Department of Transport and Regional Development

Bureau of Air Safety Investigation

Human Factors in Fatal Aircraft Accidents

Released by the Secretary of the Department of Transport and Regional Development under the provisions of Section 19CU of part 2A of the Air Navigation Act (1920).

When the Bureau makes recommendations as a result of its investigations or research, safety (in accordance with its charter) is its primary consideration. However, the Bureau fully recognises that the implementation of recommendations arising from its investigations will in some cases incur a cost to the industry.

Readers should note that the information in BASI reports is provided to promote aviation safety: in no case is it intended to imply blame or liability.

ISBN 0 642 24817 6 April 1996

This report was produced by the Bureau of Air Safety Investigation (BASI), PO Box 967, Civic Square ACT 2608.

Summary

The details of 75 fatal aeroplane accidents were extracted from the BASI database. The largest proportion (36%) of the accidents occurred on private/business flights. The three most frequent first occurrences in accidents were loss of control; collision with terrain (control unknown); and wirestrike. Most accidents had more than one contributing factor. Over 70% of the accidents involved pilot factors. The most common pilot factors related to poor judgement and decision making.

In recent years, BASI has recognised that while pilot factors are of great importance, accidents frequently have their origins in systemic or organisational failings.

DEFINITION OF TERMS

Accident	An occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked in which: (a) any person suffers death or serious injury as a result of being in or upon the aircraft or by direct contact with the aircraft or anything attached to the aircraft, except when the injuries are from natural causes, are self-inflicted or inflicted by other persons or when the injuries are to stowaways hiding outside the area normally available to the passengers and crew; (b) the aircraft incurs damage or structural failure that adversely affects the structure strength, performance or flight characteristics of the aircraft and would normally require major repair or replacement of the affected component; or (c) the aircraft is missing or inaccessible.
Agricultural	Pest and disease control, fertilising, crop seeding, poison baiting and similar operations, excluding aerial spotting of livestock (see Other aerial work).
Charter	The carriage of passengers or cargo for hire or reward (but excluding scheduled airline operations).
General aviation	All flying by civil aircraft other than high capacity air transport aircraft, gliders and sport aviation.
Low capacity airline	(Also known as regional airline and low capacity air transport.) Scheduled service operated with low capacity aircraft, i.e. aircraft with 38 seats or less and/or a maximum payload less than 4,200 kg.
Other aerial work	Mustering, fire fighting, parachute dropping, survey work, towing, aerial spotting, search and rescue or similar operations.
Private/business	Transportation of a business or leisure nature not covered by other categories of operation. Includes transportation of the owner or his or her employees.
Training	Activity under the supervision of an appropriately licensed flight instructor for the purpose of practical instruction for the issue or renewal of a licence or rating. Includes aircraft type endorsement/conversion and navigation exercises conducted as part of a course of flying training.

