Declines in accidents showed progress in 2006, but the number of fatalities remained stubbornly high as traditional risk categories continued to take a toll.

The major accident record for commercial jets, business jets and commercial turboprops worldwide in 2006 was a marked improvement over the preceding year. However, accidents in all categories resulted in the deaths of 903 people, with more than half of all major accidents continuing to occur during the approach and landing phase of flight (see "Changing Accident Classification," page 21). And loss of control (LOC) accidents involving commercial jets and controlled flight into terrain (CFIT) accidents involving commercial turboprops again accounted for the majority of fatalities in the respective categories.

While the number of accidents declined, the commercial jet fleet last year flew 5.2% more departures. The commercial turboprop fleet size was virtually unchanged. Approximately 10 percent of the world's commercial jet fleet is Eastern-built, while almost 25 percent of the commercial turboprop fleet is Eastern-built (Table 1). The business jet fleet showed the largest growth rate, with a 2 percent increase from 2005.

A brief review of data on commercial jet accidents for the previous two years will help put the 2006 results in perspective. In 2004, there were 13 major accidents involving Western-built and Eastern-built commercial jets in scheduled and unscheduled passenger and cargo operations worldwide, with 196 fatalities. That year was the first in history without a commercial jet CFIT accident, and less than half of the major accidents occurred during approach and landing.

In 2005, commercial jets were involved in 16 major accidents with 778 fatalities. Of that total, 10 occurred during approach and landing, five were CFIT accidents, and three were LOC accidents.

A Mixed Year

BY JIM BURIN

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In 2006, however, there were 11 major accidents involving commercial jets, with a total of 745 fatalities (Table 2). The accident total included six approach and landing accidents, one CFIT accident and three LOC accidents. The commercial jet major accident rate last year showed a significant decline to fewer than 0.40 major accidents per million departures, while the five-year moving average of that rate resumed the downward trend interrupted by the 2005 record (Figure 1, page 18). Accident rates can be calculated only for Western-built aircraft because there are no reliable worldwide exposure data for Eastern-built aircraft.

The Fleet — 2006

Aircraft category	Western-built	Eastern-built	Total
Commercial jets	17,609	1,839	19,548
Commercial turboprops	4,774	1,710	6,484
Business jets	—	—	12,724

Source: Ascend

Table 1

Major Accidents, Worldwide Commercial Jets
January 1, 2006–December 31, 2006

Date	Operator	Aircraft	Location	Phase	Fatal	
Feb. 8, 2006	UPS	DC-8F	Philadelphia, USA	Enroute	0	
May 3, 2006	Armavia	A-320	Alder-Sochi, Russia	Approach	113	● (Loss-of-control)
July 9, 2006	S7 Airlines	A-310	Irkutsk, Russia	Landing	126	
Aug. 22, 2006	Pulkovo Aviation	TU-154	Nr. Donetsk, Ukraine	Enroute	170	● (Loss-of-control)
Aug. 27, 2006	Comair	CRJ-100	Lexington, KY, USA	Takeoff	49	● (Loss-of-control)
Sept. 1, 2006	Iran Air Tours	TU-154	Mashhad, Iran	Landing	28	
Sept. 29, 2006	GOL	B-737	Sao Felix, Brazil	Enroute	154	
Oct. 3, 2006	Mandala Airlines	B-737	Tarakan, Indonesia	Landing	0	
Oct. 10, 2006	Atlantic Airways	BAE-146	Stord-Sorstokken, Norway	Landing	4	
Oct. 29, 2006	ADC Airlines	B-737	Abuja, Nigeria	Takeoff	96	
Nov. 18, 2006	Aerosucre Colombia	B-727	Bogota, Colombia	Approach	5	● (CFIT)

● CFIT accident ● Loss-of-control accident

Source: Ascend

Table 2

Business jets were involved in 10 major accidents in 2006, just slightly above the historical average for this type of aircraft, in which 19 people died, down from 15 accidents and 23 fatalities in 2005 (Table 3, page 18). Nine accidents happened in the first eight months of the year, and nine of the 10 were approach and landing accidents.

