-degree turn." The incident report said that contributing factors may have been "incorrect seat positioning and/or head movement."

AIR TAXI/COMMUTER

Runway Excursion Prompts Recommendation for Turn Pads

ATR ATR 72. No damage. No injuries.

Daytime visual meteorological conditions prevailed for the departure from an airport in Ireland for a flight to England. The runway was damp (the surface showed a change in color because of moisture) as the crew taxied the airplane from the ramp and backtracked along the centerline of the runway to the displaced threshold.

The crew turned left off the centerline and then right to reverse direction. The accident report said that the turn was "normal until approximately through 90 degrees (right), when it was noticed by the PF [pilot flying] that the turn was somewhat wide but not excessively so. The turn was continued. Neither flight crewmember was aware of a pavement excursion until it was felt that the aircraft was not turning normally, followed quickly by the [left main landing gear] leaving the runway."

The crew stopped the airplane, notified air traffic control, shut down the no. 1 engine and allowed the no. 2 engine to operate with the propeller brake engaged. Passengers and crewmembers disembarked normally through the rear door.

There is no taxiway, taxiway turnaround or turn pad at the end of the runway. To complete a 180-degree turn, crews must taxi the airplane off the centerline toward the runway edge and turn back toward the centerline. The report said that typically, an airplane passes through the centerline at 90 degrees and re-intercepts the centerline from the other side.

"An aircraft the size of the ATR 72 is well capable of carrying out a 180-degree turn on a 30-meter-wide [98-foot-wide] runway … once the steering angle is greater than 45 degrees and up to 60 degrees," the report said. "However, when using the shallower steering angles (45 degrees to 50 degrees), it does require that the reversal of direction be initiated relatively close to the runway's edge. Where this is not done and/or if the steering angle is set below 45 degrees or a higher angle is not maintained throughout the maneuver, safety margins are likely to be compromised. In the case of [the incident airplane], it is considered that any one, or a combination of all three, of these factors contributed to the aircraft leaving the paved surface."

As a result of the investigation, the Air Accident Investigation Unit of Ireland recommended that, in future runway extensions or other runway improvements, turn pads should be constructed at both ends of the runway. The airport management accepted the recommendation.

Crew Conducts Landing on Unavailable Runway

Fairchild SA227-DC Metro 23. No damage. No injuries.

After a morning domestic flight, the crew landed the airplane at an airport in Australia. At the time of the landing, the runway was described in a notice to airmen (NOTAM) as "not available, due to aerodrome line-marking works." (Equipment and personnel were not on the runway at the time, however.)

The accident report said that the pilot-in-command had read the NOTAM, but "he only noticed that the line-marking works were in progress and not that the runway was not available." Company regulations did not require the copilot to read NOTAMs before departure.

In a "method of working plan," issued seven months before the incident, describing the work to be done, the airport operator said that the runway would be closed only during resurfacing and that there would be no operational restrictions during line marking. The report cited the Australian Civil Aviation Safety Authority *Manual of Standards*, which said that an airport "operator must not close the aerodrome to aircraft operations due to aerodrome works unless a NOTAM giving notice of the closure has been issued not less than 14 days before the closure takes place."

In this incident, the NOTAM for line marking was not issued in accordance with the manual or with the method of working plan.

After the incident, the operator began requiring both flight crewmembers to read NOTAMs before departure.

Frozen Spring Tabs Cited in Pitch-control Anomaly

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

During takeoff from an airport in Scotland for a flight to England, the captain experienced "extremely high" pitch-control forces for rotation of the airplane and considered rejecting the takeoff because he believed that the elevators might have been stuck. The airplane became airborne. After establishing the airplane in stabilized flight, the captain "carefully exercised the pitch control, whereupon the pitch-control forces returned to normal," the accident report said.

During additional handling checks, there were no further anomalies, and the crew continued the flight to the destination airport, where they conducted a normal landing.

Examination of the airplane revealed deicing fluid on the forward section of the tailplane but not on the aft section, the elevator hinges and the spring tabs, which were dry.

The report said that the unusually high pitch-control forces "probably [were a result of] frozen spring tabs, caused either by incomplete deicing before flight or by rehydration of the deicing fluid residue."

After the incident, the airplane manufacturer issued two all-operators messages for Dash 8 series 100, series 200 and series 300 airplanes, citing freezing of rehydrated deicing fluid residue as a potential cause of the restriction of spring tabs and recommending periodic washing of "aerodynamically quiet" areas of the airplanes to remove the residue of rehydrated deicing fluid.

CORPORATE/BUSINESS

Holes Found in Engine Case After In-flight Loss of Power

Raytheon Beech Bonanza A36TV. Substantial damage. One minor injury.

Daytime visual meteorological conditions prevailed for the business flight in the United States. The pilot said that during cruise flight at 9,000 feet, the engine began to "shake and then shudder." The engine stopped producing power, and the windshield was covered with oil.

The pilot maneuvered the airplane to land in what appeared to be an open field, but the airplane struck trees and wires just before reaching the field.

