Risky Business

A U.K. CAA report says crash data illustrate the need for new safety measures to target business jet operations.

BY LINDA WERFELMAN

Business jets worldwide are involved in a disproportionate number of crashes, according to a U.K. Civil Aviation Authority (CAA) study that cited comments from U.K. pilots and operators who recommended improvements in pilot training, pilot communications with regulators and air traffic controllers, and fatigue-fighting efforts.[1]

Data showed 59 fatal business jet accidents from 2000 through 2007 and a fatal accident rate of 1.68 per million flight hours (Table 1, and Figure 1, **p. 28**) — considered "statistically significantly higher" than the fatal accident rate for large Western-built jets and turboprops.[2] The business jet category includes all civil usage: corporate/executive and ferry/positioning flights, emergency services, commercial training and private flights, in addition to passenger and cargo flights.

In comparison, the fatal accident rate was 0.17 per million flight hours for Western-built jets and 0.83 per million flight hours for Western-built turboprops. These categories include passenger and cargo flights only.

The CAA cited previous reports that have discussed a wide variation in fatal accident rates among different types of business jet operations, ranging from a low of 0.24 per million flight hours for corporate business jets to a high of 3.49 per million flight hours for commercial air taxi operations (Figure 2, **p. 28**).

Of the 59 fatal accidents recorded in the eight-year period, more than one-third involved ferry or positioning flights (Table 2, **p. 29**), and more than half occurred during approach and landing, said the study.

The study identified the most frequent primary causal factor in the 59 fatal accidents as the crew's "flight handling," cited in 16 accidents, or 27 percent. "Lack of positional awareness — in air" was cited in 11 accidents, or 19 percent.

"A primary causal factor from the flight crew–related group was allocated in 78 percent of the fatal accidents," the study said. "It is recognized that flight crew errors may arise for many reasons and should not necessarily imply that the pilot was to blame. Most fatal accidents were the result of a combination of causal and circumstantial factors, which often involved more than one party."

The most frequent causal factor was identified as the flight crew's "omission of action/inappropriate action," cited in 25 accidents, or 42 percent.

The primary circumstantial factor was "poor visibility or lack of external visual reference," cited in 21 accidents (36 percent), the study said. Other frequently cited circumstantial factors were "non-fitment of presently available safety equipment," cited in 19 accidents (32 percent) and "failure in CRM[3] (cross-check/coordinate)," cited in 16 accidents

Fatal Accidents and Hours Flown, Worldwide

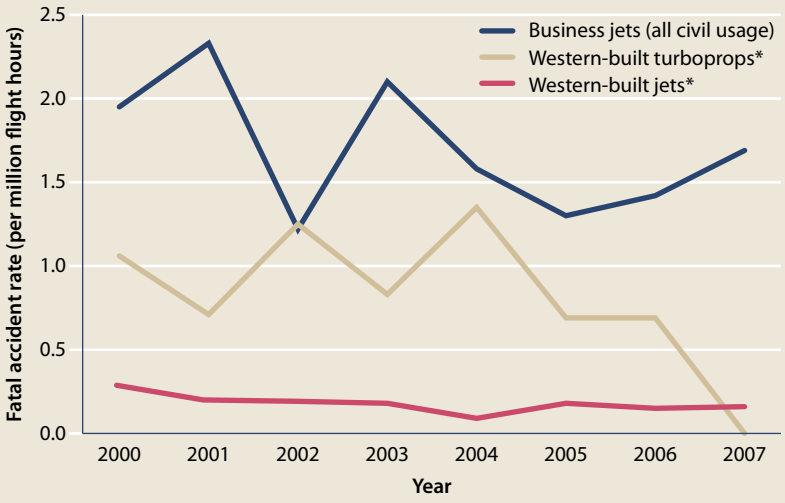
	Western-Built Jets*		Western-Built Turboprops*		Business Jets (All Civil Usage)	
Year	Number of Fatal Accidents	Number of Flight Hours	Number of Fatal Accidents	Number of Flight Hours	Number of Fatal Accidents	Number of Flight Hours
2000	9	37,413,247	8	7,570,609	7	3,594,460
2001	8	37,671,792	5	7,087,417	9	3,857,120
2002	8	37,820,727	8	6,413,272	5	4,113,305
2003	7	38,884,717	5	5,997,777	9	4,283,100
2004	4	43,368,069	8	5,922,736	7	4,433,485
2005	8	45,509,142	4	5,793,290	6	4,614,613
2006	7	47,814,025	4	5,780,481	7	4,922,866
2007	8	50,974,343	0	5,939,240	9	5,324,713
Total	**59**	**339,456,062**	**42**	**50,504,822**	**59**	**35,143,662**