INTRODUCTION

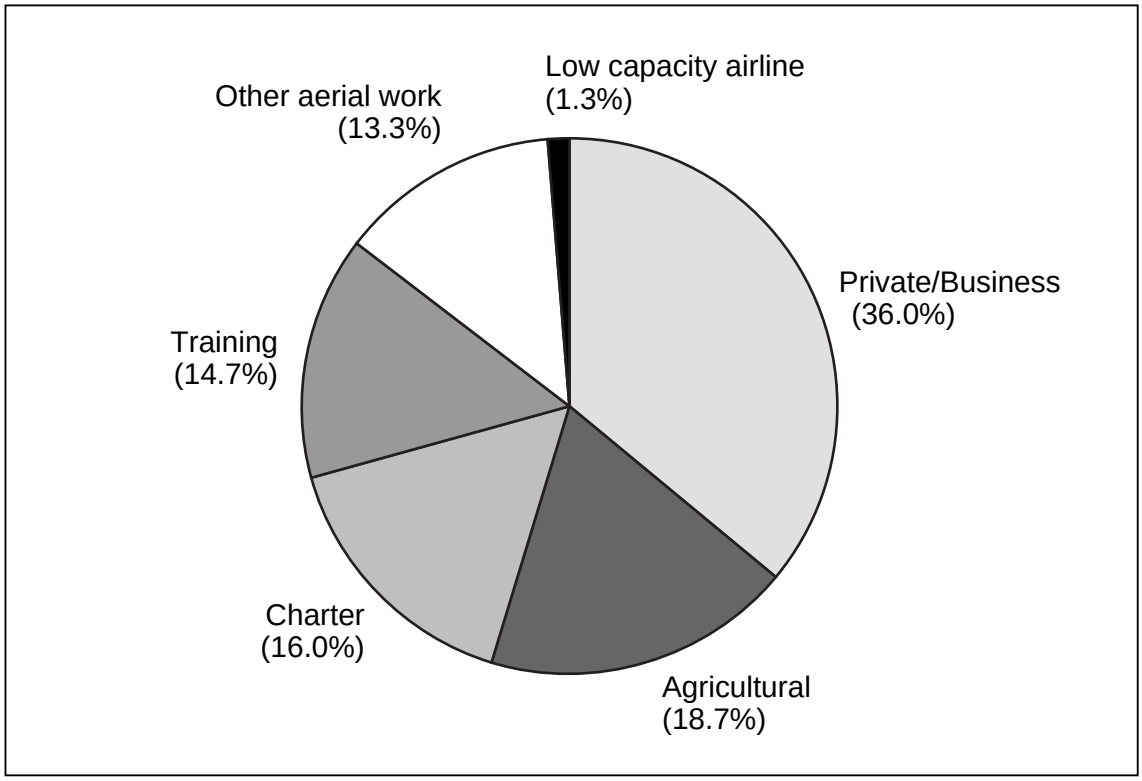
This analysis was conducted on the 75 fatal aeroplane accidents which occurred in the period 1 January 1988–31 December 1990. Seventy-four accidents involved general aviation aircraft and one accident involved a regional airline aircraft. One hundred and sixty-two deaths resulted from the accidents. Most of the accidents (57 of 75) involved single-engine aircraft.

Accidents to rotary wing aircraft, gliders and sport aviation aircraft were excluded.

Type of operation

The largest proportion of accidents occurred on flights categorised as private or business (see fig. 1). One accident in the sample occurred on a regional airline flight (low capacity airline).

