Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Aviation Research and Analysis Report - B2006/0002

International Fatality Rates

A Comparison of Australian Civil Aviation Fatality Rates with International Data

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ISBN and formal report title: see 'Document retrieval information' on page v.

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DOCUMENT RETRIEVAL INFORMATION

Report No.	Publication date	No. of pages	ISBN
B2006/0002	July 2006	62	1 921092 37 8

Publication title

International Fatality Rates: A Comparison of Australian Civil Aviation Fatality Rates with International Data

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Abstract

How does Australia's aviation safety record compare with that of other Western countries? To answer this, fatal accident and fatality rates for Australia were compared with similar rates for the United States, Canada, the United Kingdom, and New Zealand, between 1995 and 2004 (the latest year for which comparable data was available). The ATSB aviation accident and incident database was searched to identify all fatal accidents involving Australian civil registered aircraft during this period. The dataset was then matched with comparable datasets for the overseas countries, taking into consideration the variation in operational definitions between the countries. In the period studied, Australia had no high capacity regular public transport fatal accidents and one low capacity regular public transport fatal accident. The key findings indicated that the fatal accident rate for Australian air carrier operations, which includes all regular public transport and commercial charter operations, was slightly higher than the rate for the United States for all years, except for 2002 when it was marginally lower, and for 2004, when the rate was zero. The fatal accident rates for the non-general aviation sector for both countries are largely influenced by the commercial charter (Australia) and on-demand (United States) operational categories, which each have a much higher fatal accident rate than scheduled airline services. In Australia, commercial charter operations account for 32 per cent of the total air carrier activity. This has a greater impact on the overall air carrier fatal accident rate compared with the United States, where on-demand operations account for only 15 per cent of the total air carrier activity. If Australia's activity profile mirrored that of the United States, Australia's overall fatal accident rate would fall below that of the United States. Both Australia and the United States recorded a significant downward trend for the general aviation fatal accident rate. For most years, the rate of fatal accidents for all operations in Australia was slightly lower than that for Canada. Australia also recorded a significant decline in the rate of non-public transport fatal accidents during this period compared with the United Kingdom. Australia recorded one low capacity regular public transport fatal accident, which resulted in eight fatalities, and New Zealand recorded two fatal accidents, which resulted in 10 fatalities. The general aviation fatal accident rate for Australia was lower than the rate recorded for New Zealand, and showed a downward trend. Overall, the findings showed that Australia's fatal accident and fatality rates were mostly similar to the corresponding rates of the other countries examined. Using North America and the United Kingdom to represent world's best practice and as a benchmark of aviation safety, the findings demonstrate that Australia has a good safety record.

EXECUTIVE SUMMARY

In March 2006, the ATSB published the aviation research paper *Analysis of Fatality Trends involving Civil Aviation Aircraft in Australian Airspace between 1990 and 2005*. The paper reported on the trends and characteristics of fatal accidents and associated fatalities involving civil registered aircraft operating in Australian territory between 1990 and 2005. The paper was initiated in response to claims in the media in late 2005 that the commercial aviation fatal accident rate in Australia was increasing and may now be the worst ever.

In contrast to the media claims, the results of the paper indicated that the number of fatal accidents and fatalities had declined significantly between 1990 and 2005. The highest number of fatal accidents (n = 30) occurred in 1990 and the lowest number occurred in 2002 (n = 10). The highest number of fatalities (n = 64) occurred in 1990 and the lowest number occurred in 2004 (n = 23). The results also indicated that the number of fatalities had increased by 11 between 2004 and 2005. This increase was influenced by a fatal accident near Lockhart River in Queensland, where 15 people died. The number of fatalities reported in 2005 remained below the annual average of 40 calculated for the 16-year period.

The previous research paper provided an important insight into aviation safety trends for Australia. To expand on the findings and provide a benchmark of aviation safety in Australia, this report compares fatal accident and fatality rates for Australia with similar rates for the United States (US), Canada, the United Kingdom (UK), and New Zealand (NZ). To establish comparable measures, the ATSB accident data was matched to the overseas datasets, taking into consideration the variation in operational definitions.

The analysis focused on the 10-year period between 1995 and 2004. In general, the findings indicated that Australia's fatal accident and fatality rates were comparable with the corresponding rates for the other four countries. The key findings indicated that:

- Australia's air carrier[1] fatal accident rate, which includes all regular public transport and commercial charter operations, was slightly higher than the US rate for all years across the period, except for 2002 when it was marginally lower, and for 2004, when it declined to zero. The associated fatal accident rates for commercial charter operations in Australia and its US equivalent, on-demand services, were the greatest contributors to the overall air carrier fatal accident rate for both countries. However, as the proportion of air carrier activity associated with commercial charter operations is double that of on-

1 Air carriers in Australia refer to all regular public transport and commercial charter (passenger and cargo) operations involving Australian civil registered aircraft. Air carriers in the US generally refer to those operators that fly aircraft in revenue services under Part 121 and Part 135 of the *Code of Federal Regulations*. Part 121 applies to major airlines and cargo carriers that fly large transport–category aircraft while Part 135 applies to commercial air carriers flying smaller jet and turboprop aircraft ('commuter' airlines) and 'air taxis' on-demand. In March 1997, Part 121 changed to include scheduled aircraft with 10 or more passenger seats (National Transportation Safety Board, 2000; US Title 14 Code of Federal Regulations (14 CFR) Part 121, 2006; 14 CFR Part 135, 2006).

demand services, Australia's overall air carrier fatal accident rate was affected to a greater extent.

- The highest air carrier fatality rate for Australia was in 2000, when 1.2 fatalities per 100,000 hours flown occurred, and the lowest rate in 2004, when no fatalities occurred. For the US, the highest air carrier fatality rate was 2.3 in 1996 and the lowest in 1998 and 2002, when 0.2 fatalities occurred per 100,000 hours flown for each year.
- Both Australia and the US recorded a significant downward trend for the general aviation fatal accident rate.
- Across most of the 10-year period, the fatal accident rate for all operations in Australia was slightly lower than the rate for Canada.
- Both Australia and Canada recorded a significant downward trend for the fatal accident and fatality rates for the category of 'all operations'.
- The comparison of the fatal accident rate for public transport aircraft between Australia and the UK suggested that Australia's rate was higher, however this analysis was limited by the ability to match the data.
- Over the reporting period, Australia recorded a higher rate of public transport fatalities than the UK up to 2003, with both countries dropping to zero in 2004.
- Australian non-public transport fatal accident and fatality rates were generally less across the 10-year period than the UK.
- Australia's general aviation fatal accident rate was lower than the rate for New Zealand, and showed a downward trend.
- Australia recorded no high capacity regular public transport fatal accidents, whereas New Zealand recorded two, which involved seven fatalities.
- Australia recorded one low capacity regular public transport fatal accident, which involved eight fatalities, and New Zealand recorded two fatal accidents, which involved 10 fatalities.

Together, the comparison of Australia's fatal accident and fatality rates with the US, Canada, UK and New Zealand provided a basis upon which to identify differences in safety trends between 1995 and 2004. To summarise, Australia's fatal accident rates were comparable with those calculated for the US and Canada. Australia had a slightly better safety record in relation to UK non-public transport operations and the UK had a slightly better safety record in relation to Australian public transport operations. Australia also had a better safety record in relation to all regular public transport and general aviation operational categories in New Zealand.

Using North America and the UK to represent world's best practice and as a benchmark of aviation safety, the overall finding arising from this examination is that Australia has a good safety record, and one that is similar to the safety records of the other countries examined. Importantly, however, a number of factors beyond a country's level of safety need to be considered when interpreting the results. Those identified in the report included population and the environment, and aviation industry-related factors. The report also identified a number of methodological factors that may have influenced the findings. These included the accuracy of data matching between countries and the difficulty in finding a common measure to benchmark aviation safety across the world.

ABBREVIATIONS

ATM	Air transport movements
ATSB	Australian Transport Safety Bureau
CAA	Civil Aviation Authority
CAR	Civil Aviation Regulations
CASA	Civil Aviation Safety Authority (Australia)
CFR	Code of Federal Regulations
DOTARS	Australian Government Department of Transport and Regional Services
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
MTOW	Maximum take-off weight
RPT	Regular Public Transport

1 INTRODUCTION

1.1 The Australian Transport Safety Bureau

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal body located within the Australian Government Department of Transport and Regional Services (DOTARS).

The ATSB's mission is to maintain and improve transport safety and public confidence through:

- independent transport accident and incident investigation;
- safety data analysis and research; and
- safety communication and education.

The ATSB investigates aircraft accidents and incidents (occurrences) to identify contributing factors and make safety recommendations. The ATSB also maintains a database of aviation safety occurrences involving Australian registered aircraft (occurring both in Australia and overseas) and occurrences in Australia involving foreign-registered aircraft. Transport safety investigations and analyses of safety data are conducted in accordance with the International Civil Aviation Organization (ICAO), Annex 13 Standards and Recommended Practices and the *Transport Safety Investigation Act 2003* and regulations.

1.1.1 Background to the report

In April 2006, the ATSB published the aviation research paper *Analysis of Fatality Trends involving Civil Aviation Aircraft in Australian Airspace between 1990 and 2005* (ATSB, 2006). The paper reported on the trends and characteristics of fatal accidents and associated fatalities involving civil registered aircraft operating in Australian territory between 1990 and 2005. The paper was initiated in response to claims in the media in late 2005 that the commercial aviation fatal accident rate in Australia was increasing and may now be the worst ever.

The findings presented in the research paper indicated that fatal accidents and fatalities had declined significantly between 1990 and 2005, with the highest number of fatal accidents and fatalities occurring in 1990. The number of fatalities for 2005 was higher than 2004, primarily due to a fatal accident near Lockhart River in Queensland on 7 May 2005, when 15 people died. Both the number of fatal accidents and fatalities reported in 2005 were below the annual average of 40 calculated for the 16-year period. The results also indicated that the fatal accident rate for commercial and non-commercial operations was low and had declined significantly between 1990 and 2005.

The research paper provided an important insight into safety trends for Australian aviation. It also provided the ATSB with a basis upon which Australia's safety record could be examined within the global aviation context. In recognition of the benefits that such an examination would have, the Executive Director of the ATSB commissioned the present report, which involves an analysis of international data.

1.1.2 Objective of the report

The overall objective of this report was to expand on the findings presented in the previous research paper by comparing Australian fatality rates with the most recent available international data. Specifically, the objectives were to:

- Compare the rate of fatal accidents for Australia with similar rates for the US, Canada, UK and New Zealand, between 1995 and 2004.
- Compare the rate of fatalities for Australia with similar rates for the US, Canada, UK and New Zealand, between 1995 and 2004.

By making these comparisons, the ultimate purpose of the paper was to benchmark aviation safety in Australia.

2 BACKGROUND INFORMATION

2.1 The Australian aviation industry

The Australian civil aviation industry can be divided into four main categories based on *Civil Aviation Regulations 1988*[2]. These are regular public transport (RPT), charter, aerial work and private operations. Civil aviation operations do not include military operations.

Regular public transport operations are those used for the commercial purpose of transporting persons generally, or transporting cargo for persons generally, for hire or reward in accordance with fixed schedules to and from fixed terminals over specific routes with or without intermediate stopping places between terminals[3]. Charter operations are those that carry passengers or cargo for hire or reward and either not on fixed schedules or not available for use by persons generally[4].

Aerial work is further sub-divided as:

- aerial surveying;
- aerial spotting;
- agricultural operations;
- aerial photography;
- advertising;
- flying training;
- ambulance functions;
- carriage of goods for the purposes of trade other than on fixed schedules; and
- any other purpose that is substantially similar to those specified above[5].

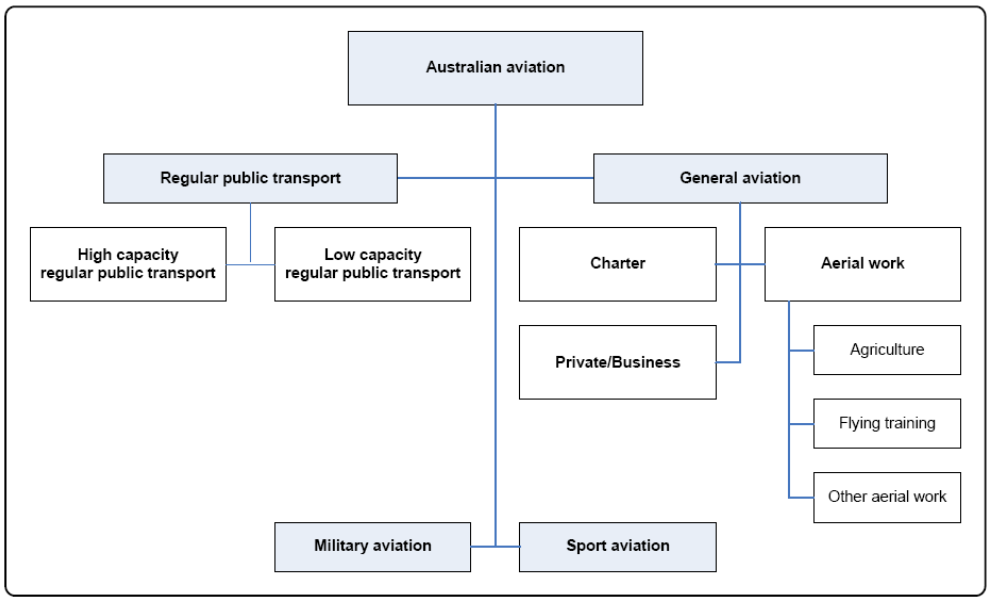
Private operations include the personal transportation of the aircraft owner, operations for purposes that do no include remuneration, and those components of flying training relating to endorsement of an additional type or category of aircraft in a pilot licence[6].

2 Civil Aviation Regulations 1988 (CAR) 2 (6).
3 CAR 206 (1) (c) and CAR 2 (7) (c).
4 CAR 206 (1) (b) and CAR 2 (7) (b).
5 CAR 206 (1) (a) and CAR 2 (7) (a).
6 CAR 2 (7) (d).

2.2 ATSB accident and incident database

The ATSB is responsible for the independent investigation of accidents and incidents involving civil aircraft in Australia. The ATSB's aviation accident and incident database captures data predominantly from accidents and incidents involving RPT and general aviation aircraft. Some data on sport and military operations are included in the database. Investigations into accidents involving sport operations (eg ultralights, microlights, gyrocopters, gliders and hang gliders) will only be conducted if it benefits future safety and sufficient resources are available (ICAO, 2003). Military operations are generally overseen by military safety authorities.