*** Passenger and cargo flights only.**

Source: U.K. Civil Aviation Authority

Table 1

Fatal Accident Rates, Worldwide

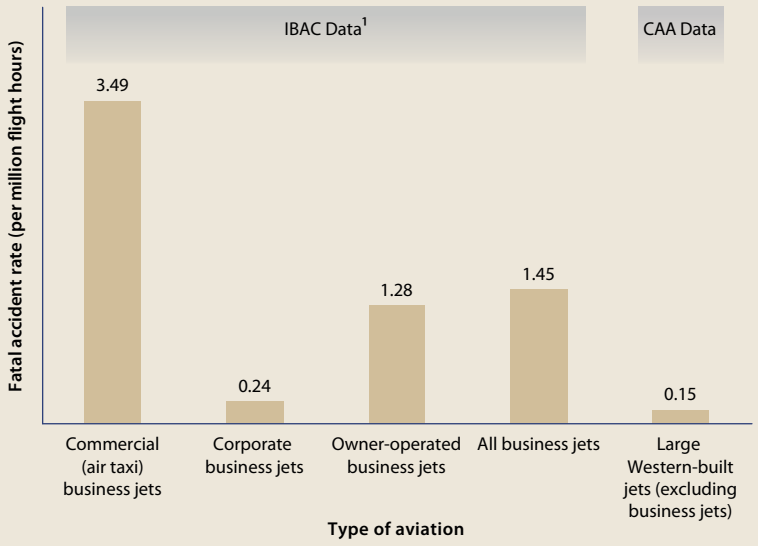


*** Passenger and cargo flights only.**

Source: U.K. Civil Aviation Authority

Figure 1

Fatal Business Aviation Accident Rates, Worldwide, 2003–2007



[1] Data in these categories were obtained from the International Business Aviation Council (IBAC) and Robert Breiling and Associates. CAA = U.K. Civil Aviation Authority

Source: U.K. Civil Aviation Authority, International Business Aviation Council

Figure 2

(27 percent). The most frequently cited consequence was "post-crash fire," which occurred in 33 of the 59 accidents (56 percent), followed by "loss of control in flight," 30 accidents (51 percent), and "controlled flight into terrain," 15 accidents (25 percent).

U.K. Fatal Accidents

Of the 59 fatal accidents, one occurred in the United Kingdom and another involved a U.K.-registered business jet being operated outside the country, the study said.[4]

The fatal accident rate for all U.K.-registered business jets from 2000 through 2007 was 3.3 per million flight hours, and the rate for the subset of public transport business jets was 7.97 per million flight hours, the study said. Fatal accident rates were calculated at 0.10 for large public transport airplanes — those weighing more than 5,700 kg (12,566 lb) — and 3.21 for small public transport airplanes — weighing 5,700 kg or less.

However, the study noted that the fatal accident rates for business jets and small public transport airplanes should be "treated with caution due to the relatively low amount of utilization accumulated and the low number of fatal accidents." The rates might not be representative of the safety of those segments of the industry, the study said.

Thirteen serious events — defined as fatal accidents, non-fatal reportable accidents, serious-injury accidents and serious events that must be reported under the Mandatory Occurrence Reporting Scheme (MORS) — were recorded involving all U.K.-registered business jets from 2000 through 2007, and seven were recorded involving public transport business jets.