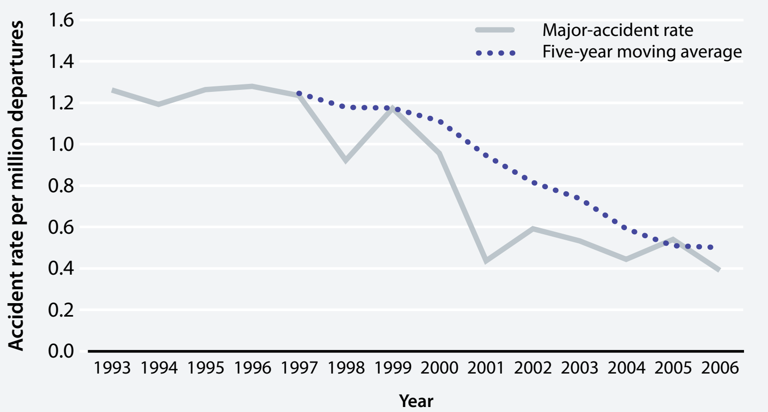
There were 23 major accidents last year involving commercial turboprops, including all Western-built and Eastern-built turboprop aircraft with more than 14 seats, with 139 fatalities (Table 4, page 19). The total was down from 247 deaths in 39 commercial turboprop accidents in 2005, but there were more than twice as many accidents as the total for commercial jets last year. Eleven of the commercial turboprop accidents occurred during approach and landing, and five were CFIT accidents.

Persistent Killers

As has been the case for the last 20 years, the types of fatal accidents that continue to predominate are CFIT, approach and landing and LOC. Recent data clearly show the importance of eliminating these types of accidents: In 2004, there were 196 commercial jet fatalities. In 2005, there were 778 commercial jet fatalities. The difference? There were no CFIT accidents and only one LOC accident in 2004, compared with five CFIT accidents and three LOC accidents in 2005. The eight accidents accounted for more than 70 percent of 2005 fatalities.

The five-year moving average of commercial jet CFIT accidents continues to improve, but slowly (Figure 2, page 20). Despite a 30 percent decrease in CFIT accidents since 1998, a look at the average trend line highlights the difficulty of sustaining low CFIT accident numbers. The average number of commercial jet CFIT accidents for the past decade has been stuck at around four, while the average number of CFIT accidents

Western-Built Commercial Jet Major-Accident Rates, 1993–2006



Note: Worldwide departures are estimated through Dec. 31, 2006. Total departure data are not available for Eastern-built aircraft.

Source: Ascend

Figure 1

Major Accidents, Worldwide Business Jets
January 1, 2006–December 31, 2006

Date	Operator	Aircraft	Location	Phase	Fatal	
Jan. 2, 2006	Avcom	Hawker 700	Kharkov, Ukraine	Approach	3	
Jan. 24, 2006	Goship Air	Citation Ultra	Carlsbad, CA, USA	Landing	4	
Feb 15, 2006	Jet 2000	Falcon 20	Kiel, Germany	Landing	0	
Feb. 16, 2006	Lech Air	Citation I	Busckin, Iraq	Approach	6	●
June 2, 2006	International Jet Charter	Lear 35	Groton, CT, USA	Approach	2	●
June 26, 2006	Great Ideas Corp	Hawker F3	Barcelona, Venezuela	Landing	0	
July 5, 2006	Vigojet	Saberliner	Mexico City, Mexico	Landing	0	
July 19, 2006	Tomco II	Citation Encore	Cresco, IA, USA	Landing	2	
Aug. 28, 2006	Netjets	Hawker 800	Carson City, NV, USA	Descent	0	
Dec. 30, 2006	Fact Air	Sabreliner	Culiacan, Mexico	Approach	2	

● CFIT accident

Source: Ascend

Table 3

involving all commercial aircraft — jets and turboprops — has been about 12 a year.

The ability of the terrain awareness and warning system (TAWS) to help prevent CFIT accidents remained unchallenged in 2006 as, once again, no TAWS-equipped aircraft was involved in a CFIT accident. The fact that there has never been a CFIT accident involving a TAWS-equipped aircraft is ample proof that the best way to reduce the risk of a CFIT accident is to install TAWS.