Figure 1: ATSB statistical groups for the Australian aviation industry



For statistical purposes, the ATSB divides the Australian aviation industry into several different groups. As shown in figure 1, the two major groups are RPT and general aviation, with RPT divided into high capacity and low capacity operations. General aviation is divided into charter, private[7] and business, and aerial work. Aerial work includes operations involving agriculture, flying training and other aerial work. The main statistical groups used in this report include:

Regular public transport

Regular public transport operations refer to commercial operations used for the purpose of transporting persons generally, or transporting cargo for persons generally. These operations are conducted for hire or reward in accordance with fixed schedules to and from fixed terminals over specific routes with or without intermediate stopping places between terminals[8].

7 Aircraft being operated with the experimental designation are included in the private category for recording and analysis purposes.

8 CAR 206 (1) (c) and CAR 2 (7) (c).

- ***High capacity RPT***

Regular public transport operations conducted in high capacity aircraft. A high capacity aircraft refers to an aircraft that is certified as having a maximum capacity exceeding 38 seats or a maximum payload exceeding 4,200 kg[9].

- ***Low capacity RPT***

Regular public transport operations conducted in aircraft other than high capacity aircraft. That is, aircraft with a maximum capacity of 38 seats or less, or a maximum payload or 4,200 kg or below[10]. The ATSB refers to these aircraft as low capacity aircraft.

General aviation

'General aviation' is defined as all non-scheduled civil flying activity other than RPT and sport aviation operations. General aviation operations can be further divided into commercial and non-commercial operations. General aviation commercial operations include charter and aerial work. Aerial work includes, for example, flying training, agriculture operations, surveying, aerial photography, and aerial ambulance operations. Non-commercial refers to private and business operations.

- ***Charter operations***

Charter operations involve the carriage of cargo and/or passengers on non-scheduled operations by the aircraft operator, or the operators' employees, in trade or commerce, excluding regular public transport operations.

- ***Aerial work***

Aerial work operations comprise agricultural operations, flying training and other aerial work[11].

a. **Agricultural operations** - operations involving the carriage and/or spreading of chemicals, seed, fertilizer or other substances for agricultural purposes. It includes operations for the purpose of pest and disease control. Agricultural operations are a component of aerial work, but are usually separated for analysis purposes.

b. **Flying training** - flying under instruction for the issue or renewal of a license, rating, aircraft type endorsement or conversion training, including solo navigation exercises conducted as part of a course of applied flying training. Flying training is a component of aerial work, but is usually separated for analysis purposes.

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9 Civil Aviation Orders Section 82.0

10 Civil Aviation Orders Section 82.0

11 Due to the large proportion of aerial work operations associated with agricultural operations and flying training, these groups are separated for analysis. The remaining aerial work operations are referred to as 'other aerial work'.

c. **Other aerial work** - includes operations conducted for the purposes of aerial work other than 'flying training' and 'agricultural operations'. Operations classified as other aerial work include aerial operations involving surveying and photography, spotting, ambulance, stock mustering, search and rescue, towing (including glider, target and banner towing), advertising, cloud seeding, fire fighting, and coastal surveillance.

- ***Business***

Business flying is associated with a business or profession, but not directly for hire and reward.

- ***Private***

Private flying refers to flying for recreation or personal transport that is not associated with a business or profession. Test and ferry/positioning flying is not grouped under private flying. Such activity is allocated to the principle operation that is generally undertaken by the aircraft.

Sport aviation

Typically, the ATSB does not investigate and report on sport aviation accidents or incidents. For the purposes of this report, however, it was necessary to include data on sport aviation. This included sport aviation activities involving hang gliders, balloons, autogyros, gliders/sailplanes, ultralights and airships.

2.3 Accident indicators

To identify aviation industry safety trends it is necessary to use some type of measure or indicator. Previous ATSB research papers have used a number of different indicators to examine aviation safety and industry trends in Australia, including: (1) activity indicators such as hours flown, departures, and aircraft movements, (2) industry indicators relating to the year of aircraft manufacture, and (3) accident indicators such as fatal and non-fatal accidents.

Accident indicators have enabled the ATSB to examine the characteristics and safety trends of accidents, fatal accidents and fatalities in Australia. For example, the report *Aviation Safety Indicators: A report on safety indicators relating to Australian Aviation* (ATSB, 2005), used accident rates to examine the number of fatal and non-fatal accidents for the general aviation sector between 1990 and 2003. Although this report demonstrated that accident rates provide a useful approach for measuring aviation safety in Australia, the ability to compare these rates with those of other countries is less straight forward.

Comparisons of relative safety rates are difficult to determine due to the paucity of, and cost associated with, the collection of reliable exposure data. Another difficulty relates to the variation in the way that different countries define and interpret what is an aviation 'accident'. This variation can lead to different and often misleading results when conducting international comparisons.

One approach to addressing the problem of definition is to use the most widely accepted definition of an aviation accident. This definition is the one developed by ICAO and adopted by its member States, which includes the countries referred to in this report. The definition is provided in Annex 13 to the Convention on International Civil Aviation (ICAO, 2001):

- **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) a person is fatally or seriously injured as a result of:

  – being in the aircraft, or

  – direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or

  – direct exposure to jet blast,

  except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or

  b) the aircraft sustains damage or structural failure which:

  – adversely affects the structural strength, performance or flight characteristics of the aircraft, and

  – would normally require major repair or replacement of the affected component,

  except for engine failure or damage, when the damage is limited to the engine, its cowlings or accessories; or for damage limited to propellers, wing tips, antennas, tires, brakes, fairings, small dents or puncture holes in the aircraft skin; or

  c) the aircraft is missing or is completely inaccessible.

  Note 1. For statistical uniformity only an injury resulting in death within thirty days of the date of the accident is classified as a fatal injury by ICAO.

  Note 2. An aircraft is considered to be missing when the official search has been terminated and the wreckage has not been located.

The ICAO definition for an aircraft accident has been adopted by Australia and has been incorporated into ATSB investigative and data analysis processes. In this report, accidents involving a fatal injury, referred to hereafter as ‘fatal accidents’, were used as the primary measure for comparing Australia’s fatal aviation accident rates with other countries. Only fatal accidents were examined, since this provides the only really reliable data for comparing airline safety (Barnett, Abraham, & Schimmel, 1979). Furthermore, only those countries that define a fatal accident in accordance with the ICAO definition were included in the analyses.

It is also important to note that another accident indicator is hull losses. A hull loss refers to damage to a commercial airplane that is substantial and beyond economic repair, an airplane that remains missing after a search for wreckage has been terminated, or an airplane that is substantially damaged and inaccessible (Boeing, 2002). Hull loss accidents may involve either fatal or non-fatal injuries. Although hull losses are not used in this report, they are a commonly used measure for comparing worldwide accident rates, particularly for large passenger operations.

3 REVIEW OF THE LITERATURE

3.1 Literature on worldwide accident rates

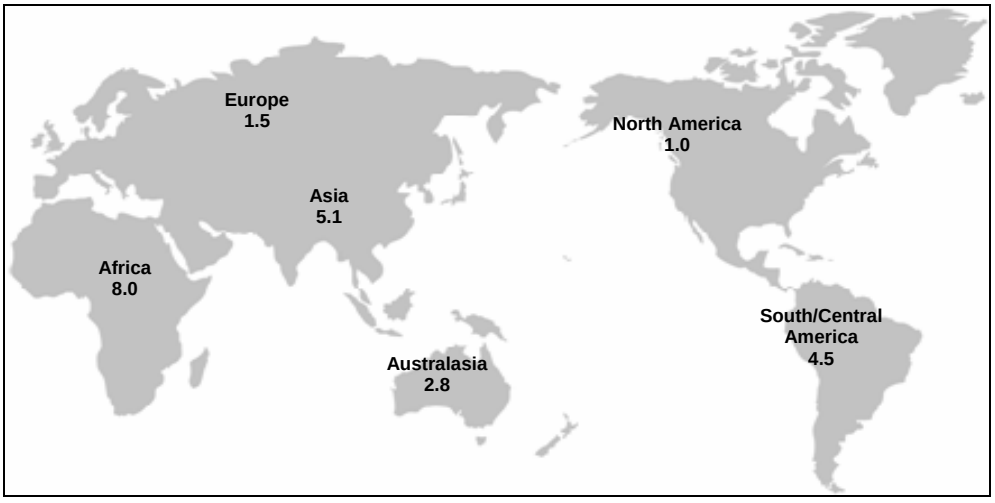
A number of aviation organisations have produced studies on worldwide accident rates. These studies provide an insight into different approaches that can be used to compare fatality rates between different regions around the world. They also highlight some of the methodological issues associated with examining world-wide accident data as an indicator of relative safety.

Global fatal accident review – UK Civil Aviation Authority (1998)

In 1998, the UK Civil Aviation Authority (CAA) published a review of global fatal accidents between 1980 and 1996 (UK Civil Aviation Authority, 1998). The review examined fatal accidents involving jet and turbo-prop aeroplanes above 5,700 kg maximum take-off weight (MTOW) and covered a range of operations, including public transport, business, commercial training and ferry/positioning flights. In total, 621 fatal accidents were identified. Fatal accident rates were calculated for the period 1991 to 1995 using airport traffic statistics for 324 airports.

The accident rate across the region of operation, as defined by Airclaims[12], was analysed (figure 2). The analysis included accidents to western-built[13] aircraft for the whole period and eastern-built[14] aircraft from 1990.

Figure 2: Fatal accidents during passenger and freight/ferry/positioning flights per million commercial ATMs by region, 1991 to 1995



Source: UK Civil Aviation Authority (1998)

12 Airclaims is an international provider of information, consultancy and claims management services.

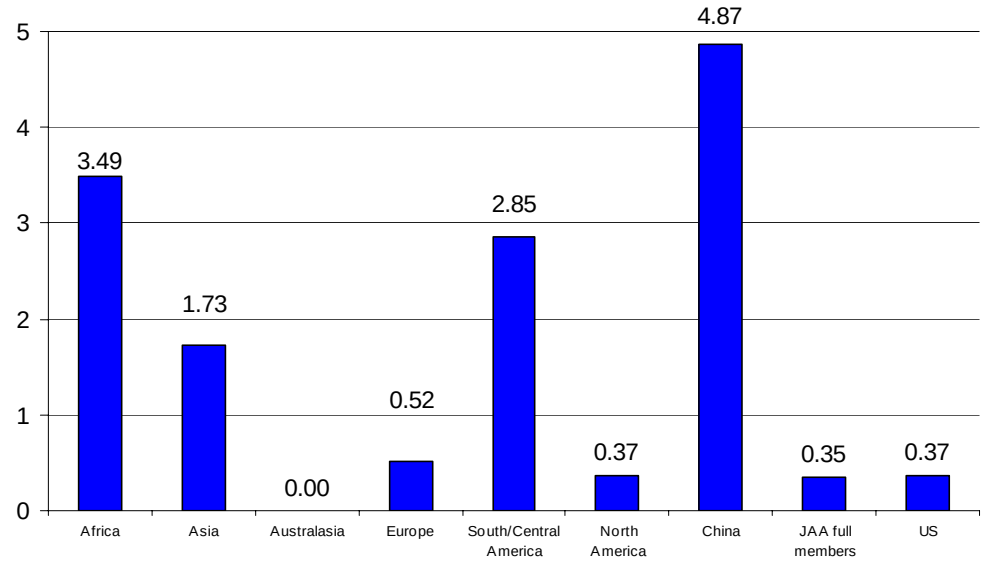
13 Western-built: The term used by various organisations and States to describe aircraft built in countries other than the Confederation of Independent States (former Soviet Union).

14 Eastern-built: The term used by various organisations and States to describe aircraft built in the Confederation of Independent States (former Soviet Union).

The report found that the highest fatal accident rate was for operators from Africa, where 8.0 accidents occurred per million commercial air transport movements (ATMs). The rate for Australasian[15] operators was 2.8.

Of the 621 fatal accidents identified, 180 were attributed to western-built jets. These accidents were examined across operator region, using the number of flights for calculating the accident rates (figure 3). The findings showed that China had the highest rate of occurrences, with 4.87 fatal accidents per million flights. Australasia had the lowest rate of occurrences, with a zero fatal accident rate per million flights.

Figure 3: Fatal accidents for western-built jets per million flights by region, 1991 to 1995



Source: UK Civil Aviation Authority (1998)

15 The countries included in the Australasia region were American Samoa, Australia, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, New Zealand, Northern Marianas Islands, Pacific Islands, Palau, Papua New Guinea, Solomon Islands, Tonga, Vanuatu and Western Samoa (UK Civil Aviation Authority, 1998).

Fatal accident rates were also calculated using passenger kilometres[16], between 1984 and 1996 inclusive. As shown in table 1, a much higher fatal accident rate was reported for African and South/Central American operators compared with operators from other regions.

Table 1: Fatal accidents per 100 billion passenger-km by region, 1984 to 1996

Region of operator	All accidents 1980-1996	Accidents during passenger flights	Accidents per 100 billion passenger-km 1984-1996
Africa	**62**	**27**	**7.16**
Asia	**117**	**79**	**1.86**
China	15	11	2.64
Rest of Asia	102	68	1.78
Australasia	**13**	**9**	**1.2**
Europe	**119**	**62**	**0.9**
JAA full members	63	35	0.78
Rest of Europe	56	27	1.13
South/Central America	**132**	**70**	**7.09**
North America	**177**	**63**	**0.37**
US	154	53	0.33
Canada/Caribbean	23	10	1.53

Source: UK Civil Aviation Authority (1998)

The UK CAA report provides a basis upon which a number of observations can be made regarding the examination of worldwide accident rates for high capacity air transport operations. Foremost, the report divided the world into different regions based on origin of operator. This provides another approach to comparing accident rates where exposure data (eg hours flown, aircraft movements) can be easily matched to the regional divisions. However, some of the geographic regions used in the UK CAA report capture quite diverse countries, with different geographic and aviation environments, and disparate accident records. For example, the diverse countries listed in footnote 15 were combined to form the Australasian region and the dissimilar countries of Canada and the Caribbean were combined to form another region.

Another observation is the extensive range of accident measures used throughout the report to examine various aspects of worldwide accident data. These included aircraft movements, number of flights, and passenger kilometres, depending on the data available. The report also made a distinction between western-built and eastern-built aircraft, with the majority of analyses excluding the latter group. Again, this approach demonstrates the limitations associated with availability of data – a limitation inherent to all cross-regional comparisons using relative accident rates.