The pilot said that maintenance personnel had performed an engine overhaul 15 flight hours before the accident and that he had been monitoring engine instruments. He had observed no anomalies with oil pressure, oil temperature or cylinder head temperature. An inspection of the engine revealed three holes in the engine case.

Airplane Rolls off Wet Runway During Landing

Cessna 525A Citation CJ2. Substantial damage. No injuries.

Nighttime visual meteorological conditions prevailed for the business flight in Venezuela.

The airplane was landed long on the wet runway, with about 3,000 feet (915 meters) remaining.

The airplane overran the runway and rolled into a ditch. The main landing gear collapsed.

Weakened Stall-warning System Cited in Floatplane's Stall

Cessna 305A Bird Dog. Destroyed. One fatality.

Daytime visual meteorological conditions prevailed for the overwater photography flight of the floatplane in Canada. The pilot flew the airplane in slow flight with a high power setting and the flaps extended to 15 degrees to 20 degrees. Witnesses said that the airplane was in a 10-degree to 15-degree nose-up attitude about 30 feet to 50 feet above the water.

The witnesses observed the airplane climb steeply to 70 feet to 100 feet above the water, bank left and descend to strike the water in a steep nose-down attitude.

An investigation revealed that the airspeed indicator was marked to indicate various speeds, but the following markings were improper:

- Maximum flap speed was marked as 100 knots. According to the type certificate, the speed was 87 knots;
- The never-exceed speed was marked as 170 knots. According to the type certificate, the speed was 137 knots;
- The normal stall speed was marked as 100 knots. The aircraft flight manual said that normal stall speed was 48 knots; and,
- The stall speed with flaps extended was marked as 65 knots. The aircraft flight manual said that the speed was 44 knots.

The report said that the effectiveness of the warning tone generated by the airplane's stall-warning system varied, depending on the level of ambient sounds in the cockpit. Tests on a similar aircraft showed that with the rear windows open and the airplane being flown at a high power setting, the audibility of the aural warning was reduced significantly.

The report said that descriptions of the flight were "consistent with a power-on, aerodynamic stall." The causes of the accident and contributing factors were:

- "The aircraft stalled at an altitude from which there was insufficient time or altitude to recover;
- "High ambient sound levels reduced the effectiveness of the aural stall-warning system;
- "Mounting the stall-warning system under the dash [control panel] placed it outside the pilot's normal field of view and rendered the visual stall warning ineffective; [and,]
- "Improperly placed airspeed range markings eliminated their effectiveness as visual indicators of the normal safe-flight ranges."

Airplane Strikes Car During Night Approach

Piper PA-34-200T Seneca II. Substantial damage. No injuries.

Visual meteorological conditions prevailed for the flight from Mozambique to South Africa. The pilot landed the airplane at an airport for refueling and to allow passengers to go through customs; later, he conducted a flight to a smaller, unstaffed airport with no active runway lights.

The pilot had arranged for two vehicles to be parked at the threshold of Runway 15, with their headlights illuminating the runway. During the approach, the pilot perceived the airplane to be too high, and he increased the rate of descent. During final approach, the pilot "experienced what he described as a lack of runway perspective due to the insufficient lighting and the absence of natural light (moonlight)," the accident report said.

The pilot had planned to fly the airplane low over the vehicles "to maximize the use of their lights," the report said. "He realized too late that his approach was too steep. In an attempt to flare the aircraft, he exceeded the elevator control range, and [the airplane] collided with the roof of one of the vehicles."

The impact caused the nose landing gear to separate from the airplane, which skidded along the runway, then turned sideways and stopped.

Stiffness in Hinged Struts Cited in Landing Gear Failure

Socata Trinidad TB20. Minor damage. No injuries.

After a flight from France to England, as the pilot prepared for landing and extended the landing gear, the main landing gear "down-and-locked" green lights did not illuminate. Attempts to extend the landing gear by pulling the emergency-extension knob were unsuccessful.

A controller in the airport air traffic control tower said that the main landing gear appeared to be extended. After the pilot landed the airplane, the right main landing gear collapsed, and the right wing tip struck the runway.

"The maintenance engineer who examined the aircraft believed that the stiffness in the hinged struts was the primary reason why the landing gear did not lock down," the accident report said. "Once the hinges were lubricated and the corrosion [was] treated, the landing gear could be extended and retracted normally. According to maintenance records, the hinges had been lubricated during the 50-hour check less than three months before the accident, but the aircraft was parked outside during this period, so rain and lack of frequent use could have contributed to a deterioration of the state of the hinges."

ROTORCRAFT

Use of Nonstandard Bushing Cited in Collapse of Landing Gear Struts

McDonnell Douglas MD 520N. Substantial damage. No injuries.

The helicopter was being flown from a base in Australia to the deck of a bulk carrier ship entering a harbor. During the landing, the struts on the right landing gear fractured; the landing gear collapsed, and the main-rotor blades struck the deck.

The accident report said that the right rear strut likely failed because of fatigue cracking and that the right front strut failed because of overload. The investigation revealed that the fatigue crack had been caused by use of a nonstandard drag-brace bushing on the rear landing gear strut. The report said that the bushing "also was not fitted using protective coating material and would not have been provided with corrosion protection from the marine environment."