The fact that approach and landing accidents in 2006 accounted for slightly more than half of the major accidents involving commercial jets and commercial turboprops, plus eight of the nine business jet major accidents, clearly shows that the industry must continue to focus on improving safety in this phase of flight.

Most, if not all, of the causes of these accidents are well-documented and addressed in the Flight Safety Foundation *Approach-and-landing Accident Reduction (ALAR) Tool Kit*. These accidents frequently involve nonprecision approaches, adverse weather, unstable approaches and the failure to go around. The Foundation's CFIT/ALAR Action Group (CAAG) has conducted 24 workshops around the world to disseminate the risk-reduction interventions of the *ALAR Tool Kit*. In 2006, workshops were conducted in Caracas, New Delhi and Tokyo.

There is no consistent historical pattern for commercial jet LOC major accidents, although the numbers after 2000 showed good improvement until 2005, when the three-year moving average reversed and began a rising trend. Hopefully, the revised version of the Airplane Upset Recovery Training Aid distributed by Airbus and Boeing will assist in reducing the risk in this critical area.

Challenge of Error

When considering the statistics, it must be remembered that the Foundation's goal is to make aviation safer by reducing the risk of an accident. Commercial aviation has never had a year with zero accidents, and there has never been a flight with zero risk. There are challenges still to address.

One of the challenges is human error. Human factors specialists and aviation safety professionals agree that human error must be addressed if there is to be continued success in reducing risk. FSF founder Jerome Lederer said, "The alleviation of human error … continues to be the most important problem facing aerospace safety." Note that he said "alleviation," not "elimination."

There are many aviation safety efforts underway around the world, but few directly address the issue of human error. Most of the information on human performance and human error deals with flight crews, because that is where most of the data are available. However, everybody makes mistakes — pilots, air traffic controllers, maintenance personnel and even management people. Errors are the downside of having a brain. And there are many reasons why people make errors — training, design, corporate culture and fatigue, to name just a few.

The first step in addressing this challenge is to admit that human error is a problem and acknowledge that it is not going to go away. In 1985, the Lautman-Gallimore report from Boeing said that flight crew error was a causal factor in 70 percent of accidents from 1977 to 1984. In the 22 years since that report was released, there have been many technological advances and a lot of projects to improve various aspects of aviation safety, but there has not been much progress on this challenge. A 1999 report by the National Aerospace Laboratory (NLR)—Netherlands said that flight crews were a factor in 69 percent of accidents from 1970 to 1997. Data from Boeing about the primary causes of aircraft accidents from 1983 to 2002 show that flight crews are the leading cause of about 68 percent of all accidents. We also have data showing the involvement in accidents of errors by air traffic controllers, maintenance personnel and others.

Major Accidents, Worldwide Commercial Turboprops (> 14 Seats)
January 1, 2006–December 31, 2006