16 A passenger kilometre is achieved when a passenger is carried one kilometre. This is calculated by multiplying the number of passengers carried on each flight stage by the stage distance (ICAO, 2006)

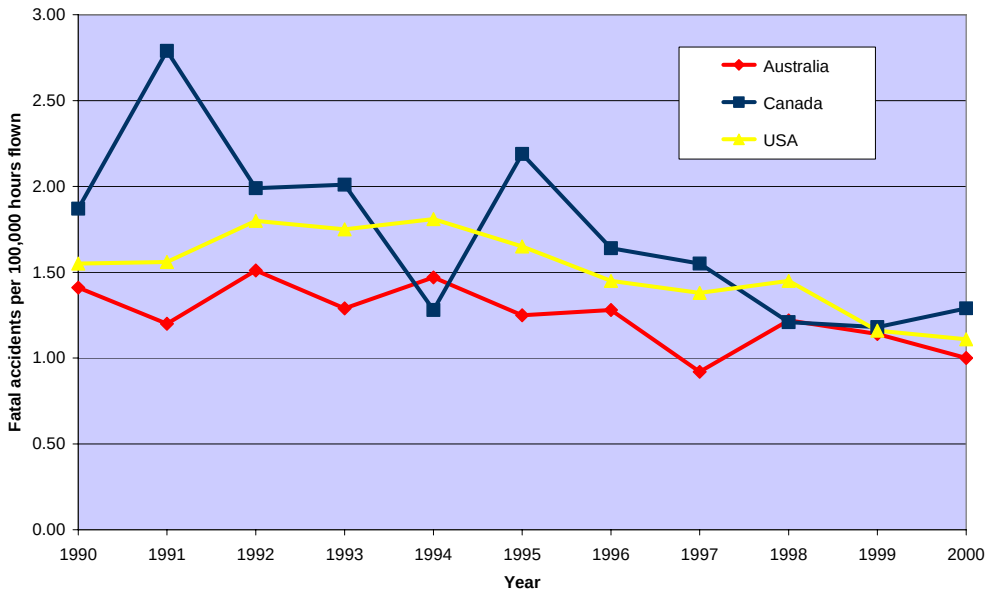
General aviation fatal accidents – ATSB (2001)

International accident data has also been used by the ATSB to compare fatal accident trends in Australia with similar trends in the US and Canada (ATSB, 2001). The analyses provided a benchmark with which to examine Australia's general aviation safety record with that of other countries. The two benchmarking measures used were fatal accidents and fatalities.

Figure 4 presents the findings for fatal accidents involving general aviation aircraft per 100,000 flight hours for 1990 to 2000. Figure 5 presents the findings for general aviation fatalities per 100,000 flight hours for 1990 to 2000. The findings indicated that:

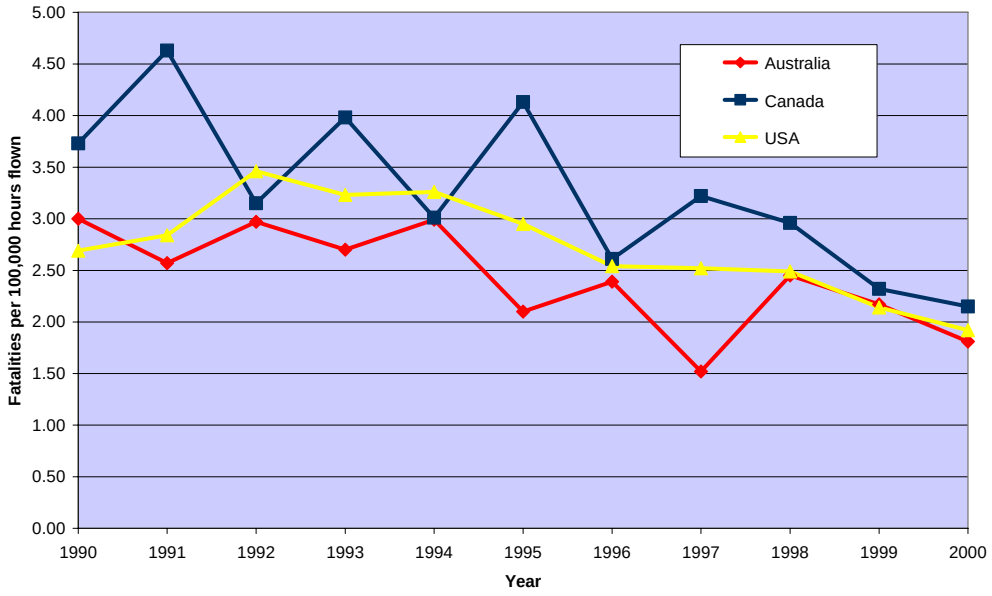
- Australia's general aviation fatal accident rate declined from 1.41 fatal accidents per 100,000 flight hours in 1990 to 1.00 fatal accidents per 100,000 flight hours in 2000[17].
- Australia's general aviation fatal accident rate per 100,000 flight hours for the year 2000 was the lowest of the three countries reported.
- Australia's general aviation fatal accident rate per 100,000 flight hours was below the Canadian and US rates for all years, except for 1994 and 1998.
- Australia's general aviation fatality rate per 100,000 flight hours was below the Canadian and US rates for all years, except for 1990 and 1999.
- The Canadian and US fatal accident and fatality rates both improved towards the end of the period examined, and were closer to Australia's rates.

Figure 4: General aviation fatal accidents per 100,000 flight hours, 1990 to 2000



17 The ATSB estimated hours flown data for the year 2000.

Figure 5: General aviation fatalities per 100,000 flight hours, 1990 to 2000



The ATSB (2001) report highlights the importance of having a common definition of an accident in order to benchmark aviation safety across the world. While the ATSB was successful in achieving this by focusing only on fatality data, the analysis was limited to the number of countries that were able to provide similar data. The analysis was also restricted to general aviation. This report extends the analysis of general aviation fatal accidents to include high capacity and low capacity air transport operations.

Accident rate comparisons - New Zealand Civil Aviation Authority

In 2002, the New Zealand Civil Aviation Authority (CAA) published a report on a comparison of accident and fatal accident rates between New Zealand and the UK, US and Australia, for the period 1990 to 2002 (Campbell, 2003). Since all nations used different criteria with which to classify aircraft operations, the authors adjusted the New Zealand data to conform with the other nations' criteria. To compare rates with Australia, the New Zealand data conformed with the ATSB's criteria for high capacity RPT and low capacity RPT operations.

The findings revealed that New Zealand had a higher number of accidents per 100,000 hours flown for high capacity air transport aircraft than Australia, between 1990 and 2002. The fatal accident rate for Australia was zero across the period, indicating that Australia has not experienced a high capacity air transport fatal accident during this time. New Zealand also had a higher number of fatal accidents per 100,000 hours flown for low capacity air transport aircraft between 1990 and 2002. Furthermore, the findings showed that New Zealand had a higher number of fatalities per 100,000 hours flown for both aircraft categories.

An important feature in this report worth noting is that in order to overcome the limitations associated with establishing comparable worldwide accident rates, the CAA re-classified the New Zealand data to match the criteria developed by the other four regions. No attempt was made to develop a single criterion upon which all four regions could be compared simultaneously.

Subsequently, all analyses presented in the report involved separate comparisons of New Zealand data with one other region. That approach has been adopted in this report.

Worldwide safety report – International Air Transport Association (2004)

The International Air Transport Association (IATA) produced an analysis of accidents involving jet and turbo-prop aeroplanes for 2004 (IATA, 2004). The report included a worldwide comparison of accident rates using hull losses per million sectors for eastern-built and western-built jets. The world was divided according to the region of operation, as defined by IATA, and comprised:

- North America
- Europe (covering Europe and the region west of the Ural Mountains)
- Far East (covering the large region east of the Ural Mountains and from Afghanistan, Pakistan, India and Sri Lanka across Asia and Australasia to Hawaii and the Easter Islands)
- South America (covering Central and South America)
- Near East (Baharin, Cyprus, Arab Republic of Egypt, Islamic Republic of Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Sultanate of Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Turkey (Anatolia only), United Arab Emirates and Yemen)

The findings indicated that the Near East experienced the highest number of hull losses per 100,000 sectors flown for both western-built jets and turbo-prop aeroplanes. North America had the lowest hull-loss rate for jets, and Europe, with a record of zero, had the lowest hull-loss rate for turbo-prop aeroplanes.

The IATA safety report provides a useful basis upon which some final observations about worldwide accident data can be made. First, the report uses hull-loss accidents for examining accident data. Although it is not possible to determine the rate of fatal accidents using this indicator, it does provide an alternative method for comparing relative worldwide safety[18].

Second, the regional divisions are very broad. It is therefore not possible to determine any detail about the rate of accidents in regard to individual States or countries. To overcome this, the regions would need to be defined according to territory or geographic location of the land mass where the accident occurred. Accident and activity data would also need to be collected and analysed within these regional parameters.

Worldwide and regional trends – ICAO (2006)

In March 2006, the Directors General of Civil Aviation Conference on a Global Strategy for Aviation Safety was held in Montreal, Canada with an emphasis on

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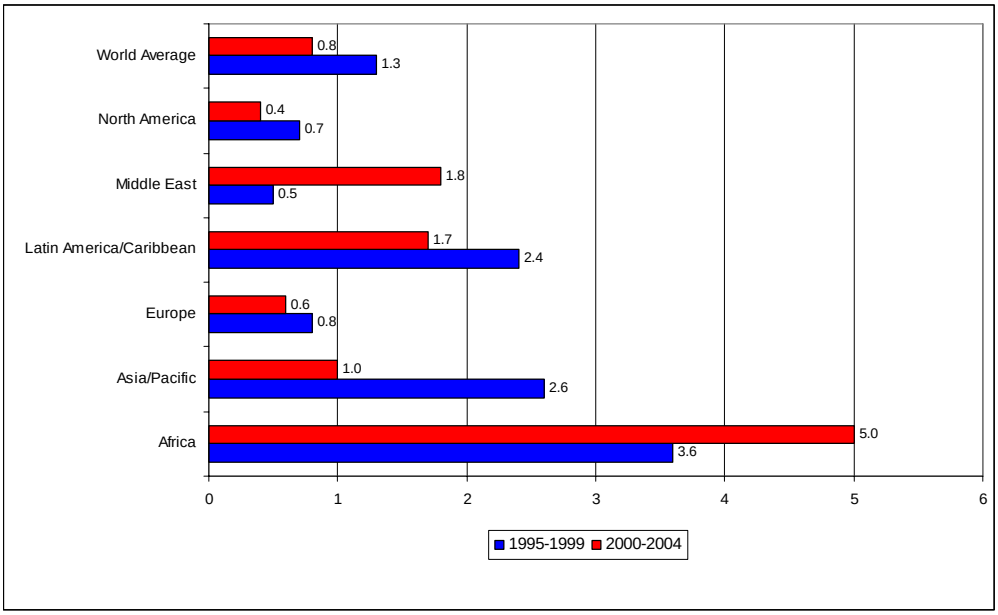
18 The use of hull loss as a measurement does not necessarily provide an indication of the severity of an accident. Older, lower value aircraft might be written off for insurance purposes if damage sustained is uneconomical to repair. Hence, relatively minor damage may be recorded as a hull loss in these circumstances. Countries with an older aircraft fleet may therefore experience more hull losses compared to countries that have a newer aircraft fleet.

improving aviation safety through the coordinated action of ICAO and its Contracting States, and the aviation industry.

The ICAO Working Paper (2006b), *Worldwide and Regional Trends in Aviation Safety*, presented at the conference, provided a comparative analysis of fatal accident rates for scheduled air transport operations across a number of regions. Due to the disparate distribution of accident figures across the regions, regional rates were calculated using 5-year averages.

Figure 6 shows the rate of fatal accidents per million departures for air transport operations involving fixed-wing aircraft over 2,250 kg by region for the reporting periods 1995 to 1999 and 2000 to 2004. Overall, the world average fatal accident rate has shown a considerable improvement in the level of aviation safety, declining from 1.3 during the 1995 to 1999 period to 0.8 for the 2000 to 2004 period. Similarly, the Asia/Pacific region has also shown a substantial improvement from 2.6 in the 1995 to 1999 period to 1.0 in the 2000 to 2004 period, slightly above the world average.

Figure 6: Fatal accidents per million departures by region for scheduled air transport fixed-wing aircraft over 2,250 kg



Source: ICAO (2006)

The significant reduction in the Asia/Pacific fatal accident rate has taken place while traffic in the region has experienced higher growth than other regions. According to ICAO, Asia/Pacific airlines carried approximately 29 per cent of the total world air traffic volumes, second to North American airlines (32 per cent) and ahead of European Airlines, which carried 27 per cent (ICAO, 2006c).

3.2 Implications for data analysis

The literature reviewed in this section highlighted the variation in approaches used by different organisations to examine and compare global accident rates. The variation stems from the lack of a widely accepted and standardised measure with

which to analyse accident data. This situation is problematic, since it may lead to international differences in the way that accident data is interpreted and classified. To address this problem, the analyses presented in this report was based on the assumption that the definition of an accident espoused by ICAO would provide the most standardised measure, and in turn, produce the most accurate results.

In addition to the issue of definition, another issue that needed to be considered concerned the extent of analyses that could be conducted. This was essentially determined by the data available. As demonstrated in the review, most worldwide comparisons report on cross-regional differences for the overall accident rate. More detailed analyses that take into consideration other factors (ie aircraft type, aircraft weight, aircraft generation, and phase of flight) are generally not considered. In this report, the most detailed examination enabled by the data available involved a comparison of Australian and New Zealand fatal accident and fatality rates in relation to the type of operation that the aircraft was conducting.

In summary, the methodological issues associated with cross-regional studies using aviation accident data suggest that careful consideration needs to be given to the statistical groupings and methods used for analysis. The analysis reported in this study was based on an assessment of these issues. It was also based on an assessment of available data. This assessment led to the decision that the most accurate approach for examining Australia's aviation fatality rates would be to conduct a number of separate comparisons with one other country. Details of the methodology used in the report are described in the following section.

Other methodological considerations and approaches are explored in the material by Barnett et al (1979, 1989, 2006), Braithwaite (2001), Duffy and Saull (2003), and Wells and Rodrigues (2004).

4 METHODOLOGY

4.1 Data sources

4.1.1 Australia

The ATSB aviation accident and incident database was searched to identify all fatal accidents involving Australian civil registered aviation aircraft from 1 January 1995 to 31 December 2004. Fatal accidents involving foreign-registered aircraft that occurred in Australian territory were excluded from the dataset. Operations involving Australian registered RPT aircraft, general aviation aircraft and sport aviation aircraft were included in the dataset. The number of hours flown for all operations was provided by the Bureau of Transport and Regional Economics.

