CofFEE

Centre of Full Employment and Equity

Prioritising safety in the allocation of Australian Aviation Rescue Fire Fighting Services (ARFFS)

Report prepared for the United Firefighters Union of Australia, Aviation Branch

Dr. Victor Quirk[1]

February 2016

The Centre of Full Employment and Equity (CofFEE) is an official research centre at the University of Newcastle, NSW, Australia.

Contact: 02-4921 7283 or coffee@newcastle.edu.au

Contents

List of Tables

List of Figures

Executive Summary

Section 1 Introduction

This study relates to issues raised in the Aviation Rescue and Fire Fighting Services Regulatory Policy Review Public Consultation Paper, released by the Department of Infrastructure and Regional Development, in December 2015 (DIRD, 2015).

The public's perception of the safety of the aviation sector is of crucial industry concern. Australia has an enviable record free of commercial airliner fatalities, despite numerous potentially disastrous incidents over the years.

Aviation is a crucially important transportation mode for connecting Australia to the world, and accounts for a significant share of the Australian economy.

Of the 190 certified airports in Australia, 28 airports have an Aviation Rescue Fire Fighting Service (ARFFS), either because they are handling more than 350,000 passenger movements per year, or because international flights land or take off from them.

ARFF is a distinct branch of firefighting, requiring specialised training and equipment to deal with aircraft accidents or airport emergencies. Their primary purpose is to maximise the survival chances of passengers and crew in aircraft accidents occurring at or near airports.

The DIRD review proposes to deregulate this area of aviation safety and constrain the future provision of ARFF services at Australian airports. This appears to have a financial motivation as it does not improve aviation safety standards.

Any valid assessment of the risks arising from the review's proposals need to place greater weight on the perspectives of those that will bear the heaviest burden of the increased risk, rather than of those that expect to gain from it. The passengers and crews involved in future aviation emergencies will bear the burden of the increased risk.

91.3% of randomly selected survey respondents over-estimated the number of airports that have ARFF in Australia, with 34% assuming they all do (Braithwaite, 2001).

Notions of 'balancing' the protection of human life with commercial profitability should not imply that these considerations carry equal weight, since by any civilised measure the two issues are incommensurable.

Australia's aviation safety reputation is a valuable national legacy that we should be nurturing and building upon, not running down in the interests of a short term, short sighted, commercial gain.

Section 2 Current institutional and regulatory framework

Australia is a member of the International Civil Aviation Organisation (ICAO). This is a United Nations specialised agency, established in 1947 following the ratification by 25 nations of the 1944 Convention on International Civil Aviation (Chicago Convention). It establishes international aviation standards that nation states can choose to adopt. These include standards to determine the establishment of ARFFs.

The Civil Aviation Safety Authority (CASA) is responsible for issuing and enforcing Civil Aviation Safety Regulations (CASR) in Australia which, along with the accompanying Manual of Standards (MoS), prescribe the required standards of airports and aviation services in Australia. Australia is generally compliant with international aviation standards as set out in the annexes of the Chicago convention, but falls significantly short of the international standard in relation to providing fire and rescue services at airports.

The Australian Transport Safety Bureau (ATSB) is the prime agency responsible for the investigation of civil aviation accidents, incidents and safety deficiencies.

Australia's civilian air traffic control (ATC) and ARFF services rest predominantly with Airservices Australia (ASA). It provides 26 airports with ARFF services, charging aircraft operators for its services.

Section 3 International Comparisons

3.1 Australia

The DIRD discussion paper offers some comparisons with the ARFF establishment / disestablishment criteria of some other countries, all of which are more generous in their service provision than Australia.

Approximately 5.1 million (3.5%) passenger movements occurred in 2014-15 at airports without a fire and rescue service available.

3.2 International comparison

3.2.1 The ICAO standards

The ICAO standard is that a certified aerodrome should have an appropriate rescue firefighting service, determined by the dimensions of the aeroplanes normally using the airport adjusted for their frequency of operations.

The standard specifies the minimum amount of extinguishing agent that an ARFF service needs to be capable of applying (in litres), and the rate it must be able to do so (litres per minute). This then implies the size and number of firefighting appliances that must be available to attend a crashed / burning aircraft.

They must be applying at least half the required extinguishing agent in 2 minutes of being told of the crash, with an absolute maximum of 3 minutes. This means services must be located at the airport.

The Australian civil aviation system is considerably at variance with the international standard. Australia gave an undertaking to review its non-compliance following an audit in 2008, yet the current review proposes to widen the extent of our non-compliance.

Empirical studies demonstrate better national aviation safety performance is associated with better compliance to ICAO standards.

3.2.2 ARFF in other countries

The review discussion paper cites examples of other countries that also depart from ICAO standards in this area, namely Canada, New Zealand, UK and the USA. Each of these applies a more rigorous standard than does Australia.

Every comparison offered in the discussion paper acknowledges that were Australia to adopt the formula used by any of these other countries, more Australian airports would be required to provide ARFFs.

Section 4 Relevant industry reviews

Senate Rural and Regional Affairs and Transport References Committee 'Airspace 2000 and Related Issues' report (2001) reviewed location specific pricing for ARFF services, and recommended: "the Government consider funding ARFF services at GA and regional airports through some degree of cross-subsidisation where a demonstrable community benefit can be shown" (SRRATRC, 2001: xv).

In November 2003, the House of Representatives Standing Committee on Transport and Regional Services published a report into hearings it held into the regional aviation sector, in which the question of the provision of ARFFs was considered. It reported:

> "The committee considered that to the extent possible, all Australians should be entitled to aviation rescue and firefighting services. It considered that location specific pricing was a blunt instrument. Furthermore, location specific pricing was inequitable and it put a different price on safety depending on location, rather than need." (STRA, 2003: 157).

It recommended a universal service charge to pay for ARFF at regional airports.

The National Commission of Audit (NCOA) was interested in Airservices Australia's assets. In its Phase One Report the Commission noted the potential to outsource some of its activities. It recommended that an independent review be undertaken with a particular focus on the scope of its activities as well as its planned capital expenditure programme. It expressed no interest in aviation safety or the performance of the agency, only in its assets.

The Aviation Safety Regulatory Review in 2013 noted the distance between Australian and ICAO standards and suggested that the trigger for establishing ARFF be reviewed, suggesting the matter of policy judgement should rest with the Department of Infrastructure and Regional Development (DIRD).

CASA has a Post Implementation Review (PIR) project AS 07/14 underway to review the manual of standards for ARFF. These projects involve consultation with the Airspace and Infrastructure users group comprising major companies, peak bodies and CASA specialist staff.

Department of Infrastructure and Regional Development (DIRD) are undertaking an Aviation Rescue and Fire Fighting Services Policy Review, (on which this report is focussed).

DIRD has been asked by the government for advice on:

- the appropriateness of current passenger traffic levels and data for the establishment and disestablishment criteria of ARFFS which currently determine whether ARFFS is required (or not required) at Australia's major airports;
- the appropriateness of requiring ARFFS at international airports where passenger traffic levels are below establishment criteria levels;
- the future use of the establishment criteria as triggers for a risk assessment of the proposed need for, or discontinuation of, the provision of ARFFS, rather than being a trigger for an automatic ARFFS requirement and what risk factors should be included as part of such a risk assessment;
- other regulatory improvements to increase ARFFS efficiency and provide potential cost savings to industry while maintaining appropriate safety standards; and
- the roles and legal responsibilities of an ARFFS provider and the state and territory fire authorities on and off airports (DIRD, 2015: 7).

The report's key proposal is to alter the threshold indicators for establishing ARFF services. It proposes to raise the current threshold of 350,000 passenger movements over the previous financial year to 500,000 per annum on a rolling month basis.

It also proposes a softening of this and the international flights criterion, so that neither automatically necessitates establishing ARFF services, but triggers a risk assessment process by CASA to determine the need for them.

Section 5 The impact of the proposed changes to thresholds

The impact of the proposed changes to the criteria for establishing / removing ARFF services will depend on the future rates of passenger movement growth at individual airports. If it is high it will delay the establishment of ARFF at several airports, if it is low it will cause the removal of existing ARFF services.

Modelling, published by BITRE in 2012, forecasts aviation traffic growth out to 2031, at an average annual growth rate of 3.7%. With the exception of Hobart, all forecast annual average growth rates over the period for which we have actual data were high.

Given the role that economic growth plays in determining demand for aviation services (hence passenger movements), and the generally pessimistic Australian and world economic outlooks widely reported for 2016-18, the weight of probability rests with there being lower passenger movement growth over the next 5 years than is predicted by the BITRE modelling.

Section 6 Do the low accident rates since the mid-90s justify diminishing our preparedness for airport emergencies and accidents?

6.1 The assertion of a cost benefit of reduced ARFF

Despite the poor level of ARFF provision at Australian airports the DIRD review proposals constitute a further departure from ICAO standards.

They assert that aviation technology is now so reliable that there is a reduced need for ARFF.

6.2 The past trend in accident rates

Accident rates fell sharply during the 1960s and 1970s from 70 per million departures to around 3-4 per million departures. There was an average of 508.2 annual jetliner fatalities from 2010 to mid-2015.

Australia has had no fatal jetliner accidents, but ATSB report a 90% rise in commercial aviation incidents and a doubling of incidents for high capacity regular passenger transport over the decade to 2013. Between 2005-2014, 12 charter flights and 2 low capacity regular passenger transport flights claimed 36 people lives, while general aviation experienced 160 accidents over the same period claiming 240 lives.

The big leaps in technological reliability were made in the 1960-70s, and we cannot expect to see significant improvements in the accident rate at this stage. With rising traffic levels the possibility exists that there will be more frequent accidents.

6.3 Factors impacting on future aviation accident rates

- Human capacity factors
- Technological complexity

- Foreign objects
- Terrorism
- Climate change
- Commercial pressure
- Aircraft life cycles

Section 7 The viability of airport risk assessments

7.1 DIRDs proposal

The review discussion paper proposes that a risk assessment be conducted once an airport reaches 500,000 passenger movements, to determine whether it warrants an ARFF. This will require it to determine the probability of an aircraft accident occurring there, and an estimate of the consequences that may arise if it does. If we do not have a reliable estimate then we may assign an inappropriate level of resources.

7.2 Modelling the probability of a rare event

An airliner crashing at an Australian airport will be a rare event, in that it hasn't happened before. Reliable estimation of the statistical probability of a rare event is prevented by the absence of a sufficiently large and appropriate reference class (set of examples) on which to base probability calculations.

In the absence of measurable experience there is greater resort to assumptions about what should be taken into account, and if these are wrong, they can have a profound effect on the result.

Modern probability methods such as Bayesian Belief Networks are specifically refuted to lend any greater validity to the modelling of rare events, nor does the resort to expert opinion.

The implicit assumption of a zero probability of a major aviation accident sits at the heart of the DIRD proposals.

7.2.1 Causal factors in aviation accidents that are not airport-related

The main causes of aviation accidents are not permanent features of airports but relate to the aircraft and crews that may be using them.

The most significant factors will be issues pertaining to the condition of the aircraft in question on the day, the condition of its crew and factors present on the day, such as wind and other environmental variables.

7.3 Anticipating the consequences of an aviation accident at a given airport

We can estimate the possible death toll of a specific type of plane crashing at a particular airport if it is not equipped with an ARFF service.

We can also surmise what long term damage the accident will do to the local economy through lost tourism, and to Australia's reputation for aviation safety.

Section 8: Determining an appropriate policy stance

8.1 Prepare for a rare catastrophic event

We can pretend it won't happen or assume it might and accept a need for firefighters at many airports, many of whom may never be called to attend a major aviation accident.

An unpredictable rare but catastrophic event is argued by Taleb (2008) to be best handled by accepting a higher level of redundancy, holding resources in reserve, foregoing their most profitable immediate short term use, and bearing higher costs, in order to maximise the chance of survival.

Protecting Australia's world-standard aviation safety record should be given a high national priority.

8.2 How we should allocate ARFF resources

The Australian government should embark on a long term program to progressively establish ICAO compliant ARFF services at all certified airports, progressively moving down the airport category scale from largest to smallest, with an immediate goal of achieving coverage to all category 10 - 6 airports. Once national coverage is established at all category 10 - 6 airports, we should establish a program to progressively develop the aviation firefighting capacity of all category 5 airports, then category 4, and so on. This may be a long term program but the direction and rate of progression should be clearly enunciated and adhered to.

These arrangements could be scaled appropriately to range from full-time permanent crews, part-time crews, retained firefighter arrangements and volunteer units, all trained and supported by the ASA or a dedicated national ARFF agency.

8.3 How should ARFF services be paid for?

Past reviews have highlighted how ARFF funding arrangements have prompted resistance to their establishment. As much as possible, the cost should fall proportionally on those who most benefit from its provision. Passengers and crews, airlines, airport operators, tourism and the broader community all derive benefit from the availability of an ARFF service.

These services should therefore be funded from a national levy on air travellers, of around seven dollars per landing at airports with ARFF which, if applied to the airports currently with an ARFF establishment, would raise about $495 million using 2014-15 annual passenger movement data. Airlines should pay the levy for their crews and non-paying passengers.

In addition to this source, the Commonwealth should provide supplemental assistance for the establishment of new services and facilities, reflecting the broader economic and strategic benefits the community derives from moving progressively toward safety compliance with the international standard.

Conclusion

The DIRD proposals constitute an intention to further diminish our compliance with ICAO standards, and lower aviation safety standards in Australia, rather than raise them as should be the function of aviation safety regulatory reform.

We cannot assume that aviation accidents will not happen nor ignore the consequences that will arise when they do.

We should value the safety legacy of the pioneers of our modern aviation services, and invest in protecting it, to preserve our international reputation for safe aviation.

In order to do this we need to make a clear determination to prioritise the safety of air passengers as so many industry spokespeople claim they do, and accept a degree of redundant resource provision, as there is no way to otherwise prepare for a rare catastrophic event.

If we are not going to install ARFF protection throughout Australia's 190 certified airports, we should mandate that the travelling public are made clearly aware of their absence.

Section 1 Introduction

This study relates to issues raised in the Aviation Rescue and Fire Fighting Services Regulatory Policy Review Public Consultation Paper, released by the Department of Infrastructure and Regional Development, in December 2015 (DIRD, 2015). The author was commissioned in January 2016 by the United Firefighters Union of Australia (UFUA) Aviation Branch, which represents the majority of Aviation Rescue Firefighters, to provide an independent analysis of the issues being raised in the review.

The public's perception of the safety of the aviation sector has always been a crucial industry concern, reflected in the strong expressions of commitment to passenger safety by all industry stakeholders, and decades of investment, research, and regulation aimed at raising and maintaining safety standards in what is an inherently risky endeavour. Millions of people now place their lives in the hands of airline operators around the world everyday, trusting that flight crews, air traffic controllers, maintenance engineers, airport staff, and regulators will perform their roles diligently and competently to minimise the risk of catastrophic accidents, and respond effectively to save lives when the inevitable accidents occur.

Australia has preserved an enviable record free of commercial airliner fatalities, despite numerous potentially disastrous incidents over the years. This is partly a legacy of the government protection the industry enjoyed, and the safety consciousness enforced by industry leaders prior to its deregulation in the late 1980s, which preserved high safety standards throughout times when commercial aircraft were less reliable and accidents more frequent around the globe (Braithwaite, 2001). With deregulation and airport privatisation, increased competition has forced greater cost rationalisation to enable lower fares to be offered which has significantly increased passenger volumes. Deregulation was accompanied by moves to make the provision of aviation safety services fully cost recoverable, which has created an incentive for some in the industry to seek their minimisation. For example, when an excise tax was placed on aviation fuel to cover the costs of the Civil Aviation Authority in the late 1980s, the general aviation sector successfully lobbied for the removal of aviation rescue firefighting services from secondary capital city airports (Archerfield, Bankstown, Essendon, Moorabbin, Parafield and Jandakot) in July 1991. Excise of Avgas was accordingly reduced from 27.395 cents per litre to 27.074 cents, less than one third of a cent (Button, 1991: 3567). Nevertheless, the statement that safety is the number one priority precedes every government and industry comment on aviation safety matters.