Date	Operator	Aircraft	Location	Phase	Fatal	
Jan. 2, 2006	Ruenzori Airways	Antonov 26	Fataki, DR Congo	Climb	0	
Jan. 24, 2006	Aerolift	Antonov 12	Mbuji Mayi, DR Congo	Landing	0	
Feb. 5, 2006	Air Cargo Carriers	Shorts 360	Watertown, WI, USA	Enroute	3	
Feb. 8, 2006	Tri Costal Air	Metro II	Paris, TN, USA	Enroute	1	
March 11, 2006	Air Deccan	ATR 7	Bangalore, India	Landing	0	
March 18, 2006	Ameriflight	Beech 99	Butte, MT, USA	Enroute	2	●
March 28, 2006	Phoenix Avia	Antonov 12	Payam, UAE	Climb	0	
March 31, 2006	TEAM	Let 410	Saquarema, Brazil	Enroute	19	●
April 16, 2006	TAM	Fokker-27	Guayaramerin, Bolivia	Landing	1	
April 24, 2006	Air Million Cargo	Antonov 2	Lashkar, Afghanistan	Landing	2	
April 27, 2006	LAC Skycongo	Convair 580	Amisi, DR Congo	Landing	8	
May 23, 2006	Air Sao Tome	DHC-6 Twin Otter	San Tome, Africa	Approach	4	
June 5, 2006	Merpati Nusantara	CASA 212	Bandanaira, Indonesia	Landing	0	
June 21, 2006	Yeti Airlines	DHC-6	Jumla, Nepal	Approach	9	●
July 7, 2006	Mango Airlines	Antonov 12	Goma, DR Congo	Climb	6	
July 10, 2006	PIA	Fokker 27	Multan, Pakistan	Takeoff	45	
July 12, 2006	TransAfrik	Lockheed Hercules	Kigoma, Tanzania	Approach	0	
July 29, 2006	Adventure Aviation	DHC-6	Sullivan, MO, USA	Takeoff	6	
Aug. 3, 2006	Tracep	AN-28	Bukavu, DR Congo	Approach	17	●
Aug. 4, 2006	AirNow	EMB-110	Bennington, VT, USA	Approach	1	●
Aug. 13, 2006	Air Algerie	Lockheed Hercules	Piacenza, Italy	Enroute	3	
Aug. 28, 2006	Paraguay Air Service	Nomad 22B	Cerrillos, Argentina	Enroute	0	
Nov. 17, 2006	Trigana Air Service	DHC-6	Puncak Jaya, Inodnesia	Enroute	12	
Dec. 30, 2006	Sky Relief	DHC-5	Nairobi, Kenya	Takeoff	0	

● CFIT accident

Source: Ascend

Table 4

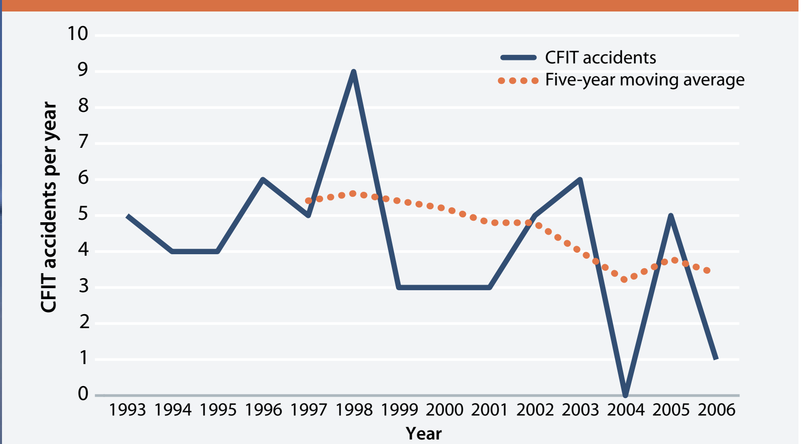
Some interventions help provide a level of defense when mistakes are made. These include crew resource management (CRM), threat and error management (TEM), and improved decision making, all of which can improve human performance and reduce the risk or the consequences of an error.

Unfortunately, human error is a tough nut to crack. It is not easy to solve a human error problem with a hardware change or technology update. And passing a rule will not help; human error does not normally lend itself to regulatory fixes.

One part of the solution is education and increased awareness. A good CRM course, training on TEM, an in-depth discussion about fatigue, learning the basics about risk management and decision making, studying the lessons learned from an accident — all help improve human performance and reduce human error.

Technology is another way to address this challenge. It does not have to be a high-tech solution; it can be as simple as a mechanical guard on a critical switch. Examples of technologies that have helped reduce the impact of human error are flight operational quality assurance (FOQA), engineered materials arresting system (EMAS), traffic alert and collision avoidance system (TCAS), minimum safe altitude warning (MSAW) system, and TAWS. Note that most of these are not designed to prevent human error. EMAS, TCAS, MSAW and TAWS are designed to mitigate an error once it happens. In fact, these systems are designed to function only if there is an error.

Western-Built Commercial Jet CFIT Accidents. 1993–2006



CFIT = Controlled flight into terrain

Source: Ascend

Figure 2

Other tools useful in addressing human error are standard operating procedures (SOPs), culture surveys and a corporate commitment to a just culture. The role of SOPs in reducing human error is major, and it has been addressed in several efforts, such as the Standard Operating Procedures Template, an element of the FSF *ALAR Tool Kit.*

Surveys assist in identifying an organization's culture; the type of culture can directly affect how human error is addressed. The Airline Management Self-Audit developed by the FSF Icarus Committee was one of the first of these surveys (*Flight Safety Digest* 11/96). Today, more sophisticated surveys benchmark an organization's culture against similar groups, highlight areas for improvement and, most importantly, provide interventions to enable movement toward a just culture.