4.1.2 United States

Information on fatal accident and fatality rates for the US was sourced from the *National Transportation Statistics 2005* (National Transportation Safety Board, 2005). This included data on all accidents involving 'air carriers' operating under Title 14, Parts 121 and 135 of the *Code of Federal Regulations* and general aviation aircraft.

The data was divided into air carrier and general aviation operations. All occurrences involving sabotage, terrorism and suicide were removed from the dataset.

4.1.3 Canada

Information on fatal accident and fatality rates for Canada was sourced from the *Statistical Summary Aviation Occurrences 2004* (Transportation Safety Board of Canada, 2004). This included all civil aviation operations excluding those involving ultralights.

4.1.4 United Kingdom

Information on fatal accident and fatality rates for the UK was sourced from the UK CAA (J.Waites, personal communication, February 18, 2006). This included data for all public transport and non-public transport operations.

4.1.5 New Zealand

Information on fatal accident and fatality rates for New Zealand was provided by the New Zealand CAA (M. Campbell, personal communication, January 13, 2006). The New Zealand CAA matched their data according to Australian operational categories defined by the ATSB.

4.2 Method of analysis

Matching the data

The dataset for Australia was matched to the dataset for the US, Canada, UK and New Zealand, taking into consideration the variation in operational definitions (table 2). This resulted in four separate datasets for Australia.

Table 2: Overseas operational definitions used to analyse the data and the equivalent definitions for Australia, as defined by the ATSB

Country	Overseas Definitions	Australian Equivalent as defined by the ATSB
US	**Air carrier** refers to US civil registered aircraft operating under 14 CFR Part 121 and 135 of the US Federal Aviation Regulations. This includes major airlines, cargo carriers, smaller commercial air carriers operating small jet and turboprop aircraft, and on-demand operations.	All **RPT** and **commercial charter** (passenger and cargo) operations involving Australian civil registered aircraft.
	General aviation predominantly refers to US civil registered aircraft operating under 14 CFR Part 91 of the US Federal Aviation Regulations. This includes aircraft flown for recreation and personal transportation and certain operations that are flown with the intention of generating revenue, including business flying, flight instruction, corporate/executive flights, positioning or ferry flights, aerial application, pipeline/powerline patrols, and news and traffic reporting. In the US, general aviation operations are conducted using a wide range of aircraft including airplanes, rotorcraft, gliders, balloons, registered ultralight, experimental aircraft and amateur-built aircraft.	All **general aviation** operations involving Australian civil registered aircraft, **with the addition of gyroplanes, gliders, balloons and ultralight** operations and the **exclusion of commercial charter** operations.
Canada	**All operational groups**, including all operations involving Canadian civil registered aircraft. This includes operations involving gliders, balloons, and gyroplanes; and excludes ultralights, hang glider and paragliders.	**All RPT, general aviation and some sport operations** (gliders/sailplanes, balloons, and gyroplanes) involving Australian civil registered aircraft.

Country	Overseas Definitions	Australian Equivalent as defined by the ATSB
UK	**Public transport** aircraft operations include the transport of passengers and/or cargo on scheduled or non-scheduled services, or other revenue services including air taxi and pleasure flights. In addition, it includes ambulance, police and search and rescue operations. **Non-public transport** aircraft operations include all operations other than public transport. This includes aerial applications, aerial survey, construction work, line inspections, club and group, business and executive, commercial operations, test, training, positioning and private flying. It does not include ambulance, police and search and rescue operations. In addition, accidents involving non-public transport aircraft with a MTOW of 5,700 kg and above were excluded due to activity data being unavailable.	All **RPT** and **commercial charter** (passenger and cargo) operations involving Australian civil registered aircraft. Ambulance, police, and search and rescue operations are not included in the Australian data. All **general aviation** operations involving Australian civil registered aircraft **with the exception of commercial charter operations**. Ambulance operations, police operations, search and rescue operations and operations involving aircraft with a MTOW of 5,700 kg are included in the Australian data. Also included are non-commercial charter operations.
New Zealand	**High capacity RPT** refers to all operations involving aircraft with 39 or more seats. This includes scheduled, unscheduled, passenger and freight operations. **Low capacity RPT** refers to all RPT operations involving aircraft with 38 seats or less. **General aviation** refers to civil aircraft used for charter, agricultural spraying, training, survey, private and business operations.	All **high capacity RPT** operations involving Australian civil registered aircraft with a maximum seating capacity exceeding 38 or a maximum payload exceeding 4,200 kg. All **low capacity RPT** operations involving Australian civil registered aircraft with a maximum seating capacity of 38 or less, or a maximum payload of 4,200 kg or below. All **general aviation** operations involving Australian civil registered aircraft.

Comparing fatal accident and fatality rates

The rates for fatal accidents and fatalities were calculated using accidents per 100,000 hours flown, for 1995 to 2004. The rates were then compared with similar fatality rates for the US, Canada, UK and New Zealand using the above definitions. This resulted in the following analyses:

Australia and US:

- Air carrier fatal accidents
- Air carrier fatalities
- General aviation fatal accidents
- General aviation fatalities

Australia and Canada:

- All fatal accidents
- All fatalities
- All fixed-wing and rotary-wing fatal accidents

Australia and UK:

- Public transport fatal accidents
- Public transport fatalities
- Non-public transport fatal accidents
- Non-public transport fatalities

Australia and New Zealand:

- High capacity RPT fatal accidents
- High capacity RPT fatalities
- Low capacity RPT fatal accidents
- Low capacity RPT fatalities
- General aviation fatal accidents
- General aviation fatalities
- General aviation fatal accidents by type of operation

4.3 Explanatory notes

- The ATSB accident and incident database is dynamic and subject to change. Recent data changes may result in differences between this report and previously published figures.

- The fatal accident rates for Australia were calculated using data for all Australian civil registered aircraft. This involved accidents that occurred in Australian and foreign territory.
- The Australian general aviation fatal accident data included one accident involving two fatalities, which occurred in 1997. The aircraft was being flown in a test for VH- certification. A VH- registration had been reserved, but the aircraft had not been VH-registered at the time of the accident.
- The most recent activity data (hours flown) available for Australian RPT and general aviation operations was for 2004.
- Data were adjusted for activity using aircraft hours flown. This was the most suitable activity data available for all categories or operation.
- Where appropriate, data were presented graphically. Linear trend lines were only included if there was a statistically significant increase or decrease in the data. Trend analyses were not performed when cell numbers were low. The *r*-square and *p* values are reported for all linear trend lines.
- Annual rates for fatal accidents and fatalities were only calculated when there was sufficient data to generate meaningful results.
- Fatality rates for the UK were unable to be matched exactly to the ATSB data. The UK data for the public transport category included ambulance, police and search and rescue operations, which were not included in the ATSB data. The UK data for non-public transport category excluded these operations, but they were included in the ATSB data. In addition, the UK data for the non-public transport category excluded aircraft over 5,700 kg, which were included in the ATSB data.

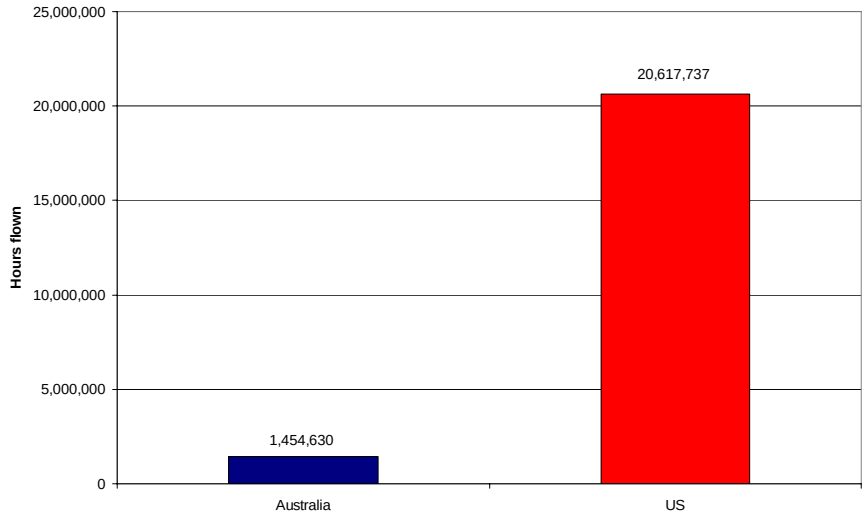
5 RESULTS

5.1 Australia and the United States

Average annual hours flown for air carriers

Figure 7 shows that the average number of hours flown annually by Australian registered air carriers[19] was 14 times less compared with US registered air carriers.

Figure 7: Average annual hours flown for Australian and US air carriers, 1995 to 2004



Number of fatal accidents and fatalities for air carriers

Table 3 shows the number of fatal accidents and fatalities for Australian and US air carrier operations between 1995 and 2004. In total, there were 26 fatal accidents involving Australian aircraft and 238 involving US aircraft during this period. The average number of fatal accidents annually during this period was three for Australia and 24 for the US. Both countries recorded the highest number of fatal accidents in 1996, with Australia recording six and the US recording 35. There were no fatal accidents for Australia in 2004. The lowest number of fatal accidents for the US was recorded in 1998 and 2002 (n = 18).

There were 86 fatalities for Australia and 1574 for the US, for 1995 to 2004. The average number of fatalities annually was nine for Australia and 157 for the US during this period.

19 For recording and analysis purposes, the ATSB includes commercial charter operations under the general aviation statistical grouping. For the purposes of this report, commercial charter operations have been included with RPT operations for the Australian and US comparative analysis (table 2 refers).

Table 3: Fatal accidents and fatalities for Australian and US air carriers, 1995 to 2004

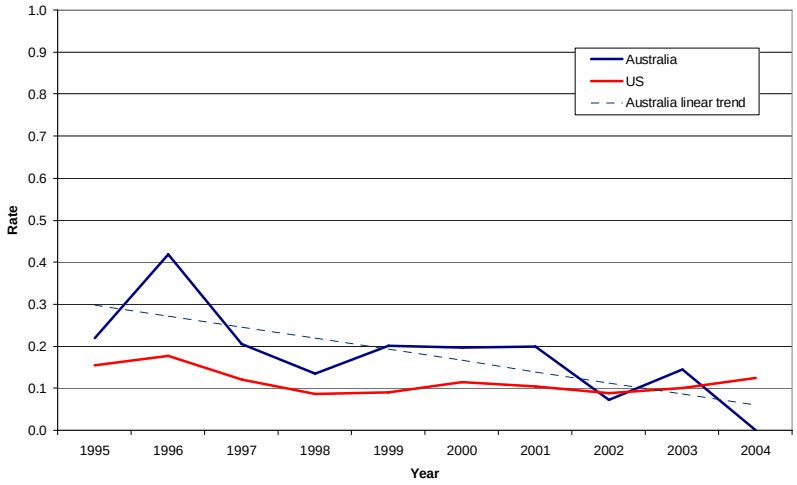
	Australia		US	
Year	Fatal accidents	Fatalities	Fatal accidents	Fatalities
1995	3	8	29	229
1996	6	13	35	457
1997	3	7	24	93
1998	2	7	18	46
1999	3	10	19	62
2000	3	18	26	168
2001	3	9	22	339
2002	1	6	18	35
2003	2	8	21	66
2004	0	0	26	79
Total	*26*	*86*	*238*	*1574*

Fatal accident rate for air carriers

Figure 8 shows the rate of fatal accidents for air carriers between 1995 and 2004. The highest rate for Australia occurred in 1996, when Australia recorded 0.4 fatal accidents per 100,000 hours flown. The highest rate for the US was in 1995 and 1996, when 0.2 fatal accidents per 100,000 hours flown occurred. The lowest rate for Australia was in 2004, when no accidents occurred. The US recorded a consistently low rate of around 0.1 fatal accidents per 100,000 hours flown from 1997 to 2004. Australia experienced a significant decline in the rate of fatal accidents during this period ($r^2 = 0.53$, $p = 0.02$).

The overall air carrier fatal accident rates for both countries are largely influenced by the higher fatal accident rates associated with commercial charter (Australia) and on-demand (United States) operational categories. In terms of activity, Australia's commercial charter operations represented 32 per cent of the total air carrier activity while scheduled airline services comprised the remainder. For the US, on-demand services represented 15 per cent of the total air carrier activity and the remainder comprised of scheduled airlines services. Hence, the considerable difference in the proportion of total air carrier activity associated with commercial charter and on-demand operations between both countries had a stronger influence on Australia's overall air carrier fatal accident rate compared to the US. If Australia's activity profile mirrored that of the US, Australia's overall fatal accident rate would fall below that of the US.

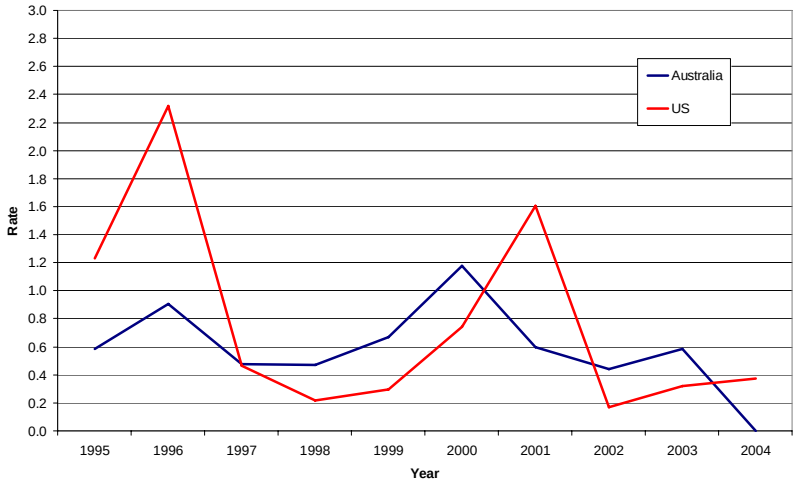
Figure 8: Fatal accidents per 100,000 hours flown for Australian and US air carriers, 1995 to 2004



Fatality rate for air carriers

Figure 9 shows the rate of fatalities for air carriers between 1995 and 2004. The highest rate for Australia was in 2000, when 1.2 fatalities occurred per 100,000 hours flown. The highest rate for the US was in 1996, when 2.3 fatalities occurred per 100,000 hours flown. The lowest rate for Australia was in 2004, when no fatalities occurred. The lowest rate for the US was in 1998 and 2002, when 0.2 fatalities occurred per 100,000 hours flown. The considerable variation in the fatality rates shown over this period is a product of the size of the aircraft involved. Fatal accidents in 1996 and 2001 in the US involved a Douglas DC-9 (ValuJet) accident on 11 May 1996 with 110 fatalities, the loss of a Boeing 747 (TWA flight 800) on 17 July 1996 with 230 fatalities and an Airbus A300 (American Airlines) accident in Bell Harbour, New York on 12 November 2001 with 260 on-board and five ground fatalities. In Australia, a Piper Chieftain (Whyalla Airlines) accident in the Spencer Gulf on 31 May 2000 resulted in eight fatalities.