Aviation is a crucially important transportation mode for connecting Australia to the world, and accounts for a significant share of the Australian economy. The aviation industry directly contributed around $32 billion to Australia's GDP in 2009, while playing a critical role in supporting our $47 billion tourism industry (Oxford, 2011). Airport operations alone are estimated to contribute more than $17 billion (Deloitte, 2012: iv). Australian airports handled over 147 million Regular Public Transport passenger movements (arrivals and departures) in the 2014-15 financial year, involving around 1.5 million aircraft movements. They also handled nearly a million tonnes of international air freight and 40,000 tonnes of international airmail (BITRE, 2015). There are 190 CASA Certified aerodromes and an additional 131 smaller registered aerodromes. An aerodrome must be CASA certified if it: (a) has a runway that is suitable for use by aircraft having: (i) a maximum passenger seating capacity of more than 30 seats; or (ii) a maximum carrying capacity of more than 3 400 kilograms; and (b) is available for use in regular public transport operations or charter operations by such aircraft (CASR 139.040).

Of these 190 certified airports, 24 had more than 350,000 passenger movements in 2014-15, and 15 received international flights, namely: Adelaide, Alice Springs, Brisbane, Cairns, Christmas Island, Cocos (Keeling) Island, Darwin, Hobart, Melbourne, Norfolk Island, Perth, Port Hedland, Rockhampton, Sydney, and Townsville (BITRE, 2015). Under current Australian civil aviation safety regulations, either circumstance requires these airports to have an approved Aviation Rescue Fire Fighting service (ARFFs). Accordingly, ARFF services operate at 28 airports around the country, 26 of which are provided by Airservices Australia (ASA), a corporate entity of the Commonwealth Government, which also manages Australia's air traffic control (ATC) services. The Department of Defence provide civil aviation ARFF coverage at the Williamtown airport near Newcastle, while the Norfolk Island Administrator is responsible for ARFF at Norfolk Island airport (DIRD, 2015: 9).

ARFF is a distinct branch of firefighting, requiring specialised training and equipment to deal with aircraft accidents or airport emergencies. Their primary purpose is to maximise the survival chances of passengers and crew in aircraft accidents occurring at or near airports. The role places a premium on speed, technical knowledge, and professional discipline, owing to the presence of aviation fuel, the possible confinement of large numbers of passengers, the potential toxicity of the materials from which aircraft are made, the speed with which aircraft cabins can reach incinerating temperatures, dangers associated with pressurised cabins and tyres, explosive bolts, batteries, and the range of injuries that can arise from impact and debris in an aviation crash.

> The rupture of fuel tanks in an aircraft crash and the consequent spillage of highly volatile fuels, and other flammable liquids used by aircraft, present a high degree of probability of ignition if these liquids come into contact with hot metal parts of the aircraft or because of sparks caused by the movement of wreckage or disturbance of the electrical circuit. Fires may also occur through the discharge of accumulated electrostatic charges at the time of ground contact or during fuelling operations. An outstanding characteristic of aircraft fires is their tendency to reach lethal intensity within a very short time. This presents a severe hazard to the lives of those directly involved and can hamper rescue or evacuation efforts (ICAO, 2014: 1.1.2).

While aircraft crash rescue is their first priority, ARFF personnel also provide crucial rapid emergency response to other life-threatening situations that arise around airports, such as aviation fuel spills, because of their ability to be first to the scene of an airport emergency. So while aviation crashes are comparatively rare, Airservices Australia report that in 2014–15, their 850 ARFF staff (firefighters and others) collectively responded to 6702 incidents, including 3685 first aid calls, which directly saved 13 lives. They were called out to 107 fuel spill incidents and supported local fire brigades through 28 mutual aid calls including a number of bushfire emergencies, attending 245 events in support of local communities throughout the year (ASA, 2015: 34, 142).

We cannot know how much loss of life or damage to property may have occurred without these ARFFS interventions, since we cannot know how many of these incidents would have otherwise escalated. We cannot know how, where and when future aviation accidents and emergencies will arise, only that they will certainly arise and place human life at risk. It is disconcerting, therefore, that the discussion paper for the present review proposes to deregulate this area of aviation safety and constrain the future provision of ARFF services at Australian airports, apparently at the behest of a commercial aviation industry focused on reducing operational costs. This is because the main provider of ARFFs (Airservices Australia) operates on a full cost recovery basis, and while its pricing structure requires prior approval by the ACCC every five years, under the present criteria for ARFF establishment /

disestablishment, we are told that projected growth in passenger traffic will soon require more airports to have ARFFs, and industry are reluctant to bear these costs (DIRD, 2015).

As with other areas of competitive profit-seeking endeavour, there is a need for private interests to be constrained by legitimate sovereign authority in order to protect the interests of the broader community, and the industry itself, from a diminution in safety vigilance. Maintaining public confidence in the safety of Australian aviation is important for its own future, and that of dependent industries such as tourism, and hence the national economy. Any perception of laxity or corner-cutting in relation to safety management could have negative long-term economic consequences. On the other hand, the strengthening of Australia's commitment to aviation safety at a time of rising international tensions could have positive economic and strategic benefits that the review proposals do not appear to have considered.

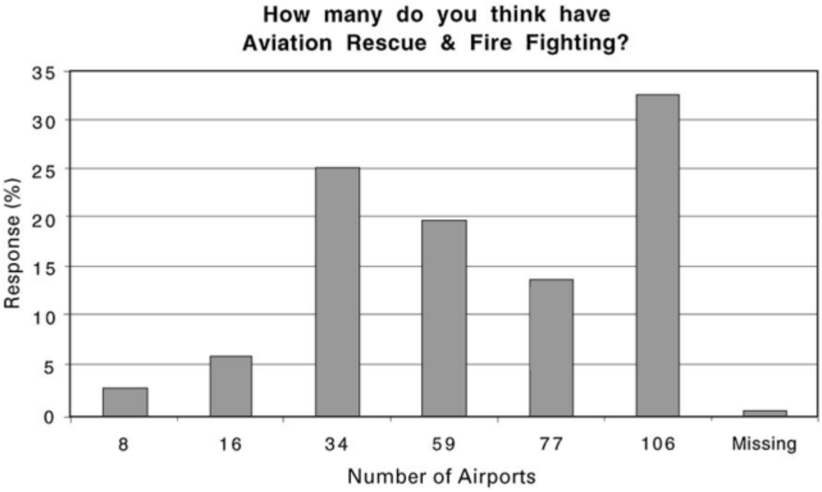
It may be the judgement of individual aviation operators, resentful of the extent and cost of regulatory compliance, that to spare themselves a service charge, they are willing to risk operating their services from airports without or with less effective aviation rescue fire-fighting protection. There can be no doubt that this is the sentiment to which the government is responding in adopting the proposals it has put forth under the current review. But while segments of the industry anticipate a financial gain from operating with more risk (i.e. less safety), any valid assessment of the risks arising from the review's proposals need to place greater weight on the perspectives of those that will bear the heaviest burden of the increased risk, rather than of those that expect to gain from it. Aircraft passengers and crews involved in future aviation emergencies, whose lives will be imperilled by the absence of capable airport fire and rescue services, will not be heard in this review process. However, can we doubt that if they could be consulted, as they are bracing for impact, or watching smoke coming out of an engine as they approach an airport, that they would strongly prefer a fully capable ARFF service to be there for them rather than not? Some might dismiss this view as unduly subjective, but these are the people who will bear the greatest burden of the risk of diminishing the coverage or capability of Australian ARFF services, not the shareholders and CEOs of aviation companies.

And while we can only conjecture that passengers in emergency situations would prefer ARFF services to be there for them, Braithwaite (2001) established in a survey of 1025 people randomly selected from around Sydney, that the Australian air travelling public greatly overestimate the extent of their provision. At that time ARFF were provided at 16 of Australia's 106 certified aerodromes. To a multiple choice question seeking their estimation of the number of airports with ARFF, 2.7% of respondents underestimated while 91.3% over-estimated, with the largest cohort (34%) indicating they presumed ARFF were at all airports (Figure 1) (Braithwaite, 2001: 114).

When supplied with pictures of aircraft and the numbers of passengers they carried, respondents were also asked: which of the following aircraft should have dedicated ARFF available at every airport it takes off from and lands at? 48.7% of respondents said the smallest plane (Piper Arrow) should only take off and land from an airport with ARFFS, and the provision of ARFF was considered necessary by more people with every increase in aircraft size (Braithwaite, 2001: 115) (See Figure 2).

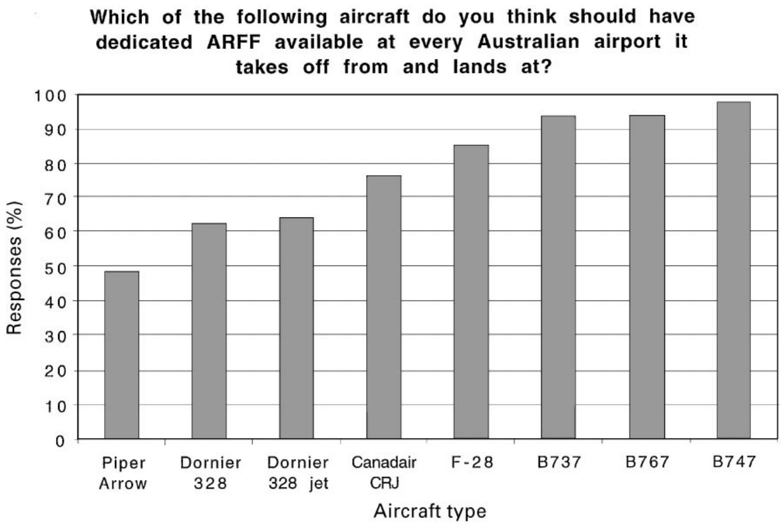
The statistical probability of an aviation accident is extremely low, far lower than the chance of an automobile accident for example, and although this point is often made people remain mindful of the risks of flying. This is thought to stem from the fact that airline passengers have less personal control of the situation: when they are driving their car, they can pull over if something goes wrong, the technology is more familiar to them and their safety does not

Figure 1: Public awareness of the availability of ARFF services.



Source: Braithwaite (2001)

Figure 2: Public sense of what aircraft warrant ARFF service



Source: Braithwaite (2001)

rest in the hands of someone they cannot even see. The potential death toll of a car accident is far less than that of a commercial airliner. Aviation accidents are prominent in our culture, reflected in the widespread media attention they attract across the globe the instant they occur, and are the subject of documentary and fictional film and television programs. And although the public's exaggerated perspective of aviation risk appears to draw the ire of risk assessment engineers and commercial operators, who view their more scientifically grounded risk estimates as more valid, we need to appreciate that it is the public's perception of the safety of aviation that keeps the industry aloft.

There is also widespread public scepticism with the ethical standards of modern private commercial enterprises across all industry sectors, and with the 'experts' they have employed to reassure the public about products, investments, trade agreements, etc., that have subsequently been exposed putting private gain ahead of the interests of the public. We shall later see that there are grounds for doubting the efficacy of applying probabilistic risk assessment modelling to allocating airport rescue and firefighting services, which would require non-transparent 'expert opinion' to determine the question. There is a significant risk that doing so would leave such assessments prone to manipulation to satisfy industry stakeholder interests at the expense of the travelling public.

Notions of 'balancing' the protection of human life with commercial profitability should not imply that these considerations carry equal weight, since by any civilised measure the two issues are incommensurable. Cost-effectiveness in safety provision does not mean that cost-cutting that increases risk or reduces safety is acceptable if it saves a lot of money. If we are to accept some risks in order to gain the personal and economic benefits of air travel, these should be diminished, not increased, by our policy interventions (such as the present review), and never increased for the reason of competition-inspired commercial cost-saving. We should also acknowledge, in the interests of national strategic interest, that Australia's aviation safety reputation is a valuable national legacy that we should be nurturing and building upon, not running down in the interests of a short term, short sighted, commercial gain.

The objective of this study is to determine whether aviation safety would be improved, unchanged, or diminished, by what is proposed in this review, and to recommend strategies for enhancing cost effective improvements to aviation safety.

Section 2 Current institutional and regulatory framework

2.1 International Civil Aviation Organisation (ICAO)

This is a United Nations specialized agency, established in 1947 following the ratification by 25 nations of the 1944 Convention on International Civil Aviation (Chicago Convention).

ICAO works with signatories to the convention on developing and monitoring compliance with international civil aviation Standards and Recommended Practices (SARPs) and policies in support of a safe, efficient, secure, economically sustainable and environmentally responsible civil aviation sector. ICAO Member States use these to ensure their local civil aviation operations and regulations conform to global norms.

'Standards and Recommended Practices for Aerodromes' were initially adopted in 1951 and are designated as ICAO Annex 14 to the Chicago Convention. Chapter 9.2 of the associated manual prescribes standards and practices for rescue and firefighting (ICAO, 1999, 2014). ICAO Document 9137-AN/898, Airport Services Manual, Part 1, Rescue and Fire Fighting provides guidance in the implementation of the Annex 14 requirements thereby helping to ensure uniform application amongst the Member States. The Civil Aviation Authority of each (Nation) State in turn publishes the corresponding regulations and guidance for their operators (SkyLibrary, 2016).

In relation to the establishment of ARFF the ICAO standard is that a certified aerodrome should have an appropriate rescue firefighting service, with a fire and rescue capability determined by the dimensions of the aeroplanes normally using the airport adjusted for their frequency of operations (ICAO, 2014: 2.1.). How the standard is intended to be applied is explained in section 3.2.1.

2.2 Civil Aviation Safety Authority (CASA)

The Civil Aviation Safety Authority (CASA) is responsible for issuing and enforcing Civil Aviation Safety Regulations (CASR) in Australia which, along with the accompanying Manual of Standards (MoS), prescribe the required standards of airports and aviation services in Australia. CASA also issues occasional Advisory Circulars (ACs) that are intended to be illustrative but not prescriptive as to how regulations might be implemented.

While Australia is generally compliant with international aviation standards as set out in the annexes of the Chicago convention, it falls significantly short of the international standard in relation to providing fire and rescue services at airports, which it has officially acknowledged and undertook to review following a critical safety oversight audit conducted by the ICAO in 2008 (ICAO, 2008).

CASR Part 139 prescribes the requirements for aerodromes used in air transport operations. Subpart 139.H specifies the requirements for the provision of aviation rescue and firefighting services (ARFFS) to aerodromes, defining minimum service standards including:

- criteria for establishment or disestablishment of ARFFS;
- provision of ARFFS outside of the criteria;
- interface arrangements with State or Territory fire brigades and other third party providers;
- quality control;
- ARFFS personnel recruitment;
- training establishments; and

- organisational requirements (CASA1, 2016).

The 139H Manual of Standards specifies detailed requirements for the provision of ARFF services, and is a disallowable instrument of the Australian Parliament, forming part of the legal regulatory framework governing the performance of ARFF services at designated (Level 1) airports (those satisfying the ARFF establishment criteria). The document also specifies standards that apply to ARFF services that other airports (Level 2) may wish to deploy, although it does not appear that these have ever been invoked (DIRD, 2015: 23).