Figure 1: **Fatal accidents to fixed wing aircraft – type of operation**



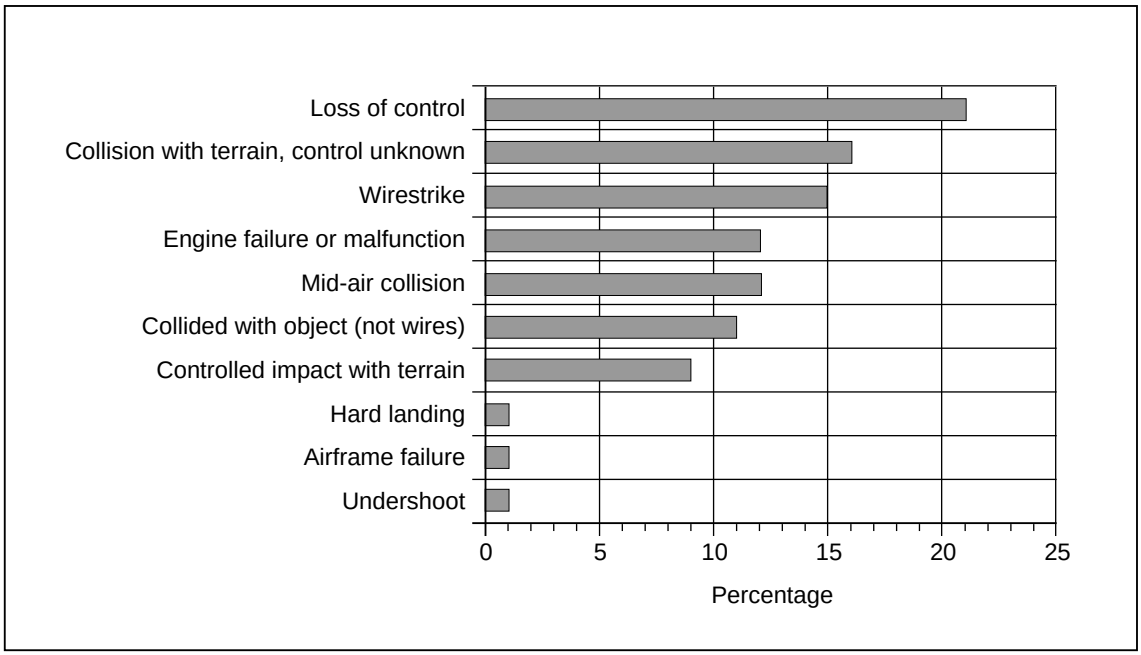
Type of occurrence

Many accidents involve a sequence of events. The following graph indicates the first event in the accident sequence. Each event may have been followed by further events not reported here. For example, an aircraft which sustained an engine failure may have then been involved in a hard landing.

The most frequent first event leading to fatal accidents was *loss of control*. The next most frequent first event was *collision with terrain, control unknown* where the investigation could not determine whether the pilot was in full control of the aircraft. *Controlled impact with terrain* refers to accidents in which the aircraft struck terrain while apparently under the control of the pilot. Such accidents typically occur in conditions of reduced visibility.

Collided with object (not wires) includes cases in which an aircraft collided with trees, buildings or other obstructions. Collision with powerlines is treated separately under *wirestrike.*

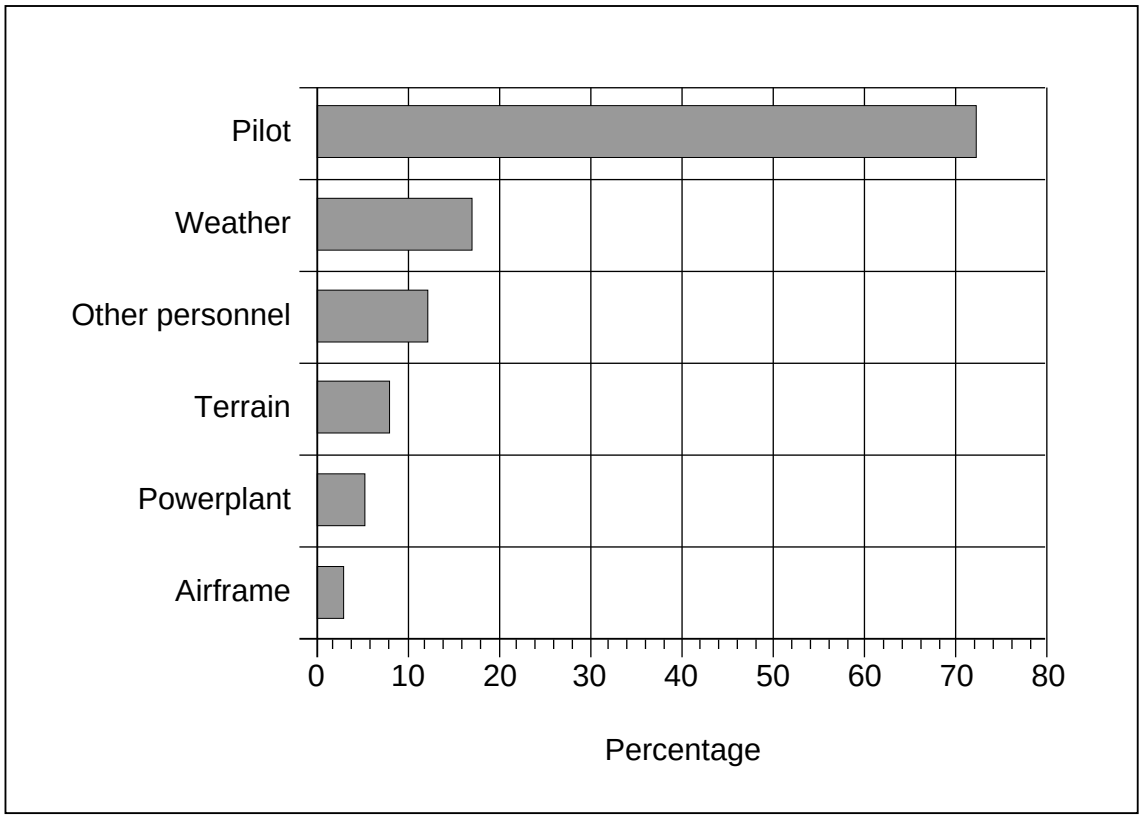
Figure 2: **Fatal accidents to fixed wing aircraft – first event**