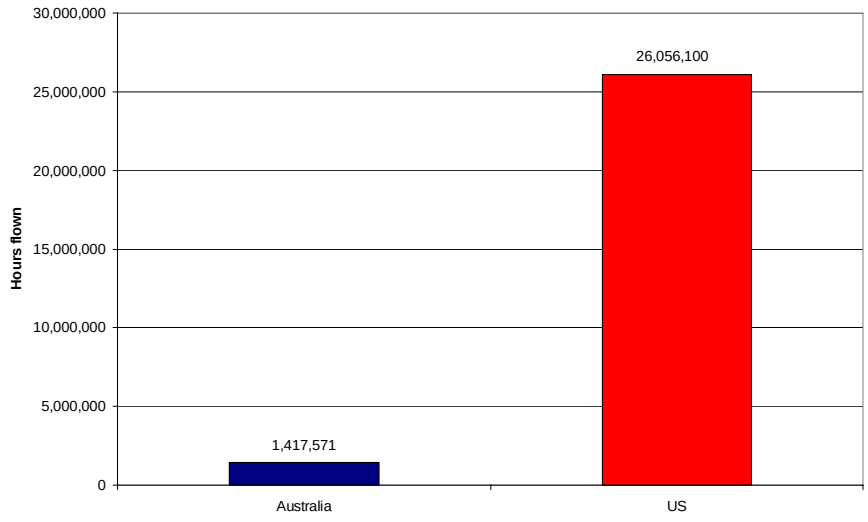
Figure 9: Fatalities per 100,000 hours flown for Australian and US air carriers, 1995 to 2004



Average annual hours flown for general aviation

Figure 10 shows that the average number of hours flown annually by Australian registered general aviation aircraft was 18 times less compared with US registered general aviation aircraft.

Figure 10: Average annual hours flown in Australian and US general aviation, 1995 to 2004



Number of fatal accidents and fatalities for general aviation

Table 4 shows the number of fatal accidents and fatalities for Australian and US general aviation between 1995 and 2004. There were 221 fatal accidents involving Australian aircraft and 3481 involving US aircraft recorded during this period. The average number of fatal accidents annually was 22 for Australia and 348 for the US. Australia experienced the highest number of fatal accidents in 1995 and 1998 (n = 28). The US recorded the highest number of fatal accidents in 1995 (n = 407). The lowest number of fatal accidents was in 2002 for Australia (n = 17) and 2004 for the US (n = 312).

There were 345 fatalities recorded for Australia and 6146 for the US between 1995 and 2004. The average number of fatalities annually was 34 for Australia and 615 for the US.

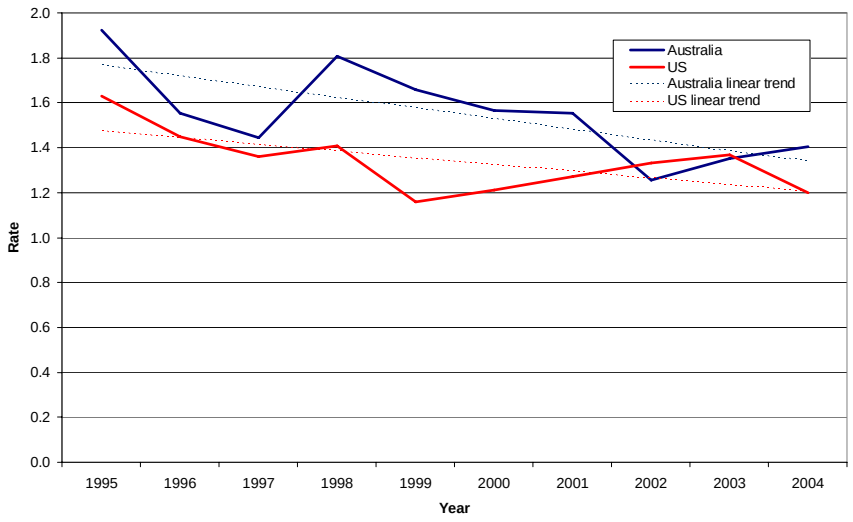
Table 4: Fatal accidents and fatalities for Australian and US general aviation, 1995 to 2004

	Australia		US	
Year	Fatal accidents	Fatalities	Fatal accidents	Fatalities
1995	28	40	407	729
1996	23	38	361	636
1997	22	30	348	629
1998	28	48	361	621
1999	25	37	339	618
2000	21	26	338	589
2001	21	34	324	561
2002	17	27	340	576
2003	18	35	351	631
2004	18	30	312	556
Total	*221*	*345*	*3481*	*6146*

Fatal accident rate for general aviation

Figure 11 shows the rate of fatal accidents for general aviation between 1995 and 2004. The highest rate for Australia was recorded in 1995, when 1.9 fatal accidents occurred per 100,000 hours flown. The highest rate for the US was in 1995, when 1.6 fatal accidents occurred per 100,000 hours flown. The lowest rate for Australia was in 2002, when 1.3 fatal accidents occurred per 100,000 hours flown. The lowest rate for the US was in 1999, 2000 and 2004, when 1.2 fatalities occurred per 100,000 hours flown. Both countries experienced a significant decline in the rate of fatal accidents during this period (Australia: $r^2 = 0.50$, $p = 0.02$; US: $r^2 = 0.42$, $p = 0.04$).

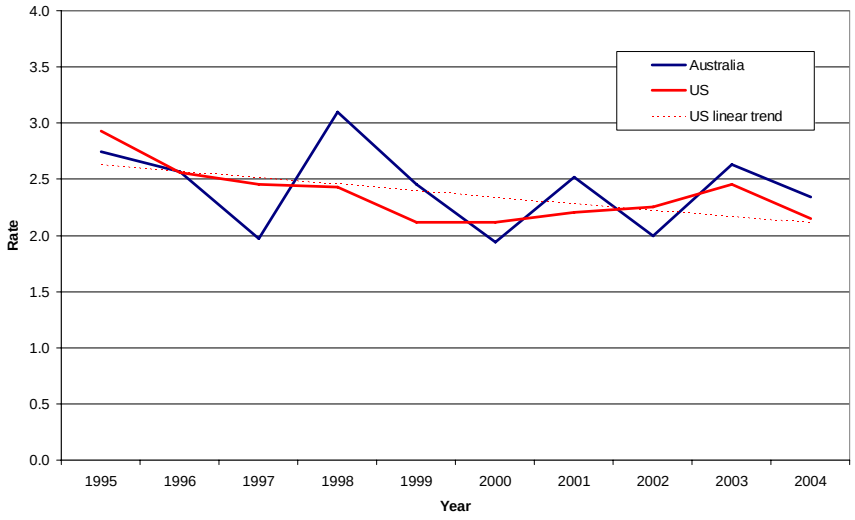
Figure 11: Fatal accidents per 100,000 hours flown for Australian and US general aviation, 1995 to 2004



Fatality rate for general aviation

Figure 12 shows the rate of fatalities for general aviation between 1995 and 2004. The highest rate for Australia was in 1998, when 3.1 fatalities occurred per 100,000 hours flown. The highest rate for the US was in 1995, when 2.9 fatalities occurred per 100,000 hours flown. The lowest rate for Australia was in 2000, when 1.9 fatalities occurred per 100,000 hours flown. The lowest rate for the US was in 1999, 2000 and 2004, when 2.1 fatalities occurred per 100,000 hours flown. The US experienced a significant decline in the rate of fatalities during this period (r^2 = 0.47, p = 0.03).

Figure 12: Fatalities per 100,000 hours flown for Australian and US general aviation, 1995 to 2004



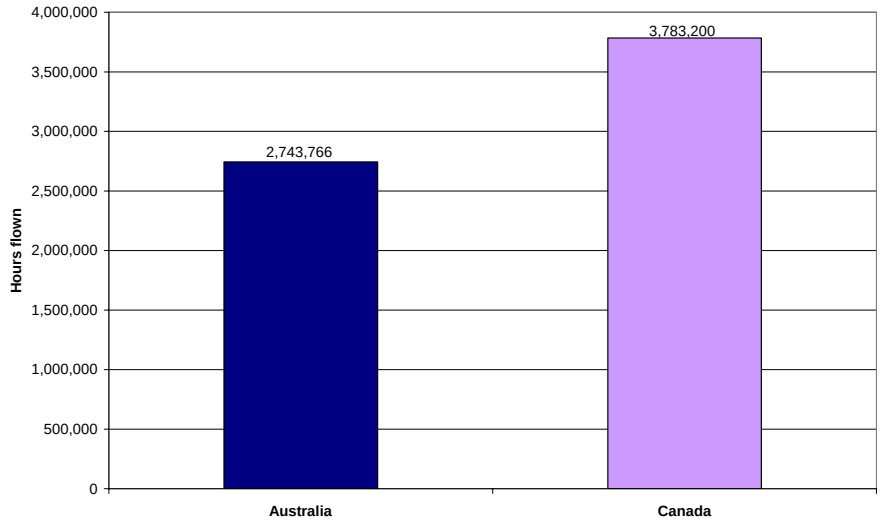
5.2 Australia and Canada

Average annual hours flown for all operations

The average number of hours flown annually by Australian registered aircraft was almost one-third (27 per cent) less compared with Canadian registered aircraft[20] (Figure 13).

20 For Canada, hours flown between 1995 and 2003 are estimated.

Figure 13: Average annual hours flown for Australia and Canada, 1995 to 2004



Number of fatal accidents and fatalities for all operations

Table 5 shows the number of fatal accidents and fatalities for Australia and Canada between 1995 and 2004. There were 208 fatal accidents involving Australian aircraft and 356 involving Canadian aircraft recorded during this period. The average number of fatal accidents annually was 21 for Australia and 36 for Canada. The highest number of fatal accidents occurred in 1999 for Australia (n = 27) and 1995 for Canada (n = 52). Both countries recorded the lowest number of fatal accidents in 2004, when 12 occurred in Australia and 24 in Canada.

There were 383 fatalities for Australia and 680 for Canada between 1995 and 2004[21]. The average number of fatalities annually was 38 for Australia and 68 for Canada.

Table 5: Fatal accidents and fatalities for Australia and Canada, 1995 to 2004

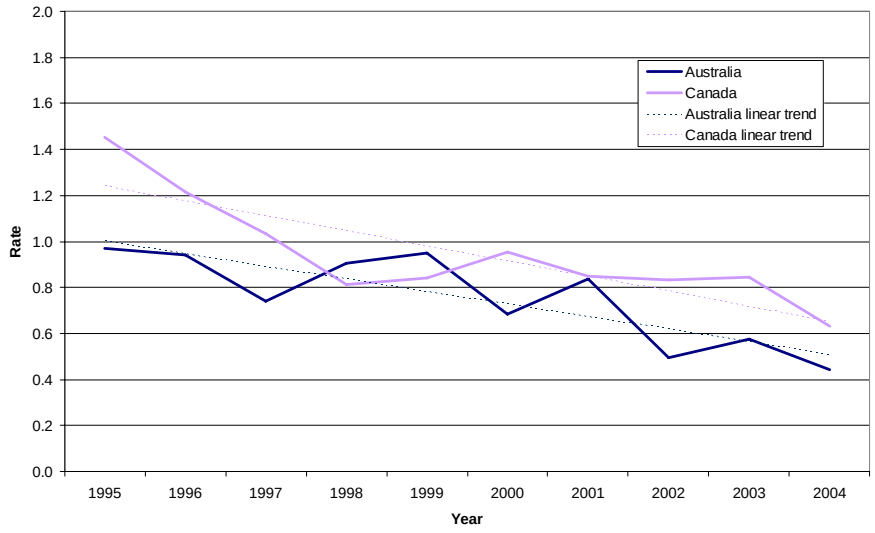
	Australia		Canada	
Year	Fatal accidents	Fatalities	Fatal accidents	Fatalities
1995	26	42	52	107
1996	26	47	44	71
1997	21	33	36	77
1998	26	49	32	87
1999	27	45	34	65
2000	19	39	38	65
2001	23	42	33	61
2002	13	28	31	51
2003	15	35	32	59
2004	12	23	24	37
Total	*208*	*383*	*356*	*680*

21 The data for Canada excludes the accident of Swissair Flight 111 on 3 September 1998 at Nova Scotia, which resulted in 229 fatalities. The aircraft, a McDonnell Douglas MD-11, was a civil registered aircraft with the Federal Office for Civil Aviation in Switzerland.

Fatal accident rate for all operations

Figure 14 shows the rate of fatal accidents for all operations between 1995 and 2004. The highest rate for Australia was in 1995 and 1999, when 1.0 fatal accidents per 100,000 hours were recorded. Canada also recorded its highest rate in 1995, with 1.5 fatal accidents per 100,000 hours flown. The lowest rate for Australia was in 2004, with 0.4 fatal accidents per 100,000 hours flown. The lowest rate for Canada was in 2004, when 0.6 fatal accidents occurred. Both countries experienced a significant decline in the rate of fatal accidents during this period (Australia: r^2 = 0.70, p = 0.00; Canada: r^2 = 0.71, p = 0.00).