2.3 Australian Transport Safety Bureau (ATSB)

This independent Commonwealth Government statutory authority was established under the Transport Safety Investigation Act 2003, whereby its functions were separated from CASA. Its function is to improve transport safety by receiving and assessing reports and safety information, independently investigating transport safety matters, identifying factors impacting on transport safety, communicating its findings to the transport industry and the public, and cooperate with other transport safety-related organisations (TSIA, 2003: Sect 12AA). It is the prime agency for the investigation of civil aviation accidents, incidents and safety deficiencies. Its legislative basis reflects Annex 13 (Aircraft Accident and Incident Investigation) to the Convention on International Civil Aviation (Chicago Convention 1944) which prescribes international principles for aircraft accident and incident investigation (ATSB, 2016).

2.4 Airservices Australia (ASA)

The provision of Australia's civilian air traffic control (ATC) and ARFF services rests predominantly with Airservices Australia (ASA), established under the *Air Services Act 1995* and now a corporate Commonwealth entity under the *Public Governance, Performance and Accountability Act 2013*. It was formed when the functions of the Civil Aviation Authority were split between it and CASA in 1995.

On 30 June 2015 ASA had 4493 staff in airports across Australia, with 853 engaged in delivering Aviation Rescue and Firefighting services. It manages four million aircraft movements (90 million passengers) across 11 per cent of the world's airspace (ASA 2015: 1).

Its operations include:

- en route and terminal air traffic services;
- accredited and operational training;
- aeronautical data services, such as charts and departure and approach procedures;
- management of airspace usage;
- tower services at 29 airports;
- aviation rescue firefighting services at 26 airports;
- noise complaint and information services; and
- management of Australian national air navigation infrastructure (ASA 2015: 2).

The current chair is retired Air Chief Marshal Angus Houston.

Section 9 of the Air Services Act 1995 specifies the manner in which ASA must perform its functions:

(1) In exercising its powers and performing its functions, AA must regard the safety of air navigation as the most important consideration.

(2) Subject to subsection (1), AA must exercise its powers and perform its functions in a manner that ensures that, as far as is practicable, the environment is protected from:
  (a) the effects of the operation and use of aircraft; and
  (b) the effects associated with the operation and use of aircraft.

(3) AA must perform its functions in a manner that is consistent with Australia's obligations under:
  (a) the Chicago Convention; and
  (b) any other agreement between Australia and any other country or countries relating to the safety of air navigation (GOA, 1995).

Provision of Terminal Navigation (TN), en route and ARFF services by ASA are declared services under section 95X of the Competition and Consumer Act 2010 (CCA), requiring ASA (under section 95Z) to notify the Australian Competition and Consumer Commission (ACCC) of proposed price increases in these declared services. Every five years the ACCC reviews ASA proposed pricing, consulting with stakeholders, and signs off on a five year long term pricing agreement. The ACCC determines the validity of subsequent annual price increases according to the degree to which they adhere to the current long term agreement.

The cost of ARFF services is currently charged directly to aircraft operators according to the airport, the category of the aircraft and Maximum Take Off Weight (MTOW) of the landing aircraft (Table 1).

Thus a Category 6 aircraft (because it is between 28m and 39m long) such as an Embraer ERJ 190 landing at any Australian airport with an ARFF service, having a deemed MTOW of 51.8 tonnes, would be charged $120.18. With its maximum load of 98 passengers that works out at $1.23 per passenger. To put this into perspective: the Department of Prime Minister and Cabinet's Office of Best Practice Regulation issued a guidance note in December 2014 for determining the value of a statistical life for use in policy cost benefit analysis, recommending that $4.2 million be considered the value of a statistical life, and $151,000 the value of a life year in 2014 dollars (PMC, 2014). Were a survivable accident to occur, and if by their presence the ARFF saved 90% of the aircraft's occupants, the value of their intervention would equate to a statistical life value around $370m. [1]

[1] The U.S. Department of Transportation determined in 2014 that the value of a statistical life had been previously undervalued and was closer to around US$9.2m (DOT, 2014). Were this applied to a theoretical Embraer 190 crash, the statistical life value of saving 90% of passengers would be around US$810m.

Table 1 Air Services Australia ARFF landing fee schedule effective 1 July 2015

	Aircraft Categories			
	6 (and below)	7	8	9 (and above)
ARFF Location	**$ / tonne**	**$ / tonne**	**$ / tonne**	**$ / tonne**
Adelaide	2.32	3.26	5.27	5.27
Alice Springs	2.32	2.32	2.32	2.32
Avalon	2.32	2.32	2.32	2.32
Ayers Rock	2.32	2.32	2.32	2.32
Ballina	2.32	2.32	2.32	2.32
Brisbane	2.32	2.57	3.41	6.09
Broome	2.32	2.32	2.32	2.32
Cairns	2.32	3.69	7.67	7.67
Canberra	2.32	9.08	9.08	9.08
Coffs Harbour	2.32	2.32	2.32	2.32
Darwin	2.32	5.46	21.75	21.75
Gladstone	2.32	2.32	2.32	2.32
Gold Coast	2.32	3.79	6.46	6.46
Hamilton Island	2.32	2.32	2.32	2.32
Hobart	2.32	10	10	10
Karratha	2.32	8.37	8.37	8.37
Launceston	2.32	2.32	2.32	2.32
Mackay	2.32	2.32	2.32	2.32
Melbourne	2.32	2.52	3.01	4.99
Newman	2.32	2.32	2.32	2.32
Perth	2.32	2.81	4.85	8.37
Port Hedland	2.32	2.32	2.32	2.32
Rockhampton	2.32	2.32	2.32	2.32
Sunshine Coast	2.32	2.32	2.32	2.32
Sydney	2.32	2.48	2.64	3.67
Townsville	2.32	13.64	13.64	13.64

Source: ASA(2014:16)

Section 3 International Comparisons

3.1 Australia

Whereas there are 190 CASA certified aerodromes in Australia, only 28 of these have an ARFF service[2]. Currently, under the CASR and the associated MOS, ARFFS must be provided at aerodromes:

- from or to which an international passenger air service operates; and
- any other aerodrome where the number of passenger movements has reached 350,000 in the previous financial year.

Australia has notified the ICAO that no ARFFs are available at several restricted use or designated alternate international airports with low passenger volumes, while CASA also approves of deviations from normal operational requirements of such services. This is the case for Learmonth, Lord Howe Island, Kalgoorlie, Horn Island, Christmas Island and Cocos (Keeling) Island (DIRD, 2015: 12).

The disestablishment of ARFFs is considered when the annual passenger numbers for an airport remains below 300,000 for a 12 month period, requiring the ARFFS provider to present the regulator with a safety case to justify the closure of the ARFFS (DIRD, 2015: 8).

Under this framework, ARFFs are provided at 28 airports in Australia, with Airservices the provider at 26 airports; namely Sydney, Canberra, Melbourne, Hobart, Adelaide, Perth, Darwin, Brisbane, Townsville, Cairns, Rockhampton, Mackay, Gold Coast (Coolangatta), Sunshine Coast, Launceston, Alice Springs, Ayers Rock, Avalon, Hamilton Island, Broome, Karratha, Port Hedland, Gladstone, Newman, Coffs Harbour, Ballina (DIRD, 2015: 9).

On the basis of 2014-15 regular transport passenger movement data of airports with more than 5,000 annual passenger movements, the airports with ARFF services account for roughly 96.2% of passenger movements. This means approximately 5.1 million (3.5%) passenger movements occurred in 2014-15 without a fire and rescue service available.

The DIRD discussion paper offers some comparisons with the ARFF establishment / disestablishment criteria of some other countries, all of which are more generous in their service provision than Australia. It does not provide detail on the principal international standard to which we are expected to comply, (ICAO) which places the emphasis on passenger aircraft size. It is useful to understand this framework to understand how far short of the mark Australia is falling.

3.2 International comparison

3.2.1 The ICAO standards

Australia is not unique in departing from the ICAO standards, although we appear to be more parsimonious in providing ARFFs than are other comparable countries. The ICAO standard is that a certified aerodrome should have an appropriate rescue firefighting service, determined by the dimensions of the aeroplanes normally using the airport adjusted for their frequency of operations (ICAO, 2014: 2.1).

---

[2] Certification is required of any aerodrome that has a runway suitable for use by aircraft having a maximum passenger seating capacity of more than 30 seats or a maximum carrying capacity of more than 3400 kg, and is available for use in regular public transport operations or charter operations by such aircraft (CASR, 139.040).

> The airport category should be determined by categorizing the aeroplanes using the airport, by first evaluating their over-all length and second, their fuselage width, as shown in Table 2. If after selecting the category appropriate to an aeroplane's over-all length that aeroplane's fuselage width is greater than the maximum width in column 3 for that category, then the category for that aeroplane is actually one category higher (ICAO, 2014: 2.1.2).

Under this standard, airports are categorised by counting the aircraft movements of the largest aircraft normally using the airport in its busiest consecutive three months of the year. Where these exceed 700 (over the 3 months) that determines the airport category, if it is less, then the airport is accorded the next lowest category (ICAO, 2014: 2.1.3).

During anticipated periods of low activity, the airport category may be reduced according to the size of the largest aircraft using the airport during that period (ICAO, 2014: 2.1.7), with airports where aircraft only handle cargo operations categorised according to a modified scale, that relates to the standard categories, as per Table 3. The rationale for this is that in non-passenger craft the lives at risk are expected to be confined to the area of the cockpit.

Having thus determined the size of the largest crashed and / or burning aircraft to which the airport fire and rescue service may need to respond, the standard specifies the minimum amount of extinguishing agent that it needs to be capable of applying (in litres), and the rate it must be able to do so (litres per minute). This then implies the size and number of firefighting appliances that are available to attend a crashed / burning aircraft (ICAO, 2014: 10-15).

The location of the fire service is determined by the need for the first responding vehicle to arrive at a crash and apply foam at a rate of at least 50% of the specified discharge rate for that category of airport in two minutes, with a maximum of three minutes. Other vehicles required to deliver extinguishing agents to the full prescribed rate must arrive in three minutes with a maximum of four (ICAO, 2014: 16). It is for this reason that local town fire departments, if they are not located on or immediately adjacent to the airport, are unlikely to meet the requirements of the ICAO.

Table 2 ICAO Airport Category For Rescue And Fire Fighting

Airport category	**Aeroplane over-all length**	**Maximum fuselage width**
(1)	**(2)**	**(3)**
1	0 m up to but not including 9 m	2 m
2	9 m up to but not including 12 m	2 m
3	12 m up to but not including 18 m	3 m
4	18 m up to but not including 24 m	4 m
5	24 m up to but not including 28 m	4 m
6	28 m up to but not including 39 m	5 m
7	39 m up to but not including 49 m	5 m
8	49 m up to but not including 61 m	7 m
9	61 m up to but not including 76 m	7 m
10	76 m up to but not including 90 m	8 m

Source: ICAO (2014)

Table 3 Airport category for all-cargo aeroplane

Aerodrome Category	Reclassification of aerodrome category for all-cargo aeroplanes
1	1
2	2
3	3
4	4
5	5
6	5
7	6
8	6
9	7
10	7

Source: ICAO (2014)

In order to meet these standards the standard also sets out the minimum number of vehicles (Table 4).

Table 4 Minimum number of vehicles

Airport category	RF vehicles
1	1
2	1
3	1
4	1
5	1
6	2
7	2
8	3
9	3
10	3

Source: (ICAO, 2014)

The divergence between the ICAO standards and those prescribed by Australia's Civil Aviation Safety Authority (CASA), are very clear. While criteria for establishing and disestablishing ARFF services in Australia pay no heed to the size of aircraft accessing Australia's airports, the provisioning of ARFF capability at those airports where services are established (according to passenger movement or international service criteria) do largely apply the ICAO system of determining airport categories. They clearly indicate that airport categories 1 - 5 are completely disregarded by the Australian regulatory authorities in relation to ARFF provision.

In certifying 190 airports and requiring less than 15% of them to have an appropriate rescue and firefighting capability that accords with Annexe 14 of the Chicago Convention, the Australian civil aviation system is considerably at variance with the international standard. The DIRD discussion paper asserts that there is nothing remarkable about this and that Australia meets its compliance obligations by lodging a notification of 'difference' with the standard.

Were this so acceptable, the finding of non-compliance in the 2008 ICAO Universal Safety Oversight Audit Programme (USOAP) that the CASA rules for ARFF establishment / disestablishment does not cover all the aerodromes that have to be certified need not have elicited this response from the Australian government:

> Australia has filed a difference with ICAO which reflects the current regulatory situation. However Australia is reviewing the regulatory requirements relating to RFF as contained in Part 139H. Corrective action proposed: this issue will be considered as part of the review of part 139H and any regulatory amendments necessary will be implemented through the standard Australian regulatory process. Action office: CASA. Estimated implementation date: By 31 December 2010 (ICAO, 2008: Appendix 3.8.6).

The discussion paper offered by the government to frame the review that is currently being undertaken, is not proposing to rectify Australia's non-compliance but to exacerbate it. It is relying on the fact that:

> Ultimately ICAO has a significant lack of authority to enforce its own policies. It relies on the assumption that the individual member states will do everything they can to maintain the system the way it is designed (Spence *et al*., 2015: 3).

The government's willingness to brazenly flout international standards in this important international sphere is one thing, but we need to be clear that it is not just our international reputation that is at stake. A recent empirical study into the relationship between a nation's compliance with ICAO standards and safety concluded:

> Despite the size of a state, the wealth of a state, the number of commercial aviation operations, or the number of total fatalities in a given period of time, the more compliant a particular state is with international standards coincides with a reduction in commercial airline fatalities. ICAO member states need to be informed of this research and understand what the findings suggest. The member states should make their best effort to ensure compliance with the international standards set forth by ICAO because an associated improvement in safety should result in a reduction in number of fatalities (Spence, *et al*., 2015: 7).

So while we have been fortunate in the low civil aviation accident rate in this country, it is a dangerous expression of hubris among regulators to suggest that this justifies being less compliant with the ICAO standard than we already are.

3.2.2 ARFF in other countries

The review discussion paper cites examples of other countries that also depart from ICAO standards in this area, namely Canada, New Zealand, UK and the USA. Each of these applies a more rigorous standard than does Australia. It omits reference to countries that are compliant with the ICAO, such as Singapore, India and Iran.

Canada uses 180,000 passenger movements as the threshold for establishing ARFFs. Were the same standard adopted in Australia, on the basis of 2014-15 passenger movement data, it would warrant ARFF capability established at Proserpine, Albury, Emerald, Kalgoorlie, Port

Macquarie, Mildura, Wagga Wagga, Mount Isa, Roma, Port Lincoln and Dubbo (BITRE, 2015). These eleven airports collectively accounted for 2.4 million passenger movements in 2014-15 undertaken without the presence of an aviation rescue fire service.

New Zealand requires ARFFs at airports handling 30+ seat jet turbo Regular Passenger Transport craft, or which have non-turbo jet aircraft with 30+ passenger capacity with more than 700 aircraft movements over the busiest consecutive three month period. While all Australian airports that can handle aircraft of 30+ seating capacity have to be certified, and around 30 which are without ARFF appear to average more than 700 aircraft movements per three months, the available data does not indicate whether these are movements of this size aircraft (BITRE 2015). Nevertheless, were this measure adopted we could expect at least another 10 airports to be ARFF eligible.

An application of the USA standard (airports handling aircraft with 9+ passenger capacity on scheduled services, and 30+ passenger seats on unscheduled services would also require a significant expansion of ARFFs.

The discussion paper claims that UK ARFFs provision is linked to aircraft maximum total weight (2730kg), however the UK requires all licenced aerodromes (public and private) to provide a rescue firefighting service where they are accessed by craft longer than 12m (CAA, 2014: 29, 362-3). This equates to a category 3 airport, whereas Australian ARFF provision effectively begins at category 6.

Every comparison offered in the discussion paper acknowledges that were Australia to adopt the formula used by any of these other countries, more Australian airports would be required to provide ARFFs.