A just culture is one that establishes an atmosphere of trust, in which personnel are encouraged to provide essential safety-related information and acknowledge errors, but where there is a distinct and acknowledged line between acceptable and unacceptable behavior. This fosters an environment in which human error can be identified and addressed.

Human error will never be eliminated. Like risk, it will be present and needs to be addressed as long as we fly aircraft. However, the goal is to eliminate as much of it as possible. The key is to start the effort. Borrowing a slogan coined elsewhere, the industry needs to wage a "war on error."

The latest data from Boeing on the primary causes of accidents from 1996 to 2005 show flight crew factors still dominate, but they are down from nearly 70 percent to 55 percent. It is unclear if this decrease indicates progress in reducing human error, or just a reflection of the fact that we are now looking for errors beyond those made by pilots. Dan Maurino, coordinator

Changing Accident Classification

After much thought, Flight Safety Foundation has departed from the use of "hull loss" or "total loss" as appropriate definitions for the most severe type of aircraft accident. Starting with this report, the Foundation will use "major accident," as defined below.

Effective aviation safety efforts are driven by data to document our performance and measure our progress. Today, there are new methods to determine safety performance, some that use non-accident data to identify potential problems and predict high risk areas before an accident occurs. However, accidents and accident rates remain the bottom line of aviation safety.

There are many different ways to determine what constitutes an accident and how to derive accident rates. The differences stem from how terms are defined. The definitions of accidents used by most national authorities largely are based on the definitions in International Civil Aviation Organization Annex 13, *Aircraft Accident and Incident Investigation*.

Ultimately, there must be a determination of what constitutes an accident, accompanied by a measure of the severity of the accident. One measure of severity is "hull loss," a manufacturer-developed term that has been widely used. A hull loss is an accident in which airplane damage is beyond economic repair. Another classification scheme used by the insurance industry differentiates "total loss" accidents, in which either the aircraft is destroyed, the damage cannot be repaired or the cost of repairs exceeds the insurance value. It is important to note that "total loss" does not mean the aircraft never flies again; in fact, several "total loss" aircraft are flying today. Accidents also are differentiated by the involvement of fatalities or substantial aircraft damage.

As mentioned above, the Foundation now uses the term "major accident" as the defining measure. A major accident involves any of the following three conditions:

- The aircraft is destroyed, which is defined as sustaining damage that exceeds a threshold defined by the Ascend Damage Index (ADI) developed by Paul Hayes of Ascend, formerly Airclaims. ADI is the ratio of the costs of repair and the projected value of the aircraft had it been brand-new at the time of the accident. If the ADI exceeds 50 percent, the accident is considered major; or,
- There are multiple fatalities; or,
- There is at least one fatality, and the aircraft is substantially damaged.

The use of the major accident classification criteria ensures that an accident is not determined by an aircraft's age or by its insurance coverage, and it gives a more accurate reflection of the high risk areas that need to be addressed.

— JB

of flight safety and human factors for the International Civil Aviation Organization, said, "The discovery of human error should be considered the starting point of an investigation, not the end point." This accurately reflects the progressive and proactive approach necessary to successfully address the challenge of human error.

If there is an accident, the question is not "Was there human error?" If there was an accident, there was human error. The questions are "Why was there human error?" and, more importantly, "What can be done to prevent or reduce the probability of it happening again?"

Over the past six years, the number of accidents has decreased as the number of departures has increased. This is an impressive accomplishment. But, to reduce the risk even more and to keep the accident rate coming down, we must address human error. We must acknowledge it, educate all aviation personnel on it and devise ways, both technical and nontechnical, to address it. Only by doing this will we truly be able to make aviation safer by reducing the risk of an accident.●

Jim Burin is director of technical programs for Flight Safety Foundation.