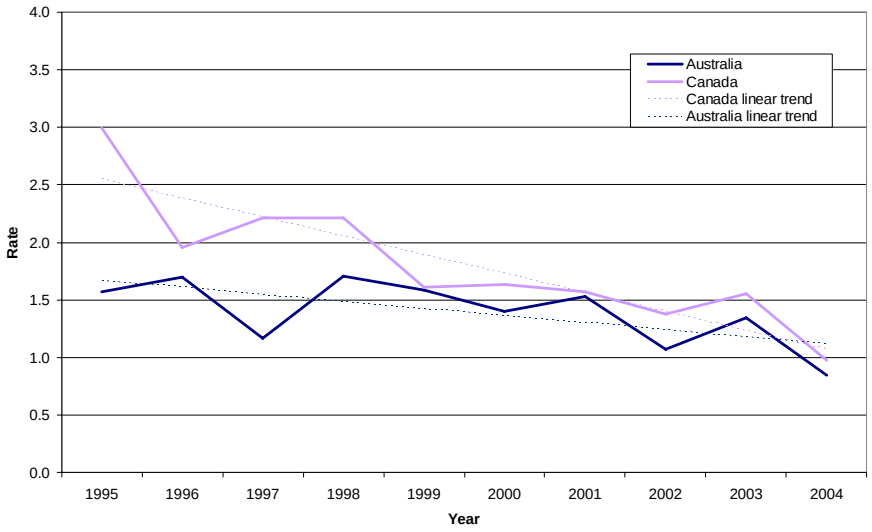
Figure 14: Fatal accidents per 100,000 hours flown for Australia and Canada, 1995 to 2004



Fatality rate for all operations

Figure 15 shows the rate of fatalities for all operations between 1995 and 2004. The highest rate for Australia was in 1996 and 1998, when 1.7 fatalities occurred per 100,000 hours flown. The highest rate for Canada was recorded in 1995, when 3.0 fatalities occurred per 100,000 hours flown. The lowest rate for both Australia and Canada was in 2004, when Australia recorded 0.8 fatalities per 100,000 hours flown and Canada recorded 1.0. Both countries recorded a significant decline in the rate of fatalities during this period (Australia: r^2 = 0.43, p = 0.04; Canada: r^2 = 0.79, p = 0.00).

Figure 15: Fatalities per 100,000 hours flown for Australia and Canada, 1995 to 2004

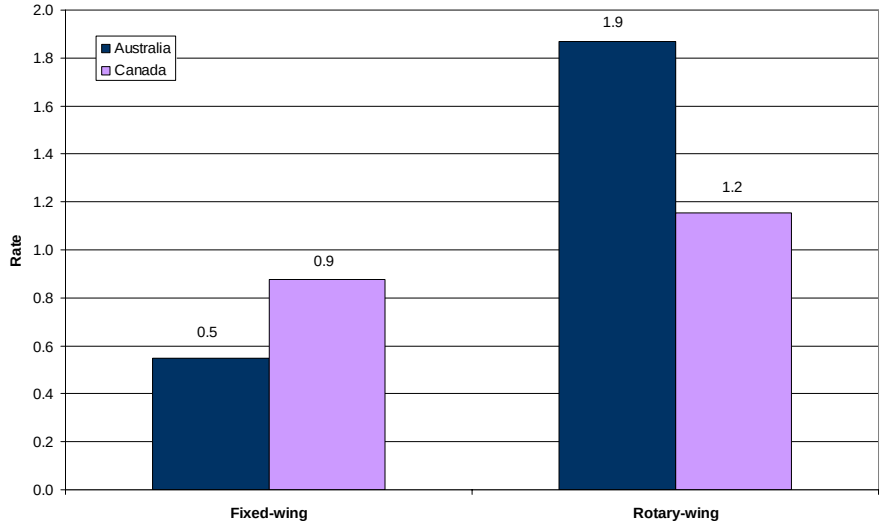


Fatal accident rate for fixed-wing and rotary-wing aircraft

Figure 16 shows the average annual rate of fatal accidents for fixed-wing and rotary-wing aircraft, between 1995 and 2004. For fixed-wing aircraft, Australia recorded 0.5 fatal accidents per 100,000 hours flown. Canada had a higher rate, with 0.9 fatal accidents per 100,000 hours flown.

For rotary-wing aircraft, Australia recorded 1.9 fatal accidents per 100,000 hours flown. Canada had a lower rate, recording 1.2 fatal accidents per 100,000 hours flown.

Figure 16: Average annual number of fatal accidents per 100,000 hours flown for fixed-wing and rotary-wing aircraft for Australia and Canada, 1995 to 2004

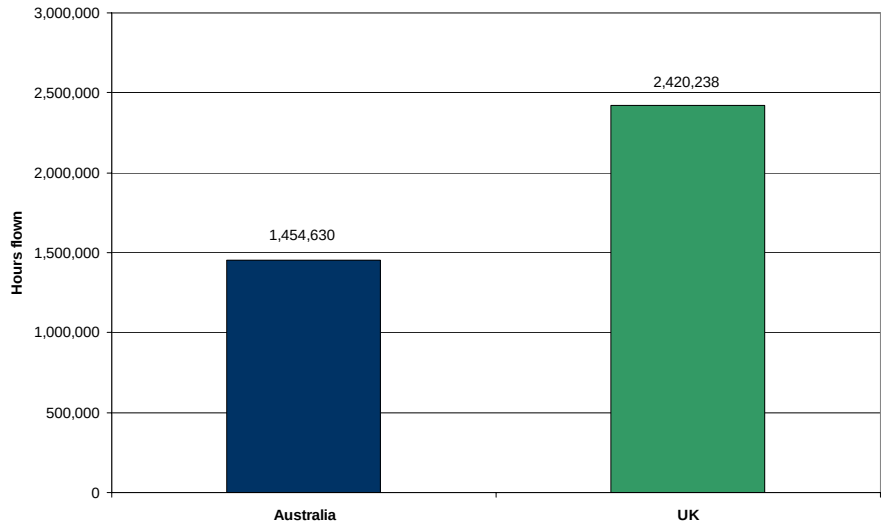


5.3 Australia and the United Kingdom

Average annual hours flown for public transport aircraft

Figure 17 shows that the average number of hours flown annually by Australian registered public transport aircraft[22] was 40 per cent less than the number recorded in the UK. The activity profiles for both countries have not been prepared as specific activity data for the UK was not available. As a result, the UK hours flown data for public transport aircraft could not be disaggregated into scheduled and non-scheduled operations. Hence, it was not possible to provide an analysis on the relative contribution of scheduled and non-scheduled services for UK public transport to the overall accident rate.

Figure 17: Average annual hours flown for Australian and UK public transport aircraft, 1995 to 2004



Number of fatal accidents and fatalities for public transport aircraft

Table 6 shows the number of fatal accidents and fatalities for public transport operations in Australia and the UK between 1995 and 2004. There were 26 fatal accidents involving Australian aircraft and 14 involving UK aircraft recorded during this period. The average number of fatal accidents annually for public transport operations was three for Australia and one for the UK. Australia experienced the highest number of fatal accidents in 1996 (n = 6), whereas the UK experienced the highest number in 1999 and 2000 (n = 3). The lowest number recorded by both countries was zero, which occurred in 2004 in Australia and in 2003 and 2004 in the UK.

22 For recording and analysis purposes, the ATSB includes commercial charter operations under the general aviation statistical grouping. For the purposes of this report, commercial charter operations have been included with public transport operations for the Australian and UK comparative analysis (table 2 refers).

In total, 86 fatalities were recorded for Australia and 55 for the UK between 1995 and 2004. The average number of fatalities annually was nine for Australia and six for the UK.

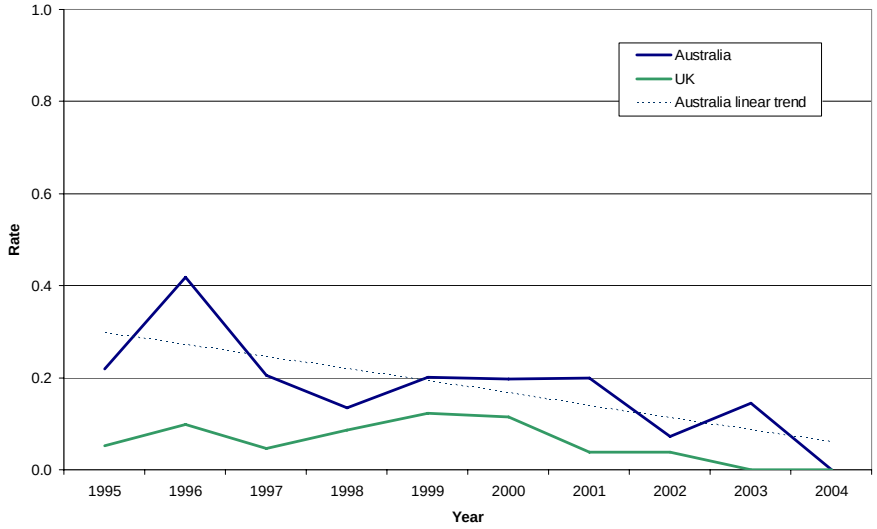
Table 6: Fatal accidents and fatalities for Australian and UK public transport aircraft, 1995 to 2004

	Australia		UK	
Year	Fatal accidents	Fatalities	Fatal accidents	Fatalities
1995	3	8	1	12
1996	6	13	2	6
1997	3	7	1	1
1998	2	7	2	4
1999	3	10	3	11
2000	3	18	3	8
2001	3	9	1	2
2002	1	6	1	11
2003	2	8	0	0
2004	0	0	0	0
Total	*26*	*86*	*14*	*55*

Fatal accident rate for public transport aircraft

Figure 18 shows the fatal accident rate for public transport operations between 1995 and 2004. The highest rate for Australia and was recorded in 1996, when Australia recorded 0.4 fatal accidents per 100,000 hours flown. The highest rate for the UK was 0.1, which occurred in 1995, 1996, 1998, 1999 and 2000. The lowest rate for Australia was in 2004, when no fatal accidents occurred. The lowest rate for the UK was in 2003 and 2004, when no fatal accidents were recorded. Australia experienced a significant decline in the rate of fatal accidents during this period ($r^2 = 0.53$, $p = 0.02$).

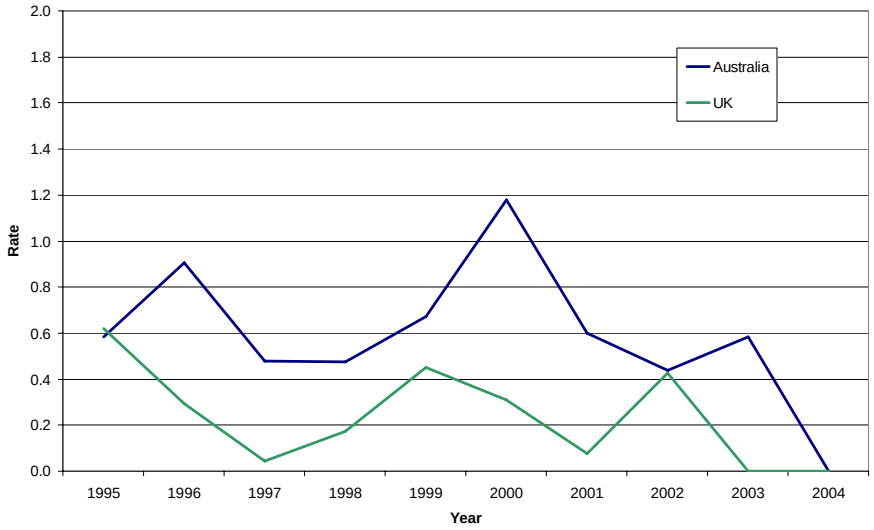
Figure 18: Fatal accidents per 100,000 hours flown for Australian and UK public transport aircraft, 1995 to 2004



Fatality rate for public transport aircraft

Figure 19 shows the rate of fatalities for public transport aircraft between 1995 and 2004. The highest rate for Australia was in 2000, when 1.2 fatalities occurred per 100,000 hours flown. The highest rate for the UK was in 1995, when 0.6 fatalities occurred per 100,000 hours flown. The lowest rate for Australia was in 2004, when no fatalities occurred. The lowest rate for the UK was in 2003 and 2004, when no fatalities were recorded.

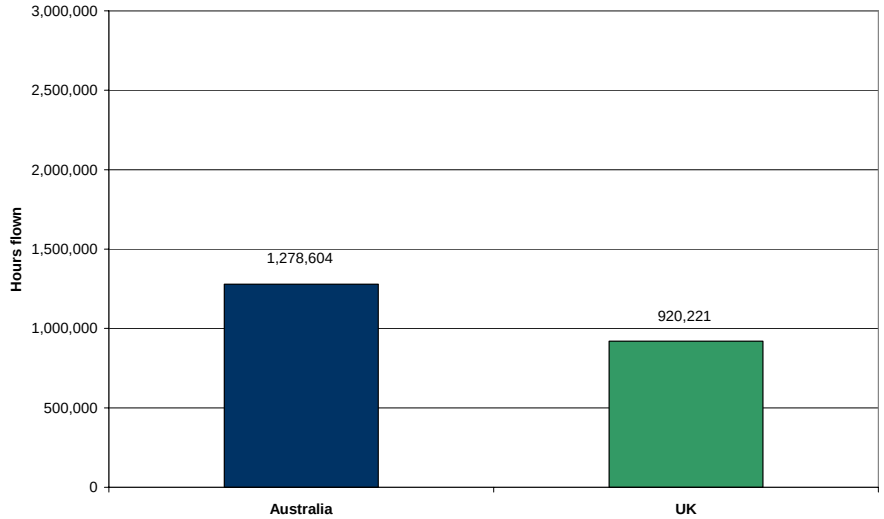
Figure 19: Fatalities per 100,000 hours flown for Australia and UK public transport aircraft, 1995 to 2004



Average annual hours flown for non-public transport aircraft

Figure 20 shows that the average number of hours flown annually by Australian registered non-public transport aircraft was more than one-third higher (39 per cent) than the average number of hours flown annually for the UK.

Figure 20: Average annual hours flown for Australian and UK non-public transport aircraft, 1995 to 2004



Number of fatal accidents and fatalities for non-public transport aircraft

Table 7 shows the number of fatal accidents and fatalities for non-public transport operations in Australia and the UK between 1995 and 2004. There were 153 fatal accidents involving Australian aircraft and 131 involving UK aircraft during this period. The average number of fatal accidents annually for non-public transport operations was 15 for Australia and 13 for the UK. Australia experienced the highest number of fatal accidents in 1998 (n = 21), whereas the UK experienced the highest number in 1996 (n = 19). The lowest number of fatal accidents for both countries occurred in 2002, with Australia recording nine and the UK recording seven.

There were 265 fatalities recorded for Australia and 222 for the UK between 1995 and 2004. The average number of fatalities annually was 27 for Australia and 22 for the UK.