The report said that there was no indication when the nonstandard bushing had been installed.

Lightning Strike Damages Rotor Blades

Eurocopter AS 332L Super Puma. Minor damage. No injuries.

The helicopter was being flown in a passenger service from the Netherlands to an offshore platform in the North Sea. The captain said that during cruise flight at 2,000 feet about 40 nautical miles (74 kilometers) south of the platform, while flying the helicopter to avoid a cumulonimbus cloud, the crew observed a flash in clear air left of the helicopter.

The crew determined that the lightning had not struck the helicopter and continued the flight to the platform and the return flight to the base on shore. After their arrival at the base, a maintenance inspection revealed minor damage to the main-rotor blades and tail-rotor blades; subsequent examination indicated that the damage to the tail-rotor blades might not have been a result of lightning, the accident report said.

The crew said weather conditions included wind from 300 degrees at 45 knots, broken clouds at 3,000 feet, indicated outside air temperature of 2 degrees Celsius (36 degrees Fahrenheit) and visibility of more than 10 kilometers (six statute miles) in light sleet.

"It is known from previous events that the presence of an aircraft can act as a trigger for a lightning discharge when conditions conducive to lightning are present but no discharges have been observed," the accident report said. ■

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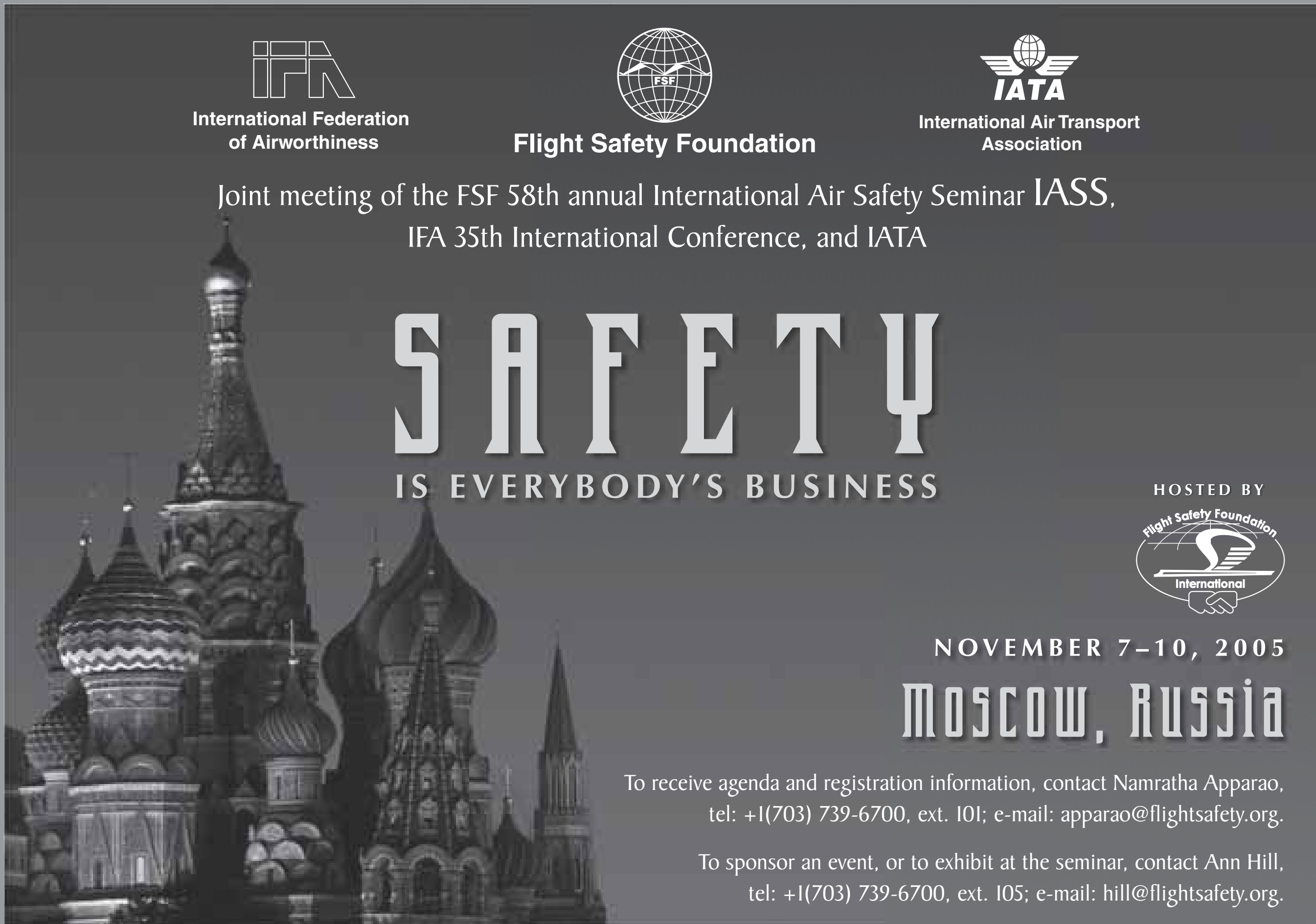

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