The serious event rate was 43 per million flight hours, compared with 19 per million flight hours for large public transport airplanes — and 80 per million flight hours for small public transport airplanes.

During the same period, low-level MORS events were reported involving 570 registered business jets and 123 public transport business jets.

The study cited the ratio between low-level and serious events as an indication of an operator's reporting culture. "The larger the ratio, the better the perceived reporting culture," the study said, noting that many low-level events may go unreported "because of the perceived lack of importance or

reluctance of the crew/operator to submit the necessary paperwork."

The largest ratio was 91:1 for large public transport airplanes. In the other three categories, the ratios were 21:1 for small public transport airplanes, 44:1 for all registered business jets and 18:1 for public transport business jets.

Questions and Answers

In addition to the review of accident data, the study included an evaluation of responses by pilots and operators of bases in the United Kingdom to two questionnaires. Although the number of responses — 11 from operators and 39 from pilots — was small, it was "sufficient to draw useful conclusions," the study said.

Sixty-five percent of the responses were from pilots of light and medium weight aircraft. Eighty-five percent of the respondents were between the ages of 30 and 50, with an average of 2,800 flight hours in business jets. About half held air transport pilot licenses from the U.K. CAA; the other half held similar licenses from the U.S. Federal Aviation Administration. About 20 percent had flown other types of jet aircraft.

"Findings suggested that pilots might have incomplete understanding or variable ability in areas such as use of auto-flight modes (particularly in relation to vertical guidance), energy management and poor weather operations," the study said. "Limited use of simulation for recurrent training reduces opportunities for practice, lack of pre-course preparatory material reduces training effectiveness, and lack of training in additional duties peculiar to business jet operations may cause such tasks to distract pilots from primary flying tasks."

In addition, the study said, "There was concern regarding the limited ability of pilots to conduct safe flight without a serviceable FMS [flight management system]."

When questioned about their greatest concerns, about half of the pilots cited flight crew fatigue; other frequently cited concerns were operations in poor weather conditions, the reliability of ground deicing service, "inability to cope without FMS" and commercial pressure.

Operators said that they were most concerned about operations in ice and snow, the inability of pilots to cope without FMS, landing accidents and overruns, and flight crew fatigue.

Business Jet Fatal Accidents, 2000–2007

Operation Type	Number of Fatal Accidents
Ferry/positioning	21
Private/business	17
Cargo	6
Passenger	5
Air ambulance	4
Training	3
Other	3

Source: U.K. Civil Aviation Authority

Table 2

Training Concerns

The study found that pilot training programs were the greatest concern for both pilots and operators and suggested a re-examination of course content to correct possible deficiencies.

"Of particular concern would appear to be the lack of any training in the area of the pre-/post-flight responsibilities and passenger interaction, and also on awareness of the corporate environment and additional duties of the corporate pilot," the study said.

Although this area might not have a direct effect on safety, "there was a risk that crew attention could be distracted from the flying task by concerns and uncertainty about supplementary duties," the study said.

In addition, the questionnaire responses indicated that current training should be reviewed to improve understanding of auto-flight modes, especially in relation to vertical guidance, the study said. "This was an area that appeared to be causing a disproportionate number of errors, as indicated by the number of level busts being recorded by ATC [air traffic control]," the study added.

The study also found that "limited use of simulation" during recurrent training meant that pilots had little opportunity to practice scenarios that could not be replicated safely during flight. The study recommended improved simulator training and development of a system that would use simulator data to record student pilot performance.

Other recommendations included a call for a review of training principles for automation training in large airplanes to apply those principles to improved training for business jet pilots.

Regulatory Confusion

Operators and pilots complained in questionnaire responses and interviews that they had difficulty identifying appropriate contacts within the CAA and that they were uncertain about the relationships between the CAA, the European Aviation Safety Agency (EASA) and the European Joint Aviation Authorities (JAA), especially about how the responsibilities of those authorities affected business aviation.