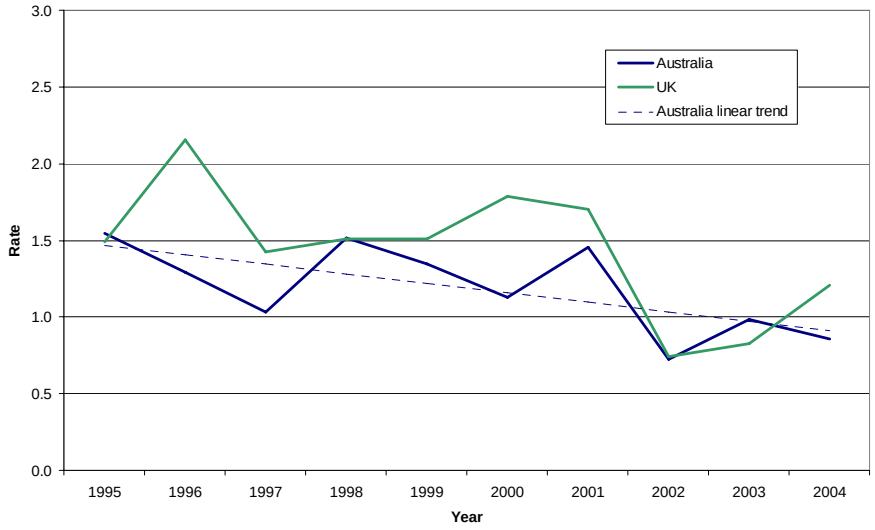
Table 7: Fatal accidents and fatalities for Australian and UK non-public transport aircraft, 1995 to 2004

	Australia		UK	
Year	Fatal accidents	Fatalities	Fatal accidents	Fatalities
1995	20	31	13	18
1996	17	30	19	33
1997	14	21	13	17
1998	21	39	14	22
1999	18	29	14	31
2000	14	19	16	29
2001	18	31	15	25
2002	9	18	7	13
2003	12	26	8	16
2004	10	21	12	18
Total	*153*	*265*	*131*	*222*

Fatal accident rate for non-public transport aircraft

Figure 21 shows the fatal accident rate for non-public transport operations between 1995 and 2004. The highest rate for Australia was recorded in 1995 and 1998, when 1.5 fatal accidents occurred per 100,000 hours flown. The highest rate for the UK was in 1996, when 2.2 fatal accidents occurred per 100,000 hours flown. The lowest rate for Australia was recorded in 2002, when 0.6 fatal accidents occurred per 100,000 hours flown. The lowest rate for the UK was in 2002, when 0.7 fatal accidents occurred per 100,000 hours flown. For a substantial period covered by this study Australia had a lower rate of fatal accidents for non-public transport aircraft. Moreover, Australia recorded a significant decline in the rate of fatal accidents over the 10 years covered by the study (Australia: $r^2 = 0.43$, $p = 0.04$).

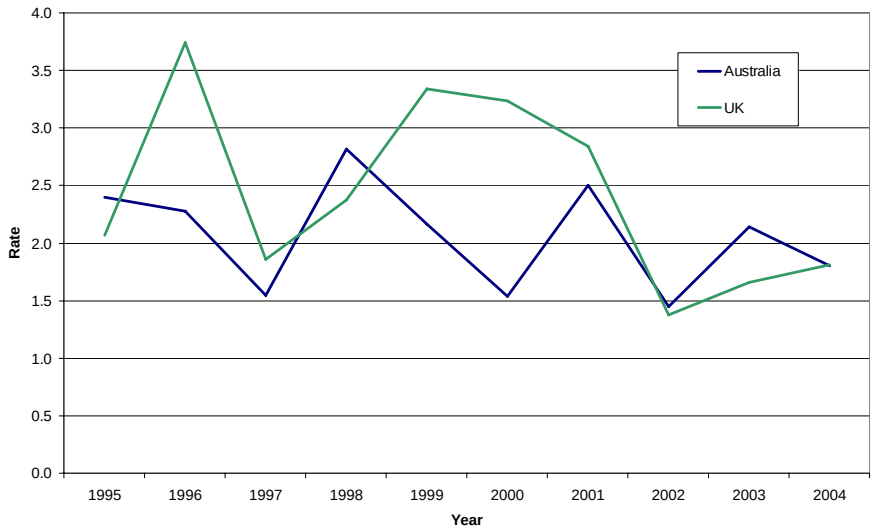
Figure 21: Fatal accidents per 100,000 hours flown for Australian and UK non-public transport aircraft, 1995 to 2004



Fatality rate for non-public transport aircraft

Figure 22 shows the rate of fatalities for non-public transport aircraft between 1995 and 2004. The highest rate for Australia was in 1998, when 2.9 fatalities occurred per 100,000 hours flown. The highest rate for the UK was in 1996, when 3.7 fatalities occurred per 100,000 hours flown. Both countries recorded the lowest rate in 2002, with Australia recording 1.3 fatalities per 100,000 hours flown and the UK recording 1.4.

Figure 22: Fatalities per 100,000 hours flown for Australia and UK non-public transport aircraft, 1995 to 2004

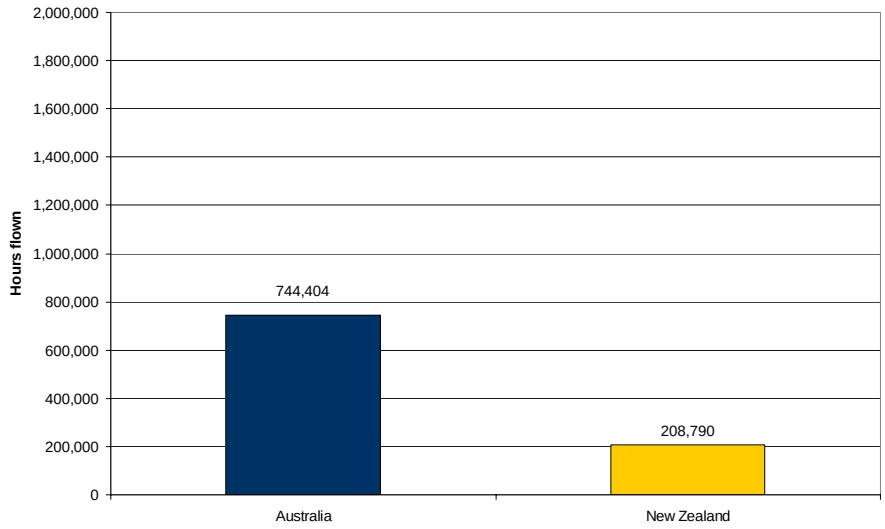


5.4 Australia and New Zealand

Average annual hours flown for high capacity RPT

The average number of hours flown annually by Australian registered high capacity RPT aircraft was more than three and a half times greater than the average number of hours flown annually for similar aircraft in New Zealand (figure 23).

Figure 23: Average annual hours flown for Australia and New Zealand high capacity RPT, 1995 to 2004



Number of fatal accidents and fatalities for high capacity RPT

Australia and New Zealand both recorded a relatively low number of fatal accidents between 1995 and 2004 (table 8). Australia recorded no fatal accidents or fatalities for this period. New Zealand recorded two fatal accidents and seven fatalities during the same period.

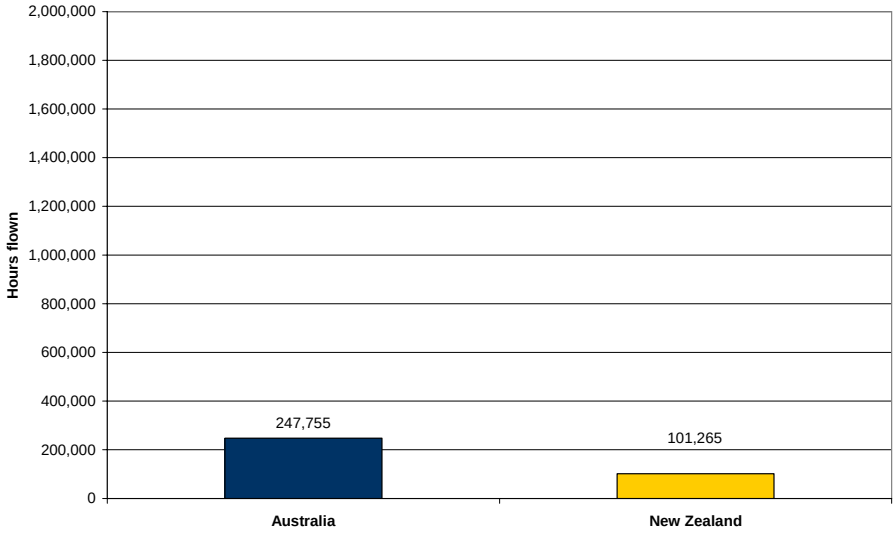
Table 8: Fatal accidents and fatalities for Australia and New Zealand high capacity RPT, 1995 to 2004

	Australia		New Zealand	
Year	Fatal accidents	Fatalities	Fatal accidents	Fatalities
1995	0	0	1	5
1996	0	0	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	0	0	0	0
2001	0	0	0	0
2002	0	0	0	0
2003	0	0	1	2
2004	0	0	0	0
Total	*0*	*0*	*2*	*7*

Average annual hours flown for low capacity RPT

The average number of hours flown annually by Australian registered low capacity RPT aircraft was almost two and a half times greater than the average number of hours flown annually for the same aircraft in New Zealand (figure 24).

Figure 24: Average annual hours flown for Australia and New Zealand low capacity RPT, 1995 to 2004



Number of fatal accidents and fatalities for low capacity RPT

Australia and New Zealand both recorded a relatively low number of fatalities between 1995 and 2004 (table 9). Specifically, Australia recorded one fatal accident, which resulted in eight fatalities, and New Zealand recorded two fatal accidents, which resulted in 10 fatalities.

The overall fatal accident rate for the period 1995 to 2004 for Australia and New Zealand was 0.04 and 0.2 respectively. The overall fatality rate was 0.32 and 1.0 for Australia and New Zealand respectively. Due to the low number of accidents for both countries, the annual fatal accident and fatality rates were not calculated.

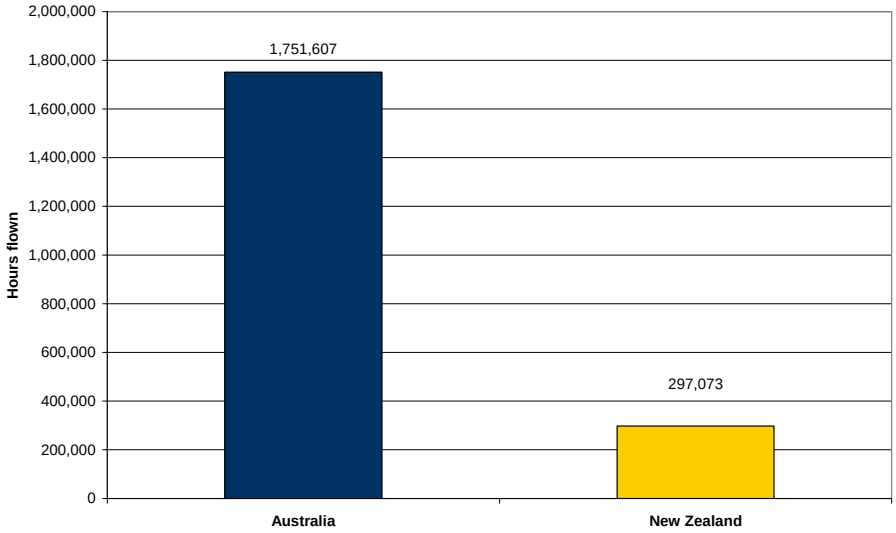
Table 9: Fatal accidents and fatalities for Australia and New Zealand low capacity RPT, 1995 to 2004

	Australia		New Zealand	
Year	Fatal accidents	Fatalities	Fatal accidents	Fatalities
1995	0	0	0	0
1996	0	0	1	5
1997	0	0	0	0
1998	0	0	1	5
1999	0	0	0	0
2000	1	8	0	0
2001	0	0	0	0
2002	0	0	0	0
2003	0	0	0	0
2004	0	0	0	0
Total	*1*	*8*	*2*	*10*

Average annual hours flown for general aviation

The average number of hours flown annually by Australian registered general aviation aircraft was almost six times greater than the average number of hours flown annually by similar aircraft in New Zealand (figure 25).

Figure 25: Average annual hours flown for Australia and New Zealand general aviation, 1995 to 2004



Number of fatal accidents and fatalities for general aviation

Table 10 shows the number of fatal accidents and fatalities for Australia and New Zealand between 1995 and 2004. There were 178 fatal accidents involving Australian aircraft and 78 involving New Zealand aircraft during this period. The average number of fatal accidents annually was 18 for Australia and eight for New Zealand. Australia recorded the highest number of fatal accidents in 1995, 1996 and 1998 (n = 23) and New Zealand recorded the highest number in 1999 (n = 10).

The lowest number of fatal accidents was recorded in 2002 and 2004 for Australia (n = 10), and in 2001 for New Zealand (n = 5).

There were 343 fatalities recorded for Australia and 153 for New Zealand for 1995 to 2004. The average number of fatalities annually was 34 for Australia and 15 for New Zealand.

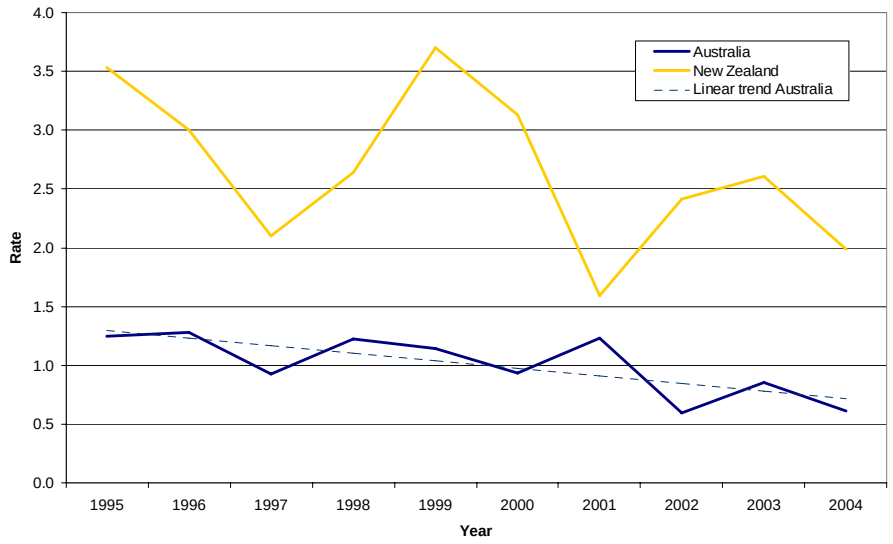
Table 10: Fatal accidents and fatalities for Australia and New Zealand general aviation, 1995 to 2004

	Australia		New Zealand	
Year	Fatal accidents	Fatalities	Fatal accidents	Fatalities
1995	23	39	9	15
1996	23	43	8	11
1997	17	28	6	12
1998	23	46	7	12
1999	21	39	10	27
2000	16	29	9	24
2001	21	40	5	6
2002	10	24	8	17
2003	14	34	9	18
2004	10	21	7	11
Total	*178*	*343*	*78*	*153*

Fatal accident rate for general aviation

Figure 26 shows the rate of fatal accidents for general aviation between 1995 and 2004. The highest rate for Australia was in 1996, when 1.3 fatal accidents occurred per 100,000 hours flown. The highest fatal accident rate for New Zealand was in 1999, when 3.7 fatal accidents occurred per 100,000 hours flown. The lowest rate was in 2002 and 2004 for Australia (n = 0.6) and 2001 for New Zealand (n = 1.6). Australia experienced a significant decline in the rate of fatal accidents during this period ($r^2 = 0.55$, $p = 0.00$).