Section 4 Relevant industry reviews

4.1 Airspace 2000 and Related Issues: Report by the Senate Rural and Regional Affairs and Transport References Committee (2001)

In April 2001 the Senate Rural and Regional Affairs and Transport References Committee published a report on its enquiry into several aspects of recent aviation policy, including the application of location specific pricing to the provision of ARFF services.

It noted that the introduction of location specific pricing was occasioned by a legal challenge to Airservices Australia of its right to impose network charging, that was subsequently rejected by the High Court in December 1999. The impact of LSP had been to charge considerably more to users of smaller regional airports for ARFF services, which led to pressure for removal of those services from general aviation airports.

> Prior to 1985, ARFF services were mandatory at all commercial airports in Australia which processed 150,000 passengers or more a year, and all secondary airports which processed 200,000 passengers or more a year. However, in 1985, the requirement for ARFF services at secondary airports processing 200,000 passengers or more a year was removed, resulting in a decline in the number of airports with ARFF services from 27 to 18 (SRRATRC, 2001: 35).

It heard evidence of the withdrawal of ARFFs from regional airports over the previous 20 years, including Bankstown which was at that time the busiest general aviation airport in the country. A United Firefighters Union of Australia official testified:

> ICAO, the International Civil Aviation Organisation, demands that a fire service at an airport has to respond and be at any part of the airport within three minutes, absolute maximum. The reason for that is because an aircraft is a firefighter's nightmare. It is an aluminium tube which burns quickly and breaks up easily; it is cramm packed with 100 people all sitting in tiny little seats with the very minimum of exits and surrounded by fuel (SRRATRC, 2001: 36).

The pressure to reduce ARFF from general aviation airports was acknowledged to be the consequence of location specific pricing. Consequently Recommendation 5:

> The Committee recommends that the Government consider funding ARFF services at GA and regional airports through some degree of cross-subsidisation where a demonstrable community benefit can be shown (SRRATRC, 2001: xv).

4.2 2003 House of Representatives Standing Committee on Transport and Regional Services

In November 2003, the House of Representatives Standing Committee on Transport and Regional Services published a report into hearings it held into the regional aviation sector, in which the question of the provision of ARFFs was considered (STRA, 2003: 152-158).

Industry stakeholders expressed concern with the cost of ARFF and the conditions under which it was provided. They objected to Location Specific Pricing, introduced to encourage capital investment in the event of the services being privatised, because airports with lower volumes of traffic had a disproportionately higher per passenger charge, discouraging use of the airport. Users of regional airports were paying several times the rates charged by major metro airports.

On the question of the necessity of ARFF, the committee rejected assertions by Virgin Airlines that the majority of aviation accidents do not happen near aerodromes, determining that 70% of accidents do so. In their submission, Virgin called for a risk management approach that took the probability of an accident into account rather than use of arbitrary thresholds (e.g. 350,000 passenger movements). Virgin argued that local fire services could be given responsibility to provide ARFFs.

Citing the ICAO, the committee noted about 70 per cent of aircraft crashes occur on aerodromes; of those that occur on aerodromes, 90 per cent are survivable. People on board a major aircraft that is involved in fire can survive up to four minutes; and intervention of an aviation rescue and firefighting service within the four minutes can extend that time limit allowing people on board to be rescued.

They noted a survey by UNSW in 2001 that found 75% of respondents were prepared to pay an extra $5 in their airfare to ensure ARFF services were available at airports. Airservices explained regional communities were divided over the withdrawal of ARFF, some fearing it increased the perceived risk of flying, while others considered a reduced cost may encourage RPT passengers:

> The committee considered that to the extent possible, all Australians should be entitled to aviation rescue and firefighting services. It considered that location specific pricing was a blunt instrument. Furthermore, location specific pricing was inequitable and it put a different price on safety depending on location, rather than need (STRA, 2003: 157).

Recommendation 17:

> The committee recommends that the Department of Transport and Regional Services and Airservices Australia introduce a universal service charge for aviation rescue and firefighting services at regional airports to reduce the wide disparity in the charges for those services and to reduce the overall impact of the charges on regional aviation costs (STRA, 2003: 158).

It also called for a working party to be established to consider the practicalities of co-locating local fire services in reasonable proximity to regional airports in order that these take responsibility for ARFF coverage at some airports, with Airservices Australia responsible for supplying equipment and specialised training free of charge (Recommendation 18).

Responding in May 2007, and noting the role of the ACCC in justifying ASA prices, the Howard Government responded to recommendation 17:

> Following an extensive review of ARFFS prices, the ACCC endorsed a new pricing structure on 21 December 2005, which took effect on 1 January 2006 until 30 June 2009. The new pricing structure is no longer location-specific where charges reflect the cost at each location providing an ARFFS, and where destinations with low volumes of airline activity have the highest charges. There is now an element of cross-subsidisation which has seen a significant reduction in ARFFS prices at regional and smaller airports. The prices were received favourably by regional stakeholders.
>
> The new structure is a balanced approach for dealing with the pricing inequities that existed under the full location-specific pricing policy that Airservices previously applied to ARFFS. They fulfil the Government's commitment to ensuring that Airservices' long- term pricing decisions maintain the provision of affordable aviation services including at regional and smaller airports.

> The Government remains committed to introducing contestability for the provision of aviation rescue and fire fighting services. In that regard, the Department of Transport and Regional Services has prepared a Discussion Paper for consultation with interested parties on a range of ARFFS issues including the introduction of contestability. Other issues the Paper is addressing include the most appropriate establishment criterion for the provision of ARFFS at domestic airports, who should have the primary responsibility for ensuring the provision of ARFFS, and the most appropriate timing for establishing ARFFS (GOA, 2007: 26).[3]

In response to the suggestion of locating town fire stations in the proximity of airports, and for ASA to equip them, the government responded by emphasising that it would be a matter for state and regional fire services to liaise with the airport operators about, and to take proposals to ASA if they wished, apparently dismissing a role for the Commonwealth in the matter:

> However, it is important to note that there may be a considerable cost to regional communities if the fire fighting service for a major airport was co-located to accommodate both the town and the airport. To meet aviation requirements, a combined town and airport fire service would need to be located close enough to the airport to enable it to respond in the 3-minute timeframe mandated by the Part 139H of the Civil Aviation Safety Regulations 1998, which set the standards for the provision of aviation rescue and fire fighting services. This may have safety implications for the community if the airport's distance from the town affects the fire brigade's response time (GOA, 2007: 27).

4.3 National Commission of Audit

The National Commission of Audit established by the Abbott Government in October 2013 reported in March 2014 that Airservices Australia was one of the four largest holders of Commonwealth assets, worth $1.23 billion, noting that:

> Airservices Australia owns air traffic control and landing infrastructure including 1079 buildings at 684 sites around Australia, two major centres in Melbourne and Brisbane, four terminal control units, 29 towers at international and regional airports, and aviation rescue and firefighting stations at 22 airports. Airservices also maintains a range of aviation navigation and surveillance equipment around the country.
>
> The Commission understands Airservices Australia intends to invest $1.1 billion over the period from 2013 to 2018. Ongoing investment in tower infrastructure and technology, the replacement of back-up terrestrial based navigation aids and surveillance equipment upgrades account for the majority of investment in the upcoming years and are designed to improve the efficiency and safety of air transport.

[3] The thirst for privatising assets that generate net income and deliver services that the public would prefer to not be conducted on a profit seeking basis had evidently abated when on September 30, 2013, the Australian reported that Malcolm Turnbull and Warren Truss, ministers for Communications and Transport respectively, had ruled out the possibility of assets for which they were responsible being considered for privatisation. In particular: "A spokesman for Mr Truss, the Nationals leader and Transport and Infrastructure Minister, was adamant that Air Services Australia would remain a government-owned entity. 'We have not and are not considering the privatisation of these assets,' he said" (The Australian, 30/9/2013: 8).

> Future investments also include replacing and upgrading Airservices Australia's core air traffic management system, which will reach its end of life in the second half of the decade (NCOA2, 2014: 9-10).
>
> Airservices Australia retains an essential role in air traffic control and aeronautical safety. In its Phase One Report the Commission noted the potential to outsource some of its activities. Further to this, the Commission considers that an independent review be undertaken of the organisation with a particular focus on the scope of its activities as well as its planned capital expenditure programme (NCOA2, 2014: 93).

Consequently, recommendation 15 part D of the phase two report was that:

> an independent review be undertaken of Airservices Australia with a particular focus on the scope of its activities as well as its planned capital expenditure programme (NCOA2, 2014: xxvi).

It is noteworthy that the NCOA did not report that they were interested in exploring outsourcing or privatisation of aviation rescue firefighting services in order to improve aviation safety, nor did they state they were motivated by doubts as to the quality or capability of the ASA ARFF service to effectively perform this role. Their only concern was with the market value of the fire engines, garages, observation towers, communications equipment, etc., that are used to do ARFF work. Selling the service off was therefore viewed as a way for a government to transfer assets and a profitable net revenue stream to a private operator, generate income for the financiers and consultants handling the deal, and provide a bookkeeping adjustment to national accounts that could be erroneously spun as a benefit. Studies of privatisation and outsourcing at the state government level raise significant doubts that the practice has delivered the cost and performance quality its advocates once confidently claimed for it, and there is considerable evidence of public disquiet with privatisation activity that state governments have ignored at their peril (Cook, *et al*., 2012; Woods and Lewis, 2015).

4.4 Aviation Safety Regulatory Review

The Commonwealth Government launched an Aviation Safety Regulatory Review in 2013 with terms of reference requiring a report to the Minister for Infrastructure and Regional Development by May 2014. In relation to ARRFs the subsequent report noted:

> In Australia, the requirement for aviation rescue and firefighting (ARFF) services is triggered when an airport receives 350,000 passenger movements in a year. While the service levels provided in Australia match ICAO requirements for certain airport categories, this threshold trigger is unique to Australia. The Panel understands there are a range of different perspectives among Australian Government agencies on whether the trigger should be changed, or if a range of graduated services should be adopted. Because the matter requires a clear policy judgement, the Panel would expect the Department to take the lead in providing policy guidance to the regulator and service provider (ASRR, 2013: 23).

The Government responded to the report in December 2014, and in relation to ARFFS stated it:

> has asked the Department to provide it with policy advice on … a range of potential improvements to the efficiency and clarity of Aviation Rescue and Fire Fighting Services requirements including the use of risk assessments...

> The Department will develop this policy advice in consultation with other aviation agencies and industry, noting that this policy development role will not change the statutory responsibilities of our aviation safety agencies (ASSR2, 2014: 8, 4).

4.5 CASA Post Implementation Reviews

CASA itself is undertaking two Post Implementation Reviews (PIRs) of the standards for which it is responsible in relation to services delivered by Airservices Australia:

> Standards Development project AS 14/24 has been approved to conduct a PIR of the Part 139 regulatory framework to ensure that it aligns with current regulatory policy (including ICAO), industry developments and evolutions in technology. The overarching aim of the project is to conduct a comprehensive review of the Part 139 rule set and develop a proposal for regulatory change for industry to consider a range of options. Amendments to the Part 139 rule set may also result in amendments to the existing suite of CASA advisory materials.
>
> Any amendments will be developed in close consultation with industry through the Airspace and Infrastructure Users Group and issued in draft form for public comment. CASA will send notification via the Aircraft and Aerodromes mailing list when proposed amendments are available for public consultation.
>
> **Subpart 139.H**
>
> Standards Development project AS 07/14 has been updated to reflect the revised terms of reference for the conduct of a PIR on Subpart 139.H Manual of Standards. This will ensure that the Part 139.H MOS aligns with current regulatory policy (including ICAO standards), industry developments and the many evolutions in technology since their inception, while balancing the need for industry to deliver a safe aerodrome rescue and firefighting service without unnecessary economic burden.
>
> Any amendments will be developed in close consultation with industry through the Airspace and Infrastructure Users Group and issued in draft form for public comment. CASA will send notification via the Aircraft and Aerodromes mailing list when proposed amendments are available for public consultation. (CASA, 2016a).

These review projects reflect the consultative process CASA has adopted, whereby specific areas of regulation are reviewed by teams comprising CASA personnel and industry representatives from the Airspace and Infrastructure Users Group, which includes peak body and major company representation (CASA2, 2016b). Presently they include representatives from:

- Aerial Application Association of Australia (AAAA)
- Aircraft Owners and Pilots Association (AOPA)
- Airnorth
- Airservices Australia (AA)
- Australian Airports Association (AAA) (Co-Chair)
- Australian Association of Flight Instructors (AAFI)
- Australian Business Aircraft Association (ABAA)
- Australian Customs and Border Protection Service - Coast Watch
- Australian Defence Force (ADF)

- Australian Federation of Air Pilots (AFAP)
- Australian Maritime Safety Authority - Australian Search & Rescue (AMSA)
- Australian Sport Aviation Confederation (ASAC)
- Australian and International Pilots Association (AIPA)
- CASA (Co-Chair)
- Department of Infrastructure and Regional Development
- Gliding Federation of Australia (GFA)
- Honourable Company of Air Pilots, Australia, Inc.
- Qantas
- Qantaslink
- Recreational Aviation Australia (RAA)
- Regional Aviation Association of Australia (RAAA)
- United Firefighting Union Australia (Aviation Branch) (UFUA)
- Virgin Australia
- CASA staff involved with ATM System Standards, Airspace & Aerodrome Regulation, Office of Airspace Regulation (CASA3, 2016c).

4.6 Aviation Rescue and Fire Fighting Services Policy Review: Department of Infrastructure and Regional Development (DIRD)

In December 2015, the Department of Infrastructure and Regional Development (DIRD) published a public consultation paper outlining its preferred approaches for modifying the criteria for establishing or disestablishing ARFF services at airports, and for less prescriptive regulations in relation to how ARFF services are conducted.

DIRD has been asked by the government for advice on:

- the appropriateness of current passenger traffic levels and data for the establishment and disestablishment criteria of ARFFS which currently determine whether ARFFS is required (or not required) at Australia's major airports;
- the appropriateness of requiring ARFFS at international airports where passenger traffic levels are below establishment criteria levels;
- the future use of the establishment criteria as triggers for a risk assessment of the proposed need for, or discontinuation of, the provision of ARFFS, rather than being a trigger for an automatic ARFFS requirement and what risk factors should be included as part of such a risk assessment;
- other regulatory improvements to increase ARFFS efficiency and provide potential cost savings to industry while maintaining appropriate safety standards; and
- the roles and legal responsibilities of an ARFFS provider and the state and territory fire authorities on and off airports (DIRD, 2015: 7).

The report's key proposal is to alter the threshold indicators for establishing ARFF services. It proposes to raise the current threshold of 350,000 passenger movements over the previous financial year to 500,000 per annum on a rolling month basis. It also proposes a softening of this and the international flights criterion, so that neither automatically necessitates establishing ARFF services, but triggers a risk assessment process by CASA to determine the need for them. A risk assessment into disestablishing an ARFF would be triggered when passenger movements fell below 400,000, as opposed to the less than 300,000 passenger movements over a 12 month period that currently triggers the ARFFS provider to make a safety case to CASA justifying closure (DIRD, 2015).

In establishing a case for this proposal the discussion paper outlines four ARFF establishment criteria options:

> **Measure 1: Receipt of scheduled international passenger services.** This is a requirement under ICAO.
>
> **Measure 2: Annual airport passenger numbers.** Only Canada uses passenger movements as a criterion for the provision of ARFF, requiring ARFF at airports with 180,000 passenger movements per year.
>
> **Measure 3: Percentage of overall passenger numbers**. Providing ARFF at the largest airports that collectively account for a defined proportion of total passenger numbers. It was this formula that the Hawke government used to reduce the provision of ARFF from around 50 airports to ten in 1990.
>
> **Measure 4: Aircraft movements**. This could include additional variables such as aircraft of a given size, or type of aviation activity.