Broad accident factors

Seventy-two per cent of the accidents were judged to involve pilot factors (see fig. 3). *Weather* was a factor in 17% of the accidents. *Other personnel* contributed to 12% of the accidents. *Other personnel* refers to people other than the pilot of the aircraft, and includes air traffic controllers, other flight crew and maintenance workers. Note that accidents may be assigned multiple factors.

Figure 3: **Fatal accidents to fixed wing aircraft – broad accident factors**



Pilot factors

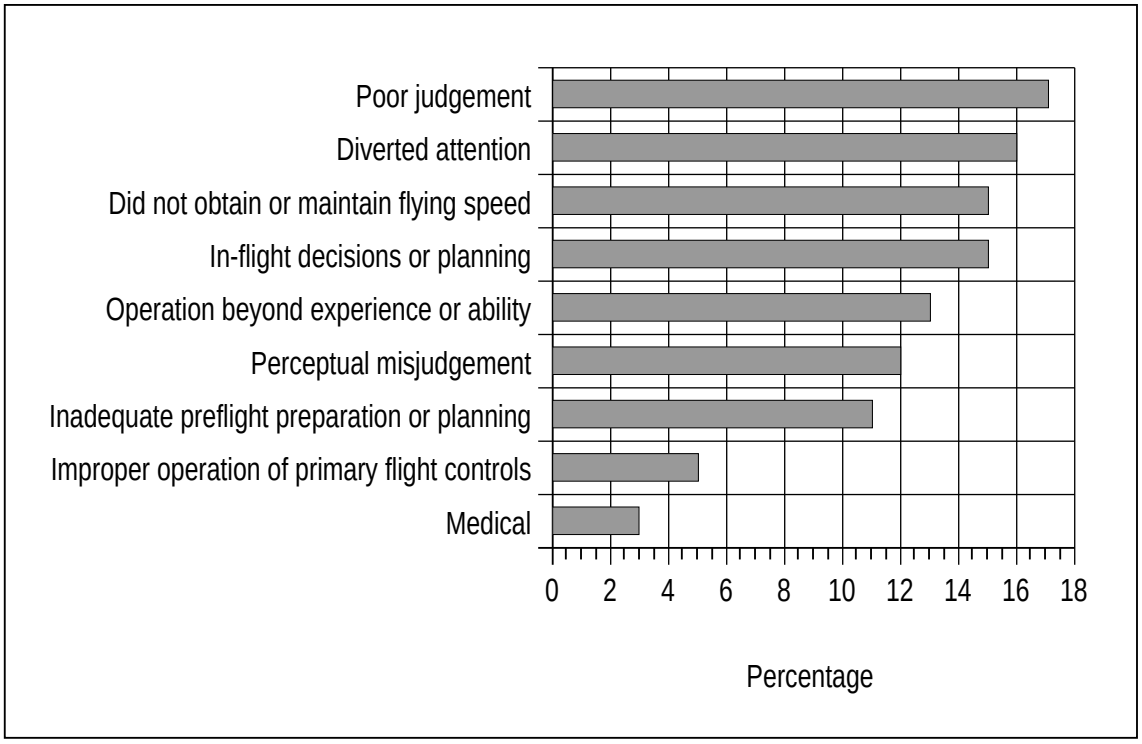
Figure 4 indicates the most frequent pilot factors in the sample of accidents. The most commonly assigned factor was *poor judgement*. Other common factors were *in-flight decisions or planning* and attempted *operation beyond experience or ability*. These results are consistent with the general worldwide finding that inadequate decision making contributes to a large proportion of accidents in general aviation and airline operations.