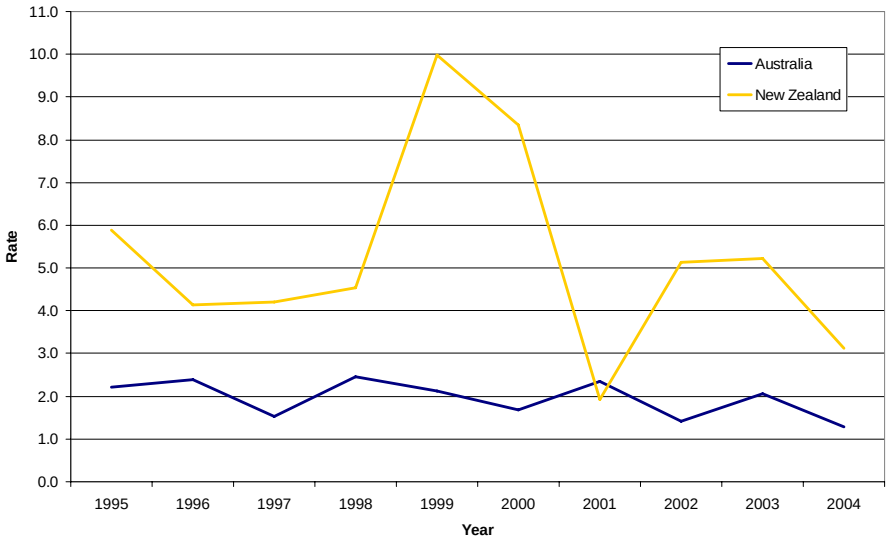
Figure 26: Fatal accidents per 100,000 hours flown for Australia and New Zealand general aviation, 1995 to 2004



Fatality rate for general aviation

Figure 27 shows the rate of fatalities for general aviation between 1995 and 2004. The highest rate for Australia was in 1996 and 1998, when 2.4 fatalities occurred per 100,000 hours flown. The highest rate for New Zealand was in 1999, when 10 fatalities occurred per 100,000 hours flown. The lowest rate for Australia was in 2004, when 1.3 fatalities occurred per 100,000 hours flown. The lowest rate for New Zealand was in 2001, when 1.9 fatalities occurred per 100,000 hours flown.

Figure 27: Fatalities per 100,000 hours flown for Australia and New Zealand general aviation, 1995 to 2004



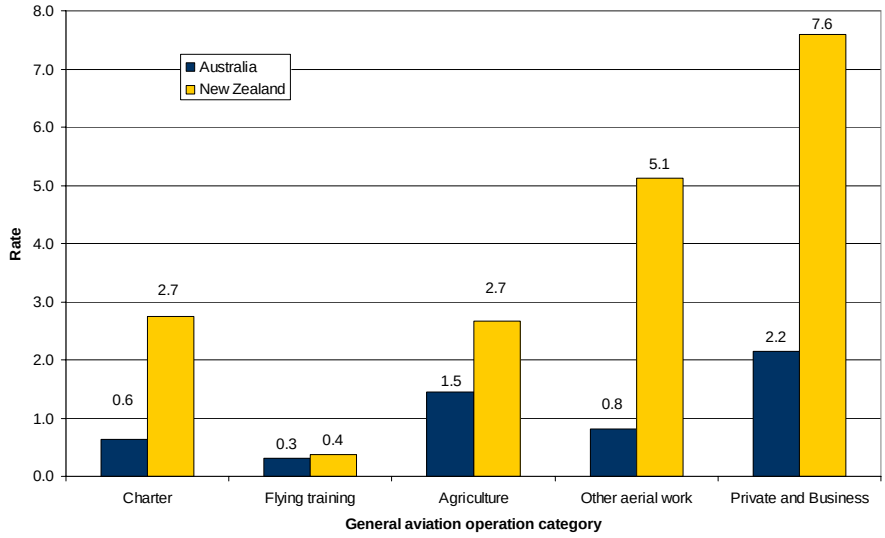
Fatal accident rate for general aviation operation categories

Figure 28 shows the average rate of fatal accidents annually for general aviation operation categories between 1995 and 2004. New Zealand recorded a higher average rate for all categories compared with Australia.

The highest average annual rate was associated with private and business operations for both Australia and New Zealand. Australia recorded an average of 2.2 fatal accidents per 100,000 hours flown annually, whereas New Zealand recorded an average annual rate of 7.6 for this category.

The lowest average annual rate was associated with flying training for both Australia and New Zealand. Australia recorded an average number of 0.3 fatal accidents per 100,000 hours flown annually. In comparison, New Zealand recorded an average annual rate of 0.4 for this category.

Figure 28: Average annual number of fatal accidents per 100,000 hours flown for Australia and New Zealand general aviation operation categories, 1995 to 2004



6 DISCUSSION

The objective of this paper was to compare Australian fatal accident rates with international data and, in doing so, provide a benchmark of aviation safety for Australia. To do this, the Australian dataset was matched with datasets established for four other countries: the US, Canada, the UK and New Zealand. North America (encompassing the US and Canada) and Europe (including the UK) were identified as having the lowest world-wide fatal accident rates for passenger and freight/ferry/positioning operations (UK CAA, 1998). Accordingly, their safety records were used as a benchmark against which Australia's performance could be assessed. The data for Australia was then compared with similar data for each of the foreign countries identified above to determine differences in the number and rate of fatal accidents and fatalities, between 1995 and 2004.

The first international comparison of fatal accident data was between Australia and the US. Two operational categories were examined, including air carrier and general aviation. For recording and analysis purposes, the ATSB includes commercial charter operations under the general aviation statistical grouping. For the purposes of this report, commercial charter operations have been included with RPT operations for the Australian and US air carrier comparative analysis (table 2 refers).

Australia had a much lower number of average annual flying hours for air carriers (see footnote 1) compared with the US (ie 14 times lower). Correspondingly, Australia recorded a much lower number of fatal accidents and fatalities than the US for this category. In relation to rates, the differences were less noticeable. Australia's rate was slightly higher than the US rate for all years, except for 2002 when it was marginally lower, and for 2004, when it declined to zero. The overall air carrier fatal accident rates for both countries are largely influenced by the higher fatal accident rates associated with commercial charter (Australia) and on-demand (United States) operational categories. In terms of activity, Australia's commercial charter operations represented 32 per cent of the total air carrier activity while on-demand services in the US represented 15 per cent. The considerable difference in the proportion of total air carrier activity associated with commercial charter and on-demand operations between both countries had a greater impact on Australia's overall air carrier fatal accident rate compared to the US. If Australia's activity profile mirrored that of the US, Australia's overall fatal accident rate would fall below that of the US. However, if Australia had one high capacity RPT fatal accident, it would have a substantial adverse impact on the comparison.

Similarly, a comparison of the general aviation category revealed a much higher number of average annual flying hours for the US compared with Australia. The higher level of activity in the US was reflected in the higher number of fatal accidents and fatalities recorded between 1995 and 2004. The rates, however, were more comparable. Both countries recorded a significant downward trend for the fatal accident rate.

The next international comparison of fatal accident data was between Australia and Canada. The data was examined for all operational categories combined (including all RPT operations, general aviation and some sports operations). Canada recorded, on average, approximately one-third more flying hours annually than Australia and recorded a higher number of fatal accidents and fatalities for all years between 1995 and 2004. Both countries recorded a significant decline in their respective fatal

accident and fatality rates, however, Australia's rates were lower than Canada's for most of the reporting period. The decline was most marked for Canada's fatality rate. This started with a relatively high rate in 1995, with three fatalities per 100,000 hours flown and decreased to less than one in 2004.

The Australian and Canadian data was further examined across the category of aircraft type. Compared with Canada, the findings showed that Australia had a lower rate of accidents involving fixed-wing aircraft, but a higher rate involving rotary-wing aircraft. The rate of fatal accidents for rotary-wing aircraft was higher than the rate for fixed-wing aircraft for both countries.

The third international comparison of fatal accident data was between Australia and the UK. The data were divided according to public transport and non-public transport operations. Australia recorded 40 per cent less average annual flying hours for public transport operations compared with the UK. Interestingly, this difference was not reflected in the number of fatal accidents or fatalities. For example, the number of fatal accidents for Australia was almost double that recorded by the UK for the period studied. Furthermore, Australia and the UK recorded no fatal accidents in 2004, but Australia recorded a higher rate of fatal accidents for all other years across the 10-year period. Australia recorded a significant decline in the rate of fatal accidents across this period. In addition, Australia recorded a higher rate of fatalities up to 2003, with both countries' rate dropping to zero in 2004.

An examination of Australian and UK non-public transport operations showed that Australia had over one-third more average annual flying hours than the UK. Australia had a higher number of fatal accidents and fatalities than the UK. However, when taking activity into account, the rate of fatal accidents and fatalities (per 100,000 hours flown) for Australia was generally lower than the UK across most of the 10-year period. However, since 2001, the UK rates declined and became closer to those recorded by Australia. Only Australia recorded a significant decline in the fatal accident rate for non-public transport operations during this period.

The final comparison of international fatal accident data was between Australia and New Zealand. The data was divided into three groups, including high capacity RPT, low capacity RPT, and general aviation. For high capacity RPT, Australia had a much higher number of average annual flying hours than New Zealand between 1995 and 2004. Overall, however, the number of fatal accidents and fatalities for both countries was very low (and therefore rates were not calculated). Australia recorded no fatal accidents or fatalities during this period and New Zealand recorded two. These included a passenger carrying de Havilland Canada DHC-8 accident in 1995 and a cargo carrying Convair 580 accident in 2003.

The number of fatal accidents for Australian and New Zealand low capacity RPT operations was also low. Australia recorded one fatal accident that occurred in 2000, when eight people were fatally injured when a Piper Chieftain aircraft crashed into the Spencer Gulf in South Australia (ATSB Report BO/200002157). New Zealand recorded two fatal accidents, which resulted in 10 fatalities.

In comparison to both high capacity RPT and low capacity RPT operations, the number of fatal accidents was considerably higher for general aviation operations for both Australia and New Zealand. Specifically, Australia recorded 178 fatal accidents and New Zealand recorded 78. The fatal accident rate for Australia,

however, was lower than that recorded for New Zealand and showed a downward trend. The fatality rate for Australia was also much lower than that for New Zealand, for all years except for 2001. It is important to note that the rate for New Zealand was influenced by the low number of fatal accidents and low activity data recorded throughout the period.

In addition, the data for general aviation was examined by the type of operation being conducted. In all operational categories, Australia recorded a lower fatal accident rate compared with New Zealand between 1995 and 2004. For both countries, the highest rate was associated with private and business operations, with New Zealand recording a rate three times higher than that of Australia. Both countries recorded the lowest rate in relation to flying training, with less than 0.5 fatal accidents per 100,000 hours flown.

Together, the comparisons of Australia's fatal accident and fatality rates with the US, Canada, UK and New Zealand provide helpful trends between 1995 and 2004. This provides a broad indicator of aviation safety for Australia. Importantly though, there are a number of population and environmental factors that may have contributed to these differences beyond a country's level of safety.

Like many other countries, Australia's system of air travel has evolved to meet the size, density and distribution of its population. In Australia, about 70 per cent of the population is concentrated in its 10 largest cities (Gibson, Benham, & Racic, 1999). These are located predominantly along the eastern seaboard and the south-eastern corner of the continent. In contrast, vast areas in the central and northern areas of Australia remain relatively unsettled due to the arid and semi-desert conditions. The extensive distances between regional localities have led to high demand for rural and regional air services. It is possible that these features may have resulted in a higher number of general aviation accidents compared with those countries requiring less 'outback' and remote area services.

There are a number of other factors that may have influenced the findings of this report. These include, for example, weather, geography, and a number of factors relating to the aviation industry. Specific industry factors include airport infrastructure, the regulatory environment, air traffic density, and the national airport and air traffic control system. The characteristics of the airline and general aviation operators, such as fleet size, aircraft type, and type of operation, may have also affected the data.

Finally, the findings may have been influenced by the methodological approach used for defining the operational categories. As discussed in the methodology (Section 4), it was not possible to match the Australian data precisely with that of other countries. It was also difficult to provide a common measure against which to benchmark aviation safety since the definition of an aviation accident varied from country to country. In an effort to address these issues, the comparison of Australian accident rates with international rates was based only on fatal accidents (as defined by ICAO), and comparisons between only two countries at a time were performed. Future analyses would benefit from the application of standardised international definitions with which to benchmark aviation safety across the world.

7 CONCLUSIONS

The comparison of fatal accident and fatality rates presented in this report provided a broad measure with which to benchmark Australia's aviation safety record between 1995 and 2004. Overall, the findings demonstrated that Australia has a good safety record, and one that is similar to those of other Western countries. Australia's fatal accident rates were comparable with those calculated for the US and Canada. Australia had a slightly better safety record in relation to UK non-public transport operations and the UK had a slightly better safety record in relation to Australian RPT operations. Australia had a better safety record in relation to all operational categories in New Zealand.

The review of Australia's aviation safety record over the past 10 years to 2004 confirms that fatal accident and fatality rates have been declining. Moreover, the decreasing fatality trends capture the relatively small number of fatal accidents and fatalities that have been reported to the ATSB in recent years. Importantly, these findings are consistent with those of previous studies, which indicate that Australia holds one of the best safety records in the world. Australia has recorded no hull losses or fatal accidents to high capacity RPT jet aircraft. Flight Safety Foundation in its paper titled *The Changing Face of Aviation Safety* reported that Australia recorded no hull loss accidents to Western built RPT jets between 1994 and 2003 with the next lowest region being North America, which recorded 0.4 hull loss accidents per million departures (Matthews, 2005). However, a single fatal accident involving a high capacity RPT jet aircraft would lead to a major worsening in Australia's international position with respect to RPT fatality rates and there is no room for complacency.

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