The study quoted one pilot as saying, "We now live and operate in the most confusing environment. When I started my career, we were accountable to the CAA and would operate globally according to the law of whichever country

we were in. Nowadays, if you ask most pilots, we do not know where the goalposts are, as they are constantly moving. CAA-JAA-EASA — this is the real issue of safety and who we are accountable to."

Many operators voiced similar concerns, and the study said that some operators "had always felt as if this market was not embraced by the regulatory authority as were the major airlines."

The study recommended that the CAA produce a leaflet for the business jet community, explaining the community's regulatory relationship with the CAA, EASA and JAA, providing contact information and recommending sources of advice on operational issues. The study also called for an improvement in two-way communications between the CAA and business aviation organizations.

Operational Issues

Questionnaire responses from both pilots and operators indicated a shared concern over operational issues such as crew fatigue, runway contamination and aircraft icing and deicing operations, the study said.

"There had been recent high-profile accidents with causal factors being apportioned to ice contamination, and further investigation was recommended into the promotion of pilot awareness in this area," perhaps in the form of safety communications directed specifically to the business jet community.

"Recommended areas of attention included performance of smooth-wing aircraft in icing conditions, freezing residues on non-powered flight controls, runway contamination, ground deicing procedures, visual inspection and judging the severity of weather conditions," the study said.

"Whilst there had been many communications covering the above topics, nothing to date had been specifically aimed at business jet operations."

Other operational recommendations included helping increase awareness of flight crew fatigue issues by making the System for Aircrew Fatigue Evaluation (SAFE) software model available to business jet operators and informing operators of Internet-based training material.

Controller Education

In many instances, the study found, air traffic controllers and business jet pilots knew little about key aspects of each other's responsibilities.

"It would be beneficial to raise ATCO [air traffic control officer] awareness of business jet issues, with particular regard to aircraft performance such as requests for high rates of descent with low speed; last-minute changes to flight plans/SIDs [standard instrument departures], particularly at times of high workload/single-pilot operations; waypoint identification, etc.," the study said. "Business jet pilots appeared, in some cases, to be unaware of ATC expectations, for example, when a continuous descent was requested. If high rates of climb and descent were made, far in excess of other types of civilian air traffic (as many of these aircraft were capable of), multiple vertical levels would need to be allocated to this single aircraft, thus further increasing the ATCO's workload."

Pilot workloads may be increased with late changes in departure clearances, especially when accompanied by an "unnecessarily high number of radio transmissions" during critical stages of flight, and especially during operations from unfamiliar airports, the study said, noting, "This was of particular concern in single-pilot operations."

The study also cited the multiple altitude restrictions and frequency changes included in SIDs.

"Coupled with any commercial pressure to depart on time and not enabling crews sufficient time to properly brief, these scenarios compounded potential human errors that may lead to an incident," the study said.

NATS, the U.K. air navigation service provider, and the business aviation community currently are addressing some of these issues, the study said, recommending a joint CAA-NATS forum on business jet safety.

Other recommendations included a call for joint efforts to promote ATC awareness of business jet operational concerns so that controllers minimize radio transmissions and frequency changes during critical stages of flight, and recognize the effects of controller instructions — such as last-minute clearance changes — on single-pilot operations.

The study said that all of the researchers' recommendations were intended to "specifically target both the causal factors that were apparent in the fatal accident statistics, and the concerns that had been highlighted by this study."

Some findings support ongoing safety initiatives, the study said.

This article is based on CAA Paper 2009/03, "Business Jet Safety Research: A Statistical Review and Questionnaire Study of Safety Issues Connected With Business Jets in the U.K." March 29, 2009.

Notes

1. Primary findings of the study were endorsed by the Business Aviation Safety Partnership, which was established in 2007 as a partnership between the CAA, NATS and the business aviation community to identify safety issues and develop solutions.
2. After completion of the study, nine fatal accidents involving business jets occurred in 2008.
3. Crew resource management.
4. In 2008, after completion of the study, another fatal crash occurred in the United Kingdom.