In discussing these options, the report dismisses any suggestion that would increase the extent of ARFF provision, either overtly or implicitly suggesting this would have low cost-benefit.

Despite undertaking to the ICAO Audit program in 2008 that CASA would review Australia's inadequate compliance with the ICAO standard in relation to the extent of ARFF provision, the possibility of moving toward adoption of the ICAO standard (explained below) is nowhere canvassed in this review document.

The report also argues for the reduction of CASA authorisation and compliance monitoring of State and Territory fire services that assume responsibility for airports not deemed to require ARFFs. It also seeks to explicitly define aspects of airport fire and safety service provision that ARFF personnel should not undertake (DIRD, 2015). Submissions to this review will close in late February 2016.

Subsequent sections discuss the implications flowing from the proposals in this review discussion paper.

Section 5 The impact of the proposed changes to thresholds

5.1 Projected growth rates

The impact of the proposed changes to the criteria for establishing / removing ARFF services will depend on the future rates of passenger movement growth at individual airports. If airport passenger movement growth is high, the concern in the discussion paper that a large number of airports will soon require ARFFs establishment may be so, and the effect of the proposed increases to the establishment and disestablishment thresholds will be to delay the provision of ARFF services at airports around the country. The justification for such a delay, an assertion that modern improvements in aviation safety reduce the need for then, is discussed below.

Strong growth numbers, if accurate, imply the retention of existing services. This point is reinforced in the discussion paper by a proposed three year amnesty for disestablishing recently established services, by which time the forecast growth rate would raise potentially affected airports above the proposed disestablishment level (400,000) (DIRD, 2015: 23).

The review discussion paper cites modelling published by BITRE in 2012 that forecasts aviation traffic growth out to 2031, at an average annual growth rate of 3.7% (BITRE, 2012: 64). As with all modelling, this relies on assumptions that while reasonable, may or may not prove right. Indeed BITRE actual domestic passenger movements since 2011 have proved significantly lower than what the report forecasted (BITRE, 2015) (Table 5).

The report authors acknowledge that their estimates for Sydney airport are 'slightly more bullish' than those forecast in the comprehensive Joint Study on Aviation Capacity in the Sydney Region (NSW/GOA, 2012; BITRE, 2012: 24). With the exception of Hobart, all forecast annual average growth rates over the period for which we have actual data were high. Given the role that economic growth plays in determining demand for aviation services (hence passenger movements), and the generally pessimistic Australian and world economic outlooks widely reported for 2016-18, the weight of probability rests with there being lower passenger movement growth over the next 5 years than is predicted by the BITRE modelling.

But even if we are to accept BITRE's analysis, the forecast growth rate most appropriate to the airports potentially affected by the proposed changes, is not that for 'all airports' as argued in the DIRD discussion paper, but that for 'all other airports' which excludes the eight capital city airports and the five largest non-capital city airports (Newcastle, Cairns, Gold Coast, Townsville and Launceston). The forecast growth rate for 'all other airports' is 2.3% (BITRE, 2012: 59).

Applying this rate of annual average growth to those airports presently immediately above and below the cusp of requiring ARFFs, the proposal to raise the establishment / disestablishment thresholds by 43% and 33% respectively is likely to occasion the removal of existing ARFFs from some airports and delay their establishment at other busy airports for decades. Tables 6 illustrates the point by indicating the elapsed time, in number of years from 2014-15, at which the airports in question will reach different thresholds of passenger movements under different growth rates.

Table 5 Forecast Vs Actual Average Annual Growth rates 2010-11 to 2014-15

	Average Annual Growth Rates		
	Forecast	**Actual**	**Difference**
Sydney	3.1	1.2	1.9
Melbourne	3.8	2.0	1.8
Brisbane	5.3	1.8	3.5
Adelaide	2.0	0.2	1.8
Perth	7.0	2.8	5.2
Hobart	2.6	3.5	-1.1
Darwin	6.5	5.4	1.1
Canberra	2.9	-3.5	6.4
8 Capital City Airports	4.1	1.5	2.6
Newcastle	4.4	-1.4	5.8
Cairns	4.8	3.9	0.9
Gold Coast	4.6	1.4	3.2
Townsville	5.0	-2.0	7.0
Launceston	2.7	2.4	0.3
5 largest non-capital city	4.5	1.5	3.0
All other airports	3.3	1.3	2.0
All non-capital city airports	3.9	0.8	3.1
All airports	4.0	1.4	2.6

Sources: BITRE(2012), BITRE (2015)[4]

[4] International data is not defined the same between the two data sets, which could open the comparison up to doubts about commensurability, but the domestic tables are identical until the point where BITRE(2012) reverts to forecast.

Table 6 Financial years out from 2014-15 at which key RPT passenger movement thresholds are reached under different growth rate scenarios

Thresholds:	350,000+		400,000+		500,000+	
Growth Rate:	**3.7%**	**2.3%**	**3.7%**	**2.3%**	**3.7%**	**2.3%**
Broome*	0	0	2	2	8	-
Coffs Harbour*	0	0	4	6	10	-
Newman*	1	1	4	7	10	-
Ayers Rock*	4	6	8	12	14	-
Proserpine	7	10	10	16	16	-
Albury	10	16	14	-	-	-
Emerald	12	-	16	-	-	-
Kalgoorlie	12	-	16	-	-	-
Port Macquarie	13	-	16	-	-	-
Mildura	14	-	-	-	-	-
Wagga Wagga	15	-	-	-	-	-
Mount Isa	15	-	-	-	-	-
Roma	16	-	-	-	-	-
Port Lincoln	-	-	-	-	-	-
Dubbo	-	-	-	-	-	-

Source: BITRE (2015), author's calculations
* Denotes airport at which ARFFs are currently established

Even on the basis of the higher BITRE growth rate, only one additional airport (Proserpine) would be eligible for ARFF establishment under the present guidelines within a decade. Second, that under the lower forecast growth rate, Coffs Harbour and Newman may not exceed the 400,000 passenger movement retention level within three years, on the rolling month basis as DIRD have proposed.

It is therefore improbable that the proposed increase in threshold levels is occasioned by a pressing necessity to forestall the establishment of an excessive number of ARFF services, based on the 2012 BITRE forecast.

Section 6 Do the low accident rates since the mid-90s justify diminishing our preparedness for airport emergencies and accidents?

6.1 The assertion of a cost benefit of reduced ARFF

In 2014-15 alone more than 5.2 million passenger arrivals and departures occurred at Australian airports without adequate means of responding to an aircraft crash or fire (BITRE, 2015). Only 28 (14.7%) of Australia's 190 CASA certified airports have aviation firefighting services, whereas the ICAO standard requires that *all* certified airports maintain the capability to extinguish an aircraft on fire and rescue its occupants in an emergency on or near an airport, and to be at the crash site and applying fire suppressing agent in a maximum of three minutes (ICAO). We have seen that comparably developed countries, though not fully compliant themselves, have adopted criteria that provide better ARFF coverage and that their degree of deviation from the ICAO standard in this regard is far less than that of Australia.

The proposal to set passenger movement thresholds at levels higher than those which currently determine the issue, and for these to merely trigger a risk analysis of the need for an ARFF service, constitutes a further departure from the ICAO standards. It will mean that Australian airline passengers and crews will bear a higher level of risk (i.e., fly with less safety) than they presently do. The advocates of this approach assert a reasonable cost-benefit in doing so, because the potential financial savings are significant and the increased risks to human life are negligible. This, they argue is due to continuing improvements in accident aviation levels reducing the probability of ARFF services being required:

> The increased use of modern, safer aircraft and extension of larger aircraft to regional centres with more safety redundancies can reduce the likelihood of an aircraft accident that would require an ARFFS (DIRD, 2015: 11).
>
> ...it needs to be recognised that there are other infrastructure, technology and service measures that in the first place can be used to reduce the very low likelihood of an aviation accident before an ARFFS is required.
>
> These measures may include the establishment and enhancement of airspace management and air traffic control services and the availability of local fire services.
>
> There also continues to be improvements in modern aircraft safety, including better fire protection in the design of aircraft and changes in traffic levels that need to be taken into account (DIRD, 2015: 18).

The use of larger aircraft is, somewhat contradictorily, later also cited as a factor that may increase the risk of flying.

> ... the risk assessment process will also need to take into account any factors that might increase risk (e.g. operation of larger aircraft resulting in higher numbers of passengers per aircraft, the location of refuelling facilities or runway or related safety incidents at an airport) (DIRD, 2015: 19).

6.2 The past trend in accident rates

From the 1960s until the mid-1970s, aviation accidents involving fatalities fell dramatically around the world, from a rate of around 70 fatal accidents per million departures to around 3-4 per million departures where it has largely remained. In actual numbers, because this period coincided with significant growth in the number of aircraft movements, the average number of fatalities grew to around 1700 per year by the early 1980s and began falling. Following a brief period where it rose again between 1990-1995, it has been on a slow downward trend since.

Table 7 IATA Accident Data (2010-2014)

	2010	2011	2012	2013	2014	2015 (1st half)	Average 2010-14
Yearly flights (millions)	33.9	35	35.5	36	37.8	20.2	35.6
Total accidents	94	92	75	81	73	36	83
Fatal accidents	23	22	15	16	12	2	17.6
Fatalities	786	490	414	210	641	45[5]	508.2

Source: IATA (2015)

Australia has had no commercial high capacity fatal jet crashes, although the number of reported incidents has been growing:

> the number of incidents reported to the ATSB grew by 90% for commercial aviation in general, and more than doubled for high capacity RPT, in the decade to 2013. The ATSB points out that this growth is partly an artefact of different reporting requirements, and partly related to the overall growth in traffic. However the growth of 135% over the decade for incidents reported in high capacity RPT is just over twice the growth in the number of departures, suggesting that at least some of the increase must be real (Hampson, *et al.*, 2015).

There have been significant numbers of fatal accidents in other parts of the industry. From 2005 to 2014 there were 14 commercial air transport accidents (12 charter flights and 2 low capacity regular passenger transport flights) in which 36 people lost their lives. General aviation is substantially more dangerous, with 160 accidents over the same period claiming 240 lives, with 144 lives lost in 83 private / business flight accidents, 60 lives lost in 48 aerial work accidents, with 80 recreational aviation accidents taking 98 lives (ATSB, 2015: 12).

Technological improvements since the 1950s in aircraft design, jet engine reliability, materials, and computerised control systems have contributed enormously to the global improvement in the safety of air travel. These coincided with a strong commitment to international aviation regulation through the ICAO, and by leading national authorities such as the United States Federal Aviation Authority (FAA). The strides in aerospace engineering and air traffic control technology were often as a result of tragic accidents. Traffic Collision Avoidance Systems (TCAS), Enhanced Ground Proximity Warning Systems (EGPWS), the Low Level Windshear Alert System (LLWAS) and Runway Safety Warning System (RWS) were all designed to prevent a repetition of a major accident. But while scientists and engineers have devised solutions to some problems, those that remain are not so amenable to technological fixes. Errors in the way humans interface with the rapidly advancing technology, for example, which are often the constant in aviation misadventures, stubbornly continue to cause problems despite considerable research being directed at overcoming them. The past decade has seen a fairly stable rate of fatal accidents which could, just as likely begin to rise as the level of air traffic continues to rise.

[5] Does not include 150 killed in the Germanwings A320 crash in March 2015.

> ...the most important advances in passenger and aircrew safety have already been made several years ago, and that accident rates in Australia as well as globally have effectively stabilised for some time (Hampson, *et al*., 2015: 59).

So while incremental advances can be expected to continue to improve aviation safety, we cannot assume that these will be sufficient to constrain growth in the number of accidents and fatalities as air traffic grows, even if the rates per million trips or kilometres marginally improve. We have to accept that there will always be some degree of probability of a major civil aviation accident in Australia.

6.3 Factors impacting on future aviation accident rates

Some factors that continue to pose a risk to air travellers, and some increasingly so, include:

- Human capacity factors
- Technological complexity
- Foreign objects
- Terrorism
- Climate change
- Commercial pressure
- Aircraft life cycles

6.3.1 Human factors

70% of fatal commercial aviation accidents are related to inappropriate human actions and responses. While pilot and Air Traffic Controller (ATC) fatigue is a known major contributor (Gander, 2001), something likely to be exacerbated by industry growth pressures (e.g. skill shortages) and commercial competition, some errors are simply the consequence of subtle processes humans naturally use to frame and process information on which decisions are made (Plant and Stanton, 2012).

Efforts to address the fatigue issue include alertness and fatigue management training programs (Flower, 2000), and research into pharmacological stimulants (Caldwell, 2000), although these are acknowledged to have the potential to create more problems:

> Stimulants offer an attractive way to counter the effects of sleep loss, but continuous reliance upon pharmacological strategies is not politically palatable and may be counterproductive in the long run due to side effects, dependency and other problems (Caldwell, 2001:20).

Pilots with 10 to 12 hours duty time are involved in 1.7 times more accidents than pilots as a whole, and for those with 13 or more duty hours the accident involvement rate is over 5.5 times as high. 20% of human factor accidents occurred with pilots with 10 hours duty time, even though that represents 10% of the duty hours of surveyed pilots. Surveys of Scandinavian pilots found that 71-90% of pilots said they made errors due to fatigue, and that 50-54% had dozed off in the cockpit. 31% of surveyed UK pilots who said they had dozed off in the cockpit said they awoke to find the other pilot asleep. 75% of UK aero medical advisors consider 25% of pilots are too tired to fly safely and 68% believe pilots often fall asleep without realising (Allianz, 2014: 34).

Fatigue causes a degradation of performance in terms of decision making, visual cognitive fixation, memory, endurance, judgement and reaction times (Allianz, 2014: 35). 98% of all flights face one or more threats (events or errors beyond the influence of line personnel, which increase complexity, which must be managed to maintain the margins of safety), averaging four per flight, which are generally capably managed (Allianz, 2014: 36).

And while advances in technology have improved the reliability of commercial aircraft and airspace management, training deficiencies and an over-reliance on automation are thought to have contributed to recent aviation disasters (FAA, 2013). Automation has increased the range of skills required of commercial pilots, because as well as being able to manage sophisticated computerised systems, with requiring the equivalent of I.T. degrees, pilots still need to be able to manually fly an aircraft, the skills for which automation leaves them fewer opportunities to practice and obtain. A 2013 FAA working group noted:

> significant concerns about the development and retention of manual handling skills. This was described as a concern for several operational situations; that is, knowing what to do, especially those situations that occur very infrequently (FAA, 2013: 32).

System complexity makes transitions from automatic control and problem solving in malfunction situations more difficult:

> ...insufficient system knowledge, flight crew procedure, or understanding of the aircraft state may decrease pilots' ability to respond to failure situations (FAA, 2013: 34).

According to the Chairman of the National Transportation Safety Board (NTSB) speaking in relation to the investigation of the 2013 Asiana Flight 214 in San Francisco in 2013:

> In their efforts to compensate for the unreliability of human performance, the designers of automated control systems have unwittingly created opportunities for new error types that can be more serious than what they were seeking to avoid (Allianz, 2014: 39).

While Crew Resource Management Systems have made significant improvements in reliability, inappropriate human error remains a constant reality that is at risk of future exacerbation. The growth in world aviation poses problems for maintaining quality standards in the recruitment and training of pilots, with 235,000 new pilots estimated to be required between 2013 and 2020, and Boeing estimating nearly half a million will be required over the next two decades (Allianz, 2014: 52). Factors of fatigue, and the demand on training resources to deal with automated systems complexity, are likely to preserve human-technology interaction failures as a key cause of aviation accidents.

6.3.2 Birdstrike

Damage from foreign objects are the fifth highest generator of aviation insurance claims by number, birdstrikes in particular (Allianz, 2014). Between 2004 and 2013 the ATSB recorded 14,571 birdstrikes, most of which involved high capacity air transport aircraft (ATSB, 2014a: 13).