Examples of inadequate decision making or poor judgement are knowingly continuing a flight into adverse weather, engaging in unauthorised low flying and continuing a flight with a known low fuel state.

Medical factors were relatively rare.

Factors which were assigned to only one or two of the 75 accidents are not listed in fig. 4. These factors included *mismanagement of fuel system* and *selected unsuitable area for landing or takeoff.*

Figure 4: **Fatal accidents to fixed wing aircraft – pilot factors**



Further detail on human factors terminology

Poor judgement

For many years it was assumed that good judgement was an inevitable by-product of flying experience. However, the data that BASI has accumulated indicates that errors of judgement are made by experienced and less-experienced pilots alike.

> *The single-engine Cessna was being flown by the owner on a flying holiday with three friends. The pilot had experienced navigation difficulties during the holiday and as a result, the CAA required the pilot to undertake local navigation training before continuing the flight. Following the training, the pilot departed on the next leg of the flight with 70 minutes of daylight remaining. The flight was planned to take 55 minutes. The pilot was apparently unable to locate the aerodrome and decided to land on a curved gravel road at an open cut mine about 40 km from the planned destination.*
>
> *The pilot decided to camp the night near the aircraft. The next morning the aircraft was observed by a number of witnesses to attempt to take off from the gravel road in the opposite direction to that used for landing. This had involved passing through an 18-m wide steel frame which spanned the roadway and then negotiating a curve of about 50°. After a take-off roll of about 500 m, the aircraft became airborne for a brief distance before the landing gear struck a low mound of rocks. The aircraft then descended steeply before impacting a step of the open-cut mine about 200 ft below the level of the roadway. The pilot and two passengers were killed, one passenger survived the accident with serious injuries. The pilot was 57 years old and had accumulated 500 hours of flying experience.*

Airlines around the world recognised in the 1970s that even experienced crews could make serious errors of judgement. For example in 1979, the crew of a United Airlines DC8 were distracted for so long by a landing gear problem that they eventually ran out of fuel[1]. Many major airlines have now introduced crew resource management (CRM) training to ensure that flight crew apply principles of judgement and teamwork. However, for general aviation and regional airline operations, pilot judgement continues to be a significant accident factor. In the 1980s, the Australian Department of Aviation and equivalent bodies in the USA and Canada sponsored the development of judgement training courses for pilots. The results indicated a significant reduction in aircrew errors[2]. In 1987, the US Federal Aviation Administration (FAA) released a series of manuals oriented to the decision-making needs of general aviation pilots[3]. The FAA later released an advisory circular on the subject of aeronautical decision making[4].

Diverted attention

Pilots may divert their attention from the operation of the aircraft for a variety of reasons. Diverted attention is particularly likely when the pilot is under time pressure or stress. For example, a minor abnormality such as a landing gear warning may distract a pilot from other aspects of the flight.

In the following example, an experienced pilot collided with powerlines which he was aware of. The investigators believed that his attention had been distracted.

The pilot had been conducting superphosphate spreading operations in the area two days prior to the accident and had completed approximately 60 trips during that operation. On the morning of the accident, he had just completed the sixth load and was returning to land at the strip when the outboard section of the right wing struck powerlines. The right wing was torn from its attachment points and separated from the aircraft. The aircraft then impacted the ground in a steep nose-down attitude and came to rest 169 m from the powerlines. The pilot, who had accumulated nearly 24,000 hours flying experience, was fatally injured in the accident. It is probable that the pilot forgot about the presence of the powerlines.