Birdstrikes resulting in aircraft damage (including engine ingestions) present a significant hazard to aviation. In cases where a birdstrike results in aircraft airframe or engine damage, a considerable repair cost can also be involved. General aviation operations continue to have the highest proportion of damaging birdstrikes, with one quarter of all reported general aviation strikes between 2004 and 2013 resulting in damage (ATSB, 2014a: 36).

While US Airways Flight 1549 was famously forced to make an emergency landing in the Hudson River in January 2009 because of a birdstrike, and the 2006 conference of the Royal Aeronautical Society were told 231 lives and 80 aircraft had been lost to birdstrike, there have been no reported fatalities in Australia for this reason since 1969 (ATSB, 2014a; Ford, 2006).

6.3.3 Unmanned Aerial Vehicles (UAVs)

Foreign object damage is likely to be aggravated by the growing use of unmanned aerial vehicles (UAVs), which have already been involved in incidents with conventional air craft in Australia. For example, in March 2014 a De Havilland DHC-8 took evasive action to avoid collision with a drone at 3800 ft while on approach to Perth Airport from Kambalda, Western Australia. The ATSB were unable to determine who was operating the UAV, of which the nearby Department of Defence denied any knowledge (ATSB, 2014b). That same month, Newcastle’s Bell 412 Westpac Rescue Helicopter was forced to take evasive action when a hobbyist’s drone approached and tracked it at 1000 ft (Coyne, 2014). In the USA, in June 2015, two fixed wing aircraft engaged in fighting a bushfire were grounded when a drone was seen operating in the area.

The President of the Australian Certified UAV Operator’s Association Joe Urli was quoted saying:

> “Illegal unmanned aircraft operations are on the rise in Australia and the question of whether they will cause a serious safety incident is no longer theoretical given last week’s reported near-miss incident involving a Westpac rescue helicopter flying back to its Newcastle base.” Urli said the increase in certified operators was being outstripped by “skyrocketing” illegal operations, posing significant dangers (Ansley, 2014).

These encounters have prompted CASA and the FAA to develop UAV regulations, with CASA issuing a pamphlet warning:

> Mid-air collision: Even a small drone could bring down a helicopter if it collided with the tail rotor, or an aeroplane if it hits the propeller.
>
> Grounding: Flying your drone near a bushfire could lead to aircraft being grounded to avoid it. If a fire gets out of control because water bombing aircraft can’t fly it could cost even more lives than a collision (CASA, 2014).

The British Airline Pilots Association (BALPA) currently have a campaign for the better regulation of remotely piloted aircraft systems:

> The smaller drones (under 20kg) currently widely in use are capable of reaching around 2,000 feet and posing a risk to passenger aircraft. An example of this is a drone flown within 25m of a plane coming in to land at Southend Airport (BALPA, 2016).

A US aviation consultant wrote in a recent industry blog:

> Clearly they are a safety threat. Commercial airliners and GA pilots have been reporting increasingly more near misses at significantly less than 500 ft with a UAS on short final. Imagine a full passenger aircraft sucking one into its engine at full power on takeoff over a populated area.
>
> ...are they a security threat? You bet they are. Consider a swarm of 5-6 pre-programmed drones coming across the airport fence simultaneously from all directions, all of them weaponized... what’s your airport response? (Kotsatker, 2015).

6.3.4 Terrorism and vandalism

Aviation has been the focus of terrorist activity since the rise of hijacking in the 1960s and 1970s. The September 11 2001 attacks in the USA provoked a significant increase in security arrangements at airports, the establishment of air marshals in the USA and modifications to aircraft such as the reinforcement of cockpit doors. It is illustrative of the challenges aviation policy makers face that a risk and cost benefit assessment by Stewart and Mueller (2008) strongly supported the merits of cockpit door reinforcement, only for it to become part of the problem when Germanwings flight 4U9525 co-pilot Andreas Lubitz deliberately flew an Airbus A320-211 into a mountain in the French Alps on 25 March 2015, killing all 150 passengers and crew (Sawer, 2015)[6].

While measures such as Air Marshalls, reinforced cockpit doors and enhanced airport screening limit the capacity of unauthorised personnel to gain physical control of aircraft, computerised aircraft control and air space management systems are increasingly prone to cyber-attacks capable of producing widespread system failure. "New generation aircraft face increasing threats due to the more prevalent use of data networks, computer systems onboard and navigation systems. Indeed the whole sector is facing major cyber risks on all fronts" (Allianz, 2013: 7, 58).

Another emerging threat is that of military strength lasers, an increasing menace that although a wilful act, may not be due to terrorism as such, but the aviation equivalent of vandals throwing rocks at passing trains. The Guardian reported on 15/2/2016:

> There has been a surge in the number of reported laser attacks on aircraft in the UK in the last few years, according to Civil Aviation Authority figures. More than 1,300 incidents were reported in each of the four years from 2010 onwards, compared to only 20 in 2005.
>
> Last year saw one of the most serious cases in the UK. A British Airways pilot's eyesight was reportedly damaged when a "military-strength" laser was shone into the cockpit of his plane as it landed at Heathrow (Rawlinson, 2016).

6.3.5 Climate change

While jet aircraft are considered to have an adverse impact on the atmosphere, being significant sources of greenhouse emissions, climate change is also expected to give rise to more severe weather conditions that can endanger aircraft, though research in this area is presently limited. Koetse and Rietveld (2009), without firmly embracing a particular climate change model, see significant implications for aviation in terms of wind strength and prevailing direction (on the basis of which airports are positioned and designed), turbulence and windshear, which all have implications for aircraft safety. They suggest bad weather is implicated in 23% of aviation accidents, and that severe weather events are likely to increase as the climate continues to shift according to currently perceived trends (Koetse and Rietveld, 2009: 212-213). In the first detailed study of greenhouse effects on clean air turbulence (dangerous because it is not currently detectable by satellites or on-board radar), a focus on the transatlantic jetstream, atmospheric modelling revealed:

> ...clear-air turbulence changes significantly within the transatlantic flight corridor when the concentration of carbon dioxide in the atmosphere is doubled. At cruise altitudes within 50–75°N and 10–60°W in winter, most clear-air turbulence measures show a 10–40% increase in the median strength of turbulence and a 40–170% increase in the frequency of occurrence of moderate-or-greater turbulence. Our results suggest that climate change will lead to bumpier transatlantic flights by the middle of this century. Journey times may lengthen and fuel consumption and emissions may

[6] While cockpit doors can be opened by an access code this can be manually overridden by someone already occupying the cockpit, creating a new form of vulnerability. Lubitz locked the pilot out of the cockpit.

> increase. Aviation is partly responsible for changing the climate, but our findings show for the first time how climate change could affect aviation (Williams and Joshi, 2013: 644).

The research is being factored into the risk calculations of global aviation insurer Allianz (2014) and warrants reproduction in relation to Australian air routes. In December 2015 the ATSB reported an emerging trend in the number of occurrences of turbulence / windshear / microburst activity rising over the four years to 2015. Occurrences rose from around 10 in 100,000 departures in April-June 2010 to over 80 in January-March 2014, and spiked again to over 80 in October-December 2014, with most reports concentrated around the Sydney and Melbourne airports (ATSB, 2015b: 3).

6.3.6 Commercial Pressure

When cost-containment becomes a focus of innovation in an organisation, intentionally redundant safety measures are often viewed as opportunities for corner-cutting efficiency gains. Pious mission statements, regulations and published procedures may exist, while at an operational level job security and career opportunity may depend on using quicker and dirtier methods to get the job done. The disconnect between what people are supposed to be doing and what they are rewarded to do, is nowhere acknowledged, leaving each link in a causal chain leading to a disaster telling themselves 'we don't have to be so rigid about taking the safest course of action here, because we know the other links in the system will prevent its failure'.

> Systems and organisations continually experience change as adaptations are made in response to local pressures and short-term productivity and cost goals. People adapt to their environment or they change their environment to better suit their purposes. A corollary of this propensity for systems and people to adapt over time is that safety defenses are likely to degenerate systematically through time, particularly when pressure toward cost-effectiveness and increased productivity is the dominant element in decision making. Thus, the redundancy and other precautions added to protect against human error often degenerate over time as work practices adapt to increase efficiency within the local environment (Leveson, 2004: 247).

This can be true of a jet engine maintenance facility, parts manufacturers and distributors, or the people responsible for training, screening and monitoring airline crews, of baggage handlers and screeners, system software developers, in determining aircraft loads, or in deciding if weather conditions are appropriate for flying.

Commercial pressures and entrepreneurial hubris pose a significant risk to aviation safety, particularly at points in which decisions are taken to increase risk. Saving money by avoiding the cost of buying a fire extinguisher, in the belief that sufficient safety measures are in place to prevent a fire from happening, may turn out to be a costly mistake.

> The worldwide economic environment since 9/11/2001 has led to increased focus on managing costs resulting in increased utilisation of aircraft and flight crew members, reduction in technical engineering departments and minimising pilot training costs (FAA, 2013: 21).

6.3.7 Aircraft life cycles

Aircraft accident rates are highest at the beginning and end of their periods of service, and while the generation of aircraft since 1974 have delivered significantly improved reliability, we have already seen issues with the next generation fleet in terms of the lithium-ion batteries problems of the Boeing 787.

Thus whereas technological advances have continued to improve the safety and reliability of air travel since the birth of aviation, this has not been to the extent that they have eliminated human error or other causes of aviation disaster, which are likely to be increasingly significant factors, as with the vulnerabilities arising from increasingly sophisticated technologies, commercial pressures, political instability and emerging climactic effects.

Section 7 The viability of airport risk assessments

7.1 DIRDs proposal

The DIRD discussion paper proposes that a risk assessment be conducted of a given airport, once it has reached a threshold number of passenger movements (e.g. 500,000), to determine if it should have a rescue firefighting service, or not, implying some will be justified in doing so and some will not. The proposal seems reasonable at first glance, since risk assessments are a standard feature of commercial life, and we are used to significant decisions being made on their basis, as in allocating emergency services resources and determining the location of urban fire stations, etc. However, when we consider the nature of the risk we are attempting to assess in relation to a particular airport, we find that it is not conducive to statistical modelling, nor would other available methods be amenable to testing. It would amount to little more than an unverifiable assertion.

> we can use a rational process to assign an appropriate level of resources in anticipation of that event, even if this probability is very low. If we do not have a reliable estimate then we may assign an inappropriate level of resources (Goodwin and Wright, 2010: 356).

To assess the relative need for an ARFF at one airport as opposed to another will require an estimate of the probability of an aviation accident occurring there and an estimate of the consequences should it occur. The worst-case *consequences* of an accident at a given airport can be reasonably anticipated, since we can know the passenger carrying capacity of the largest aircraft arriving there, and a significant research effort has been directed at modelling how different airfield features might affect an aircraft overshooting or veering off a runway, etc. (e.g., Ayres, *et al*., 2013; Kirkland *et al*., 2004). However, the possibility of estimating the *probability* of a commercial high capacity regular passenger airline accident at a given airport is directly contradicted in the literature.

7.2 Modelling the probability of a rare event

A commercial jetliner accident at a specific Australian airport would be an extremely rare event, in that it has never happened before. We care about being prepared for its eventuality not because it happens frequently, but because of its potentially catastrophic consequences if it does. Reliable estimation of the statistical probability of a rare event is prevented by the absence of a sufficiently large and appropriate reference class (set of examples) on which to base probability calculations.

> ...once we try to drill down to a more useful level of detail, such as would enable us to quantify the risk of a particular kind of accident, or an accident occurring in an individual airline or even country, or of an accident occurring within a given timeframe...

[or even harder, at a given airport]

> ...such analysis becomes uninformative, because the absolute number of serious accidents over a year or even five years, when set against the number of passenger miles flown, is too small to support reliable inference (Hampson, *et al*., 2015: 62).

Without prior examples of fatal jetliner accidents at a given airport, or indeed at any airport in Australia, on what basis could we determine the frequency at which they will occur in future, at one particular airport relative to another? Additionally, if an accident probability estimate was proposed for a given airport, how could its accuracy be subsequently checked? How would our general capability of assigning appropriate probabilities of accidents at airports be confirmed?

> Predictability will be greater when we have data on a large set of similar events (i.e., a large reference class) from which relative frequency information can be obtained. This will be the case when events are defined more generally — the greater the specificity of the definition, the smaller will be its reference class (Goodwin and Wright, 2010: 356).

Since reference classes only sample the past, and because rare events provide few examples to consider, factors that may cause future rare events may not even be present in the rare instances included in a reference sample, rendering previously collected data from other times and parts of the world outmoded for future predicting purposes.

Poorly calibrated (inaccurate) forecasts may also arise from erroneous modelling of the nature of the probability of rare events, because in the absence of measurable experience there is greater resort to assumptions about what should be taken into account, and if these are wrong, influenced perhaps by the worldview, ideology, emotional state, pet theories, self-interest, etc. of the estimator, they can have a profound effect on the result. Rare events that are unimaginable until they occur, such as two airliners flying into adjacent New York skyscrapers on the same September morning, are also not part of the reference set until they occur, yet before they occur they evidently were to some extent probable since they actually occurred:

> their probabilities of occurrence (or even possibilities) are discounted due to sampling bias. The use of a reference class can therefore lead to poorly-calibrated forecasts for the occurrence of rare, high-impact, events (Goodwin and Wright, 2010: 356).

These biases and other subjective influences are not avoided by deferring to an 'expert':

> the common sense assumption of the veracity of expert judgment on the likelihood of rare, high-impact events is ill-founded. The lack of a reference class of prediction-outcome data for such rare events means that experts cannot learn from feedback, over time. It follows that bias in expert judgment is, likely to be prevalent – since solely heuristic processes can be utilised by experts in the generation of forecasts (Goodwin and Wright, 2010: 357).

Modern risk assessment strategies for estimating the probability of events with complex interrelated causes, as in the case of an aviation accident, attempt first to identify chain(s) of actual or possible causation, (Fault Trees and Event Trees), then estimate the probability of each discrete causal step. By aggregating the results they seek to arrive at the probability of the event. The notion that this can get around the problem of the scarcity of samples available for aviation accident modelling is specifically refuted by Brooker (2011). Using the example of Bayesian Belief Networks, where clusters of experts are surveyed to arrive at an average estimate of factors contributing to an accident, the same issues that Goodwin and Wright identify continue to arise. What reference set are these experts relying on to make their judgements? Humans adopt simplifying heuristics to reduce complexity which can sometimes be very accurate and sometimes very wrong. Memorable events are more likely to be influential when estimating probabilities this way whereas:

> events that have never occurred, or only occurred in the distant past, may be assigned a de-facto probability of zero, or near-zero (Goodwin and Wright, 2010: 357).

It is this implicit assumption of a zero probability of a major aviation accident that sits at the base of these proposals - we can remove the safety net because the trapeze artist has never fallen in our experience.

7.2.1 Causal factors in aviation accidents that are not airport-related

Another problem with the proposition that we can estimate the likelihood of an aviation accident at an airport is that the main causes of aviation accidents are not associated with airports but with the aircraft and crews that may be using them. This emerges in research undertaken to model what happens at airport aviation accidents.

From 1959 to 2009 55% of the world's jet fatal accidents occurred during landing and takeoff phases of the flight and accounted for 51% of onboard fatalities (Boeing, 2010). This has prompted modelling in support of airport accident risk assessment methodology, with landing and takeoff overruns and veer-offs accounting for most of the accidents occurring around airport runways (Ayres, *et al.*, 2013: 178). An overrun occurs when an aircraft attempts to land or to abort a takeoff but fails to stop on the runway, and therefore travels past the runway end. Planned landings are permissible only when the Landing Distance Required (LDR) and Accelerate / Stop Distance Required (ASDR) are less than the Landing Distance Available (LDA) and the Accelerate Stop Distance Available (ASDR), also called Emergency Distance Available (EDA) (Kirkland, *et al.*, 2004: 892).

Ayres *et al.* (2013) compiled a global airport accident database from 10 national aviation authorities (including Australia), from 1980 to 2012, noting these steadily rose until three years before this study (but conjecturing that this is possibly because causal investigations were not completed, hence reflecting an under-reporting). They focused on mapping how far aircraft deviated from the ends (overruns) or centre line (i.e., veer-offs) of the runways, and considered the sorts of consequences arising from different sorts of terrain and airfield fixtures the aircraft encountered along the way. They also considered what would have happened at different potential speeds of impact. Runway surface properties were considered to play a part in determining rates of deceleration, while the locations of concrete buildings as opposed to more 'frangible' fixtures had a bearing on where the plane would come to rest.

This study again highlights the challenges of this sort of modelling,

> Although human and organisational factors are among the most important causes of aircraft accidents, it was not possible to directly incorporate these factors into the risk models (Ayres *et al.*, 2013: 180).

None of these studies suggest the possibility that their work might lead to forecasts as to which airports are most likely to experience a crash. They seek instead to understand how different airport layouts and features might affect an aircraft once it does. Even this level of modelling (e.g., how far off a runway an aircraft will slide) is made difficult because:

> ...data difficulties exist, for example, on meteorological influences on distance and that [the extent of veer-off] is often mis-recorded in accident dockets so lateral deviations are more difficult to model.

Kirkland, *et al.* (2004), also note meteorological factors as significantly causal of overruns. Precipitation was present in 20% of 118 landing overruns, 12% had restricted visibility and 31% suffered both:

> Approximately 50% of overrun landings and 20% of take-off over runs involved a tail-wind. None of the take-offs, but 20% of the landings [in their sample of runway incidents] suffered a tailwind of more than five knots (Kirkland *et al.*, 2004: 895).

Factors amounting to human judgement and aircraft control (i.e., not features of airports) are reiterated, agreeing with previous researchers that "fast and high approaches that continued to a landing are frequently a feature of landing overruns" (Kirkland *et al*., 2004: 895). Ayres *et al*. (2013) also acknowledge accident contributing factors peculiar to the aircraft using the airfield on a given day:

> ...variation in aircraft type, wingspan, and speed ought to be included as well...
>
> ...lighter aircraft may stop faster and landing gear configuration also may have an effect on the aircraft deceleration in soft terrain, but most of these factors are not accounted for in this approach (Ayres *et al*., 2013: 184).

Load weight is emphasised by Kirkland *et al*. (2004) in their modelling of over-runs and veer-offs: over-runs occur more in aircraft carrying loads closest to their maximum take-off weight:

> The ratio of weight to maximum allowable weight is also rising as efficient revenue management systems drive load factors up and as the average passenger gets heavier.
>
> ...approximately 11% of the take-offs and 6% of the landings that resulted in an over-run had weights more than 100% of their maximum allowable take-off weight. The mean of the take-off weight as a percentage of the allowable take-off weight for the sample of non-overrun flights is 80.92%, compared with 91.98% for over-run flights. The means for landings are 91.4 and 87.5 for overun and non-overrun flights respectively. Both sets of differences are significant at the 95% level (Kirkland, *et al*., 2004: 893-894).

The scarcity of commercial airline accidents renders any attempt to gauge their probable frequency at any given airport largely impossible. What we know about aviation accidents at airports is that they can arise from an interplay of causal factors, few of which are likely to be permanent characteristics of the airports where they occur. Probably, the most significant factors will be issues pertaining to the condition of the aircraft in question on the day, how it was handled at the airport it has come from, its maintenance history, its load ratio, the condition of its crew (fatigue, mental health, experience, manual flying skill), and factors present on the day, such as wind and other environmental variables, whether it is approached by a bird or a drone, targeted by terrorists, etc.

7.3 Anticipating the consequences of an aviation accident at a given airport

Risk assessment entails estimating the probability of a risk event occurring and determining the likely consequences of it doing so. We have seen that it is not plausible to expect that we can estimate the probability of an accident occurring at a given airport. It is less problematic to work out the probable consequences.

An enormous body of empirical data exists on aviation accidents. Detailed air crash investigations databases exist in various national and international jurisdictions, detailing how accidents unfolded and usually reporting a decision as to how and why they occurred. Agencies such as the ICAO, the National Fire Protection Association (NFPA) and the Federal Aviation Administration (FAA) also commission detailed practical tests and empirical studies into all aspects of aviation accidents and emergency response strategies, which subsequently inform the design of regulatory frameworks such as the IACO SARPs.

For example, we know that if a Boeing 737-800 with 170 people on board aborts a take-off at an airport like Proserpine, lands heavily off the runway and catches fire, fully laden with fuel, that within one minute its cabin can fill with asphyxiating smoke and in three minutes reach incinerating temperatures. Without a fire service laying down foam to provide a pathway by which passengers can exit the plane, we can expect heavy, possibly total casualties, in what would otherwise be a totally survivable accident. We also know, from the largest airport practice drill conducted there in seven years, under optimal test conditions, that the local fire service takes 10-15 minutes to reach the airport (Whitsunday Times, 13/5/2015). And while we can draw some comfort that the odds are good that it will probably not be ourselves, our parents, children or friends on the plane, someone's loved ones certainly will be, and in terms of death toll it would be Australia's eighth worst disaster in the past 100 years, including war time incidents, bushfires and epidemics.

Given the ubiquitous presence of digital cameras these days, and the means of instant worldwide publication afforded by the internet, there is a good chance too that images and descriptions of the disaster will rapidly spread around the world, captioned with its location. There will probably be subsequent mainstream media coverage of grieving relatives in other countries questioning why it took so long for the airport firefighters to arrive at the scene. The world may hear of the arguments that were made of the cost-benefits in not having airport firefighters on hand like they have in their countries, because Australia doesn't subscribe to the international aviation safety standards for airport fire and rescue services.

The failure to demonstrate an adequate degree of aviation accident response preparedness at Australian airports risks a significant negative impact on the Australian economy should an aviation accident expose our poor lack of preparation to the world. Australia's special reputation as a safe aviation country would be tarnished, with anniversaries of the disaster a reminder of our policy failure. The economic impacts of aviation accidents are well documented (e.g. Lirn and Sheu, 2009).

> The perceptions that tourists have of travel risk may influence their intentions to travel and the likelihood of visiting a destination. These issues are important for understanding the marketability of tourist destinations and reflect destination characteristics that are important to tourists. Marketers and the tourism providers can encourage potential tourists to travel by decreasing the perception of travel as risky. Perceptions of safety may become increasingly important to tourism as the world becomes more dangerous. The perception of high risk associated with international travel can have a devastating effect on not only tourism but also the entire region. This was evident, for example, in Bali, where the bombings at two night-clubs in Kuta cost US$2 billion from international and domestic tourism earnings, leaving 2.7 million unemployed (Reisinger and Mavondo, 2005).

As the volume of aviation traffic grows around the world, regardless of the sophistication of modern aviation technology, accidents will happen and acquire instant prominence, influencing the travel plans of millions of discretionary air travellers.

If a serious accident does happen in Australia, how we respond to it will send an important message to the world. If the situation is successfully managed with minimal loss of life, because we have the best network of airport fire and rescue services in the world, we will preserve our reputation for aviation safety. If it emerges that the government opted to let air travellers die in order to save commercial airline operators a few dollars per seat, or to support price competition with other modes of transport, we will be a long time restoring the special reputation for safety we presently enjoy.

Section 8 Determining an appropriate policy stance

8.1 Prepare for a rare catastrophic event

There are two ways that we can deal with a rare and unpredictable event that can have catastrophic consequences:

- We can pretend it won't happen, or apply an ineffectual, tokenistic response, expose hundreds of people to an untimely and unpleasant death, and use some of the money saved to pay for a public relations campaign to repair the damage to our international reputation when our industry and government negligence is exposed; or
- We can accept the responsibility we have to protect the lives of everyone who flies to or around Australia to the best of our ability, and accept a need for firefighters at many airports who may ultimately never be called to attend a major aviation accident, though their presence will almost certainly save some lives every year.

The prospect of the unpredictable rare but catastrophic event is argued by Taleb (2008) to be best handled by accepting a higher level of redundancy, holding resources in reserve, foregoing their most profitable immediate short term use, and bearing higher costs, in order to maximise the chance of survival. The existence of duplicate organs in human bodies and their capacity to take on new functions, reflect the contribution of redundancy to enhancing evolutionary survival in living systems.

Given the prominent role that our national aviation and tourism industries play in the economy, and the long term investment made in them by the community through the public provision of regulatory and other services and infrastructure over decades, protecting Australia's world-standard aviation safety record should be given a high national priority. It is not something to be gambled with by the current generation of commercial players, or market-efficiency advocates, but should be viewed as a public asset that this generation has to leave to the next.

8.2 How we should allocate ARFF resources

The ICAO standard for ARFF provision constitutes a risk based response to the challenge of protecting lives when an aircraft of known dimensions crashes at an airport, and it is this standard that should be applied in Australia.

Australian airports are currently graded from category 1-10 according to the size of the largest planes regularly using them, as per the ICAO convention, with category 10 being an airport that handles the largest aircraft. ARFF is currently provided at some category 6 airports, and no category 5-1 airports.

The Australian government should embark on a long term program to progressively establish ICAO compliant ARFF services at all certified airports, progressively moving down the airport category scale from largest to smallest, with an immediate goal of achieving coverage to all category 10-6 airports. Once national coverage is established at all category 10-6 airports, we should establish a program to progressively develop the aviation firefighting capacity of all category 5 airports, then category 4, and so on. This may be a long term program but the direction and rate of progression should be clearly enunciated and adhered to.

Appropriate equipment should be deployed and maintained by the Commonwealth, through ASA or a specialist national ARFF service, with different staffing arrangements in place at smaller airports, based on the level of activity of the aircraft by which their airport categories are determined.

These arrangements could be scaled appropriately to range from full-time permanent crews, part-time crews, retained fire fighter arrangements and volunteer units, all trained and supported by the ASA or a dedicated national ARFF agency.

This approach deals with the intrinsic inability to predict where or when an aviation accident will occur, by eventually covering all certified airports in keeping with our international obligations. It also allocates resources on the basis of what we can predict, namely the size of the emergency challenge we are likely to face at any given airport.

8.3 How should ARFF services be paid for?

It is clear from the submissions made to past enquiries that have looked into this matter, that the greatest opposition to the wide scale provision of quality ARFF services in Australia, particularly at our regional and general aviation airports, has been the extent to which the major carriers have resisted a networked pricing structure, where the costs of the whole system are equally borne by all locations. They have argued on the basis that doing so would distort investment decisions if ARFF and ATC services were privatised at some future date. The introduction of location specific pricing delivered cost reductions to airlines operating from capital cities and motivated the general aviation community, despite having far higher accident rates, to lobby for the withdrawal of the services. Representatives of major airlines have also made tokenistic calls for regional airports to be covered by neighbouring town fire brigades, presumably aware of how ineffectual the suggestion was likely to be.

Parliamentary committees who considered the issue in 2001 and 2003 recommended that the services be funded through some form of cross subsidised arrangement, or universal surcharge, and while location specific pricing has been significantly abandoned in the ASA pricing structure, the current review continues to reflect the sentiment that ARFF are a luxury that regional and general aviation airports cannot afford. Clearly, the way we pay for aviation rescue firefighting services influences the resistance to their establishment.

The provision of ARFF services should ideally be paid by stakeholders in proportion to the benefit they derive from their provision, which can only be roughly estimated. It needs also to be very sensitive to a capacity to pay.

The passengers and air crews arriving and departing from an airport with an ARFF service are probably the principal beneficiaries of its presence because it enhances their safety.

The airline operators benefit from the protection of their aircraft and staff, while airport operators whose airports are made safer also benefit.

The tourism sector also benefits from the investment in aviation safety because it makes tourist destinations more attractive and diminishes the risk of a market decimating disaster.

The nation as a whole also derives a strategic benefit in having a skilled and equipped emergency response capability maintained around the nation's airports that can be called upon in special circumstances to help deal with other catastrophes and crises at a local or national level. ARFF teams have been deployed in life threatening emergencies such as bushfires, and to have the available skills pool supplementing our national emergency response capability is of strategic benefit to the country as a whole.

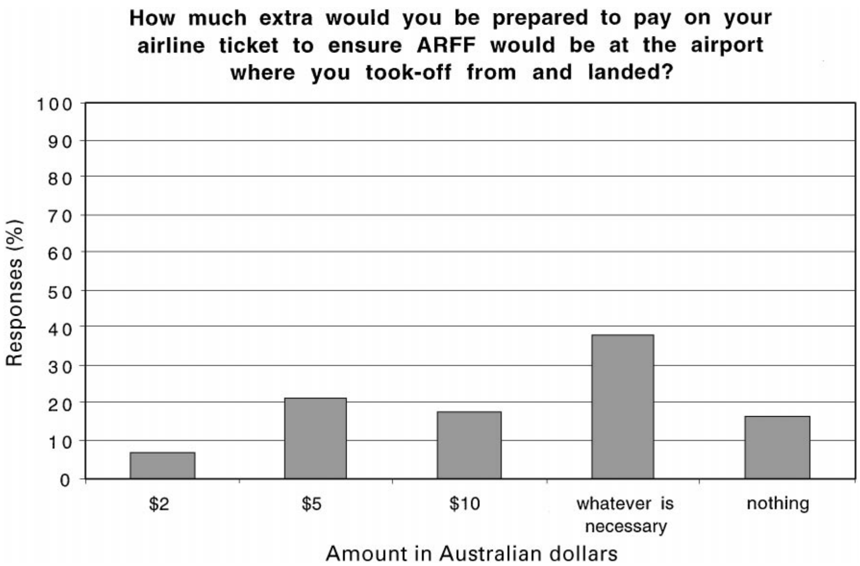
These services should therefore be funded from a national levy on air travellers, of around seven dollars per landing at airports with ARFF, which if applied to the airports currently with an ARFF establishment would raise about $495 million using 2014-15 annual passenger movement data (BITRE, 2015). Airlines should pay the levy for their crews and non-paying passengers.

Any net surplus over operating costs should be invested in the establishment of services at new airports, in order of airport category and traffic levels.

This is consistent with recommendation 17 of the 2003 House of Representatives Standing Committee on Transport and Regional Services (SCTRS, 2015).

As to how the travelling public would respond to the suggestion, we have the survey of over 1000 Sydney air travellers conducted by Braithwaite (2001), who when asked ‘how much extra would you be prepared to pay on your airline ticket to ensure ARFF would be at the airport where you took off from and landed?’, over 75% agreed to the extra surcharge (See Figure 3).

Figure 3: Public willingness to pay a universal fee for ARFF



Source: Braithwaite (2001)

In addition to this source, the Commonwealth should provide supplemental assistance for the establishment of new services and facilities, reflecting the broader economic and strategic benefits the community derives from moving progressively toward safety compliance with the international standard.

Section 9 Conclusion

The DIRD proposals constitute an intention to further diminish our compliance with ICAO standards, and lower aviation safety standards in Australia, rather than raise them as should be the function of aviation safety regulatory reform.

Raising the establishment and disestablishment thresholds for ARFF provision will further delay the establishment of ARFF at airports where large passenger aircraft are routinely landing and taking off with more than 150 passengers on board. Any day, something unpredictable can cause one of them to overshoot a runway, placing every one of those lives at risk. Without the means immediately at hand to apply appropriate quantities of fire retardant foam within 2-3 minutes, all lives may be lost in what would otherwise have been a survivable situation.