In-flight decisions or planning

Problems with in flight decisions or planning include situations where a pilot elects to continue a flight with a known deficiency, continues a visual flight into adverse weather or makes a poorly planned approach to an airfield.

The following example illustrates how inadequate in-flight decisions or planning can lead to an accident.

The short charter flight in a light single-engine aircraft had been arranged to transport three passengers to another aerodrome where they were to connect with a scheduled flight. The passengers had less than 15 minutes to make the connection. After a normal takeoff, the aircraft was seen to make an abrupt right turn at about 250 ft above the ground. The aircraft was last seen descending towards the ground in a 45° nose-down attitude. All four occupants were killed in the subsequent impact. The behaviour of the aircraft in the moments preceding the impact was consistent with a stall leading to loss of control. The investigators considered that the pilot was in a hurry to depart and had not climbed the aircraft to a safe height before making a turn downwind in turbulent wind conditions and had not maintained sufficient airspeed for continued flight under the prevailing circumstances.

Inadequate pre-flight preparation or planning

In many cases, the origins of the accident began well before the aircraft left the ground. Pre-flight preparation or planning includes the pre-flight check of the aircraft, flight planning and weather briefing. The fuel gauges of light aircraft can be unreliable and pilots are expected to visually check the amount of fuel in the tanks before flight. The following example illustrates how a minor error during this pre-flight inspection apparently led to an in-flight fuel loss.

The light twin aircraft was on a night freight flight from Sydney to Melbourne.The 23 year old pilot had accumulated 660 hours total flying time and was the only person on board the aircraft. On descent about 20 miles north of Melbourne, the pilot made a mayday call advising that he had a dual engine failure. Air Traffic Services provided the pilot with radar headings towards a nearby airfield. Two minutes into the emergency the pilot reported that his altitude was now 1,000 ft and when told that the airfield was five miles away he said that he was not going to make it. Radar contact with the aircraft was lost shortly afterwards. The aircraft subsequently impacted the face of a road cutting. It was determined that both engines had run out of fuel. A fuel stain on the left wing was consistent with an in-flight loss of fuel from the left main fuel tank cap. The investigation revealed that although apparently fastened correctly, the fuel tank cap had been prevented from sealing due to interference from a wire clip attached to the fuel cap securing chain. As a result, fuel was sucked past the cap during flight. At the same time, the floor of the bladder type fuel tank was lifted, resulting in false gauge indications.

The investigation concluded that the clip had probably lodged under the left main fuel cap during pre-flight inspection of the tank contents.

Conclusions

In conclusion, the largest proportion (36%) of fatal aircraft accidents occurred on private/ business flights. The three most frequent first events in accidents were loss of control, collision with terrain (control unknown) and wirestrike.

Most accidents had more than one contributing factor, although pilot factors were involved in over 70% of fatal accidents. The most common pilot factors related to poor judgement and decision making. BASI experience has shown that errors of judgement can be made by experienced and inexperienced pilots.

This report deals mainly with the human factors which relate to pilots. In recent years however, BASI has recognised that while pilot factors are of great importance, accidents frequently have their origins in the aviation system as a whole. Organisational factors such as training, supervision, regulation, commercial pressures and licensing are involved in a significant proportion of accidents. The investigation of these organisational or systemic factors now forms the basis of much of BASI's investigation and research effort.

---

1. National Transportion Safety Board (1979) *Aircraft Accident Report: United Airlines, Inc., McDonnell-Douglas DC-8-61, N8082U, Portland, Oregon, December 28, 1978* (NTSB-AAR-79-7) Washington DC.
2. Diehl, A. (1990) *The effectiveness of aeronautical decision making training.* Norton, California.
3. US Department of Transportation (1990) *Advisory Circular – Announcement of availability: A series of Aeronautical decision making training manuals.* (AC60-2I). Federal Aviation Administration.
4. US Department of Transportation (1990) *Advisory Circular – Aeronautical Decision Making.* (AC60-22). Federal Aviation Administration.