It is not just a problem of delaying the establishment of ARFFs at growing airports. The DIRD discussion paper's suggestion that projected passenger movement growth will effectively preserve the status quo despite the higher establishment / disestablishment thresholds relies on very optimistic growth estimates. Should these not turn out to be true, the consequence will not just be a delay in ARFF expansion, but the removal of existing ARFF services.

In any event, raising these thresholds reflects little commitment to enhancing aviation safety. Why would increasing traffic volumes not be interpreted as a signal to expand fire and rescue services, if the preservation of human life was really the policy priority? It is not possible for policy makers to know that fewer aviation accidents will happen in future, but even if it were, that would not justify the delayed establishment or removal of ARFF from any airport, since we certainly cannot know at what airport a future aviation emergency will occur. Their confidence in asserting that these proposals have negligible risk implications is baseless.

The issue cries out for a public education program explaining how poorly Australian airports are prepared for aviation emergencies. This lack of public awareness, reflected in the Braithwaite survey of 2001, has thus far enabled the commercial preoccupations of industry stakeholders to hold sway, relying on the travelling public having little comprehension of the risks they are taking in travelling to many major destinations in Australia.

The cavalier attitude that today's industry players and policy makers show toward our special reputation as a safe tourism and aviation destination is disappointing. They fail to recognise the opportunity they have, to build on the enviable safety record they inherited from their industry's heavily regulated past, by enhancing the current system's capacity to manage future emergencies. Instead they see the safety legacy they inherited as something to cash in on and risk for short term gain.

The proposed establishment / disestablishment changes are premised on two principal assumptions. The first is that recent historic gains in aviation technical reliability mean that safety regulation can and should be reduced if it produces a cost saving. The second is that it would be possible to determine the probability of an aviation accident occurring at a given airport. Both of these assumptions are unsustainable.

Firstly, we do not know that the past rate of improvement in the aviation accident rate is indicative of its future course, given emerging challenges. Technological improvements were relatively 'low hanging fruit' as compared to what remains, namely the human and environmental factors that now constitute the major causes of aviation accidents. The rising sophistication of technology is now being recognised to be producing new challenges on many fronts.

Secondly, the literature is consistently sceptical as to the value of modelling the probability of such rare events, as in the case of a commercial airliner accident occurring at a given Australian airport. Airport risk assessments can meaningfully model the consequences of a crash, but not the probability of it occurring at a specific time and place, owing to the relative scarcity of the event.

If ARFF were to be subject to an airport 'risk analysis', where a faux science process claimed to determine the risk of an accident occurring there, the situation would be ripe for regulatory capture by the interest groups whose views have appeared to have held sway over this policy area for decades. It would be prudent to require the auditor-general or similarly trustworthy office to review any such assessment to establish how much of the analysis was mere assumption.

If we actually are committed to prioritising passenger safety, and not just saying it, the logical course is clear. To properly manage an unpredictable catastrophic event that may occur in one of many possible locations, not knowing the time or place, but knowing its probable magnitude, we would have to accept a high degree of redundant preparedness, and maintain the means to respond in many locations. This reflects the ICAO position of ensuring that the means of mounting an appropriate rescue firefighting response exists at all certified airports.

On the other hand, if our commitment to passenger safety is more verbal than actual, we would probably view any redundant safety capacity as an opportunity for cost rationalisation.

It is our contention that Australia's long term economic interests are far better served by investing in a program of expanded ARFF protection, to leave the next generation an enhanced aviation safety legacy that will continue to underpin the attractiveness of our tourism and aviation industries in an increasingly unsafe world.

To this end we propose the adoption of the funding model similar to that recommended by the 2003 regional aviation review, whereby a modest standard charge be added to the price of every air ticket to fund (eventually) universal ARFF provision.

This should be achieved over time through a staged program, aimed at eventually making all certified airports fully compliant with the ICAO, beginning with category 6 airports, then category 5, etc.

For smaller airports with low volumes of traffic, combinations of retained and volunteer firefighters could be utilised, depending on the amount of air traffic, as with fire management regimes elsewhere in Australia. Airservices, or a dedicated national ARFF service, could be responsible for delivering services, and training and equipping services operating on a small scale.

By these means, the quality of Australian airport emergency response capability could then become a proud national feature, not the guilty secret it has been allowed to become.

In the absence of such a strategy, and should the recommendations of the DIRD discussion paper be adopted, certified airports that are without the capability to respond to an aviation accident within ICAO parameters should be clearly identified to the travelling public with a different certification designation. It is otherwise a clear betrayal of the trust that the travelling public place in Australian aviation to allow them to believe such services are in place when they are not.

References

ACCC (2015) Airservices Australia price notification, ACCC decision June 2015, Australian Competition and Consumer Commission, Canberra.

Allianz (2014) *Global aviation safety study: a review of 60 years of improvement in aviation safety*, Allianz Global and Corporate Specialty SE, Munich.

Ansley, G. (2014) 'Drone filled skies an emerging headache', April 3, 2014, NZHerald website. accessed 3/2/2016 at: http://www.nzherald.co.nz/world/news/article.cfm?c_id=2&objectid=11231127.

ASA (2015) *Annual Report 2014 - 2015*, AirServices Australia, Canberra.

ASA (2014) *Contract for the provision of aviation facilities and services: Effective 01 March 2015*, Airservices Australia, Canberra.

ASRR (2014) *Report of the Aviation Safety Regulatory Review*, Department of Infrastructure and Regional Development, Commonwealth of Australia, Canberra.

ATSB (2014a) *Australian Aviation Wildlife Strike Statistics 2004-2013*, Australian Transport Safety Bureau, Canberra.

ATSB (2014b) *ATSB Transport Safety Report, Aviation Occurrence Investigation AO-2014-052, Final*, Australian Transport Safety Bureau, Canberra, ACT.

ATSB (2015a) *ATSB Transport Safety Report: Aviation Occurrence Statistics 2005 - 2014,* Australian Transport Safety Bureau, Canberra, ACT.

ATSB (2015b) *Emerging trends in Australian aviation safety*. Australian Transport Safety Bureau, Canberra, ACT.

ATSB (2016) Aviation Safety Page, Australia Transport Safety Bureau Website accessed 19/01/2016 at: https://www.atsb.gov.au/aviation/aviation-safety.aspx.

Ayres, M., Shirazi, H., Carvalho, R., Hall, J., Speir, R., Arambula, E., David, R., Gadzinki, J., Caves, R., Wong, D. and Pitfield, D. (2013) 'Modelling the location and consequences of aircraft accidents', *Safety Science,* 51, 178-186.

BALPA (2016) Remotely Piloted Aircraft Systems (RPAS) Campaign, British Airline Pilots Association. Accessed 10/1/2016 at: https://www.balpa.org/Campaigns/Remotely-Piloted-Aircraft-Systems.aspx.

BITRE (2011) *Air passenger movements through capital and non-capital airports to 2030-31*, Bureau of Infrastructure, Transport and Regional Economics, Canberra.

BITRE (2015) *Regular Public Transport Services at Selected Airports, 1985-86 to 2014-15*, Bureau of Infrastructure, Transport and Regional Economics, Canberra.

Boeing (2010) *Statistical summary of Commercial Jet Airplane Accidents, Worldwide Operations*, *1959-2010*, Boeing, Seattle.

Braithwaite, G. (2001) 'Aviation rescue and firefighting in Australia - is it protecting the customer?' *Journal of Air Transport Management*, 7, 111-118.

Brooker, P. (2011) 'Experts, Bayesian Belief Networks, rare events and aviation risk estimates', *Safety Science* 49, 1142-1155.

Button, J. (1991) Excise Tariff Amendment Bill 1991, Second Reading Speech, Senator John Button, Minister for Industry, Technology and Commerce, Senate Hansard 28/11/1991.

CAA (2014) *CAP 168: Licencing of Aerodromes*, Safety Regulation Group, Civil Aviation Authority, available at: www.caa.co.uk/publications.

Caldwell, J. (2001) Efficacy of stimulants for fatigue management: the effects of Provigil® and Dexederine® on sleep deprived aviators. *Transport Research Part F 4,* 19-37.

CASA (2014) *Don't Go There: keep your unmanned aircraft away from bushfires*. Civil Aviation Authority brochure. Website accessed: 4/1/2016 at: https://www.casa.gov.au/sites/g/files/net351/f/_assets/main/lib100071/rpa_brochure_fire_fighting.pdf

CASA (2016a) Civil Aviation Safety Authority, website accessed: 2/1/2016 at: https://www.casa.gov.au/standard-page/casr-part-139-aerodromes.

CASA (2016b) Civil Aviation Safety Authority, website accessed: 5/1/2016 at: https://www.casa.gov.au/standard-page/airspace-infrastructure-users-group.

CASA (2016c) Civil Aviation Safety Authority, website accessed: 5/1/2016 at: https://www.casa.gov.au/standard-page/scc-airspace-infrastructure-users-group-members.

Coyne, A. (2014) 'Drone almost collides with Westpac Rescue Chopper', *ITNews website:* Accessed 3/2/2016 at: http://www.itnews.com.au/news/drone-almost-collides-with-westpac-rescue-chopper-380875.

Deloitte (2012) Connecting Australia: The economic and social contribution of Australia's airports, report prepared for the Australian Airports Association, Deloitte Access Economics, Sydney.

DIRD (2015) *Aviation Rescue and Fire Fighting Services Regulatory Policy Review Public Consultation Paper*, Department of Infrastructure and Regional Development, Commonwealth of Australia, Canberra.

DOT (2014) *Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in U.S. Departmental Transportation Analysis*, U.S. Department of Transportation , Washington.

FAA (2013) *Operational use of Flight Path Management Systems: Final report of the Performance based operations Aviation Rulemaking Committee / Commercial Aviation Safety Team Flight Deck Automation Working Group*, Federal Aviation Administration, Washington.

Flower, D. (2000) 'Alertness management in long haul flying', *Transportation Research Part F 4*, 39-48.

Ford, T. (2006) 'Royal Aeronautical Society Annual Conference', in *Aircraft Engineering and Aerospace Engineering*, 78 (2).

Gander, P. (2001) 'Fatigue management in air traffic control: the New Zealand approach', *Transportation Research Part 4 F,* 49-62.

GOA (1995) *Air Services Act 1995*, Government of Australia, Canberra.

GOA (2007) *Government response to the report of the house of representatives standing committee on transport and regional services 'regional aviation and island transport services: making ends meet'*, Commonwealth of Australia, Canberra.

Hampson, I., Fraser, D., Quinlan, M., Junor A., Gregson, S. (2015) *The future of aircraft maintenance in Australia: workforce capability, aviation safety and industry development. Report of findings from Australian Research Council Linkage Project 110100335*, UNSW Business School, Sydney.

IATA (2015) *Safety Fact Sheet as of June 2015*, International Air Transport Association, Montreal, Canada.

ICAO (1999) Aerodrome Standards: Aerodrome Design and Operations, International Civil Aviation Organisation, Montreal, Canada.

ICAO (2008) Final Report on the Safety Oversight Audit of the Civil Aviation system of Australia, International Civil Aviation Organisation, Montreal, Canada.

ICAO (2014) Airport Services Manual Part 1: Rescue and Fire Fighting, Fourth Edition - 2014, International Civil Aviation Organization, DOC 9137-AN/989, Montreal, Canada.

ICAO (2015) Safety Report 2015 Edition, International Civil Aviation Organization, Montreal, Canada.

Kirkland, I., Caves, R., Humphreys, I. and Pitfield, D. (2004) 'An improved methodology for assessing risk in aircraft operations at airports, applied to runway overruns', *Safety Science*, 42, 891-905.

Koetse, M. and Rietveld, P. (2009) 'The impact of climate change and weather on transport: an overview of empirical findings', *Transportation Research Part D*, 14, 205-221.

Koo, T., Caponechcchia, C. and Williamson, A. (2014) 'Measuring the effect of aviation safety risk reduction on flight choice in young travellers', *Safety Science*, 73, 1-7.

Kotsaker, A. (2015) The impact of drones on aviation safety. Posted on: http://www.aviationpros.com/blog/12115276/the-impact-of-drones-on-aviation-safety.

Leveson, N. (2004) 'A new accident model for engineering safer systems', *Safety Science,* 42, 237-270.

Lirn, T. and Sheu, J. (2009) 'The impacts of an aircrash on students' transportation choice behavior: an empirical study undertaken in Taiwan', *Transportation Research Part F*, 404-416.

Molesworth, B. and Estival, D. (2014) 'Miscommunication in General Aviation: The influence of external factors on communication errors', *Safety Science* 73, 73-79.

NCOA2 (2014) *Towards Responsible Government: The Report of the National Commission of Audit Phase Two*, National Commission of Audit, Canberra.

NSW/GOA (2012) *Joint study on aviation capacity in the Sydney Region*, Report to the Government of New South Wales and the Government of Australia, Sydney.

Oxford (2011) *Economic Benefits from Air Transport in Australia*, Oxford Economics, London.

Plant, K. and Stanton, N. (2012) 'Why did the pilots shut down the wrong engine? Explaining errors in context using Schema Theory and the Perceptual Cycle Model', *Safety Science*, 50, 300-315.

PMC (2014) *Best Practice Regulation Guidance Note: Value of statistical life*, Department of Prime Minister and Cabinet Office of Best Practice Regulation, Canberra.

Rawlinson, K. (2016) 'Laser beam incident forces Virgin flight to return to Heathrow', The Guardian, February 15, 2016, London, accessed 16/2/2016 at http://www.theguardian.com/business/2016/feb/15/plane-forced-to-return-to-heathrow-after-laser-beam-incident.

Reisinger, Y. and Mavondo, F. (2005) 'Travel anxiety and intentions to travel internationally: implications of travel risk perception', *Journal of Travel Resea*rch.

Rundmo, T. and Norfjaern, T, (2013) 'Predictors in demand for risk mitigation in transport', *Transportation Research Part F*, 20, 183-192.

Sawer, P. (2015) *Germanwings flight 4U9525 crash: Andreas Lubitz planned gesture to 'make everyone remember' him*, Sydney Morning Herald, 29/3/2015.

SCTRS (2003) *Regional Aviation and Island Transport Services: Making Ends Meet: Inquiry into commercial regional aviation services in Australia and alternative transport links to major populated islands,* House of Representatives Standing Committee on Transport and Regional Services, Parliament House, Canberra.

Spence, T., Fanjoy, R., Lu, C. and Schrengat, S. (2015) 'International standardization compliance in aviation', *Journal of Air Transport Management*, 40, 1-8.

SRRATRC(2001) *Airspace 2000 and Related Issues: Report by the Senate Rural and Regional Affairs and Transport References Committee*. Commonwealth of Australia, Canberra.

Stewart, M. G., and Mueller, J. (2008) 'A risk and cost-benefit assessment of United States aviation security measures', *Journal of Transportation Security*, *1*(3), 143-159.

Taleb, N. (2008) *The Black Swan: The Impact of the Highly Improbable*, Penguin, London.

TSIA (2003) Transport Safety Investigation Act 2003, Commonwealth of Australia, Canberra.

USDOT (2014) *Guidance on the value of a statistical life in US Department of Transportation Analyses - 2014 adjustment*, US Department of Transportation, Washington.

Williams, P. and Joshi, M. (2013) 'Intensification of winter transatlantic aviation turbulence in response to climate change', *Nature Climate Change*, vol 3, July.

Wong, D, Pitfield, D., Caves, R. and Appleyard, A. (2006) 'Quantifying and characterising aviation risk factors', *Journal of Air Transport Management*, 12, 352-357.

Woods, J. and Lewis, P. (2015) *Hate privatisation? There's nothing new about that*. The Drum, 11/2/2015, Australian Broadcasting Network.

[i] The author is a public policy consultant and research associate with the Centre of Full Employment and Equity at the University of Newcastle, Australia.