Chapter 3

'Anything in the air is a risk'[1]: RPAS and aviation safety

3.1 This chapter discusses a number of RPAS-related incidents that have occurred both internationally and domestically, and outlines how aviation bodies have responded through research and regulatory reform.

RPAS in aviation incidents worldwide

3.2 Many submitters and witnesses argued that the amendments to Part 101 of the CASR, implemented on 29 September 2016, have undermined air safety in Australia, in particular by increasing the likelihood of a collision between manned and unmanned aircraft.[2]

3.3 Although there have been no reported instances of RPAS colliding with passenger aircraft in Australian airspace,[3] the committee heard that incidents of airport closures, flight delays and near-collisions with commercial aircraft in the US, UK and elsewhere are now commonplace.[4]

3.4 In the US, RPAS-related near-misses with commercial aircraft rose by 46 per cent from 2015 to 2016, while the number of reported safety incidents involving RPAS (including RPAS flying improperly or getting too close to other

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1 Mr Chris Manning, Australian Transport and Safety Bureau, *Budget Estimates Hansard*, 23 May 2017, p. 134.

2 See, for example: International Aerospace Law & Policy Group, *Submission 19*, p. 23; Interspacial Aviation Services Pty Ltd, *Submission 74*, pp. 1–2; Austec Aerial Solutions, *Submission 13*, p. 1; Captain Phillip Stevens, *Submission 87*, p. 1; Virgin Independent Pilots Association, *Submission 11*, p. 1; Australian Airports Association, *Submission 12*, pp. 1–3; Mr John Reidy-Crofts, *Submission 89*, p. 1; Maurice Blackburn Lawyers, *Submission 22*, pp. 2–3; Helistar Aviation, *Submission 23*, [p. 5], Qantas Group, *Submission 34*, p. 1; Australasian Fire & Emergency Service Authorities Council and National Aerial Firefighting Centre, *Submission 35*, p. 2; Australian Airline Pilots' Association, *Submission 39*, p. 3; Aeroeye, *Submission 41*, [p. 2]; NSW Ambulance, *Submission 48*, p. 1; Australian Certified UAV Operators, *Submission 73*, pp. 25, 31; Regional Express, *Submission 70*, p. 2; Regional Aviation Association of Australia, *Submission 58*, [p. 2]; Civil Air Operations Officers Association of Australia, *Submission 21*, pp. 1–2.

3 Australian Transport Safety Bureau, *Submission 62*, pp. 6, 27.

4 Australian Transport Safety Bureau, *A safety analysis of remotely piloted aircraft systems 2012 to 2016* (ATSB Transport Safety Report AR-2017–016), 16 March 2017, p. 2.

aircraft) now exceeds 250 each month.[5] In the UK, RPAS-related complaints increased twelvefold in the space of two years, and in 2016 alone, 70 near-misses between planes and RPAS were reported.[6] As at October 2017, Canada had seen 1567 RPAS incidents in 2017, including 131 incidents that were deemed an 'aviation safety concern'.[7]

Major incidents

3.5 On 21 September 2017, a civilian RPAS collided with a US Army UH-60 Black Hawk helicopter east of Staten Island, New York. Reports suggest that the Army helicopter sustained damage to its main rotor blade, window frame and transmission deck.[8] The US Federal Aviation Administration (FAA) stated that this was the first confirmed in-flight collision between an RPAS and a piloted US aircraft in the country.[9]

3.6 On 12 October 2017, a commercial passenger Skyjet plane heading to Québec City's Jean Lesage International Airport was struck by an RPAS. Emergency measures were put in place and the plane, which sustained minor damage, was able to land safely. The collision took place about three kilometres from the airport at an altitude of 450 metres.[10]

3.7 At Las Vegas' international airport earlier this year, an RPAS captured footage of its flight from directly above an 180-passenger airplane. Although the jet landed successfully, many in the RPAS community condemned the actions of the

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5 Ryan Browne, 'Drones: How disruptive are they and what is being done to regulate them?', *CNBC*, 4 July 2017, https://www.cnbc.com/2017/07/04/drones-how-disruptive-are-they-and-what-is-being-done-to-regulate-them.html (accessed 29 September 2017); Alan Levin, 'Surge in Drone Safety Reports Prompts 'Emergency' Action at FAA', *Bloomberg*, 14 October 2017, https://www.bloomberg.com/news/articles/2017-10-13/surge-in-drone-safety-reports-prompts-emergency-action-at-faa (accessed 17 October 2017).

6 Ryan Browne, 'Drones: How disruptive are they and what is being done to regulate them?', *CNBC*, 4 July 2017 (accessed 29 September 2017); Mariella Moon, 'UK reports 70 drone near-misses at Heathrow in 2016', *engadget.com*, 31 March 2017, https://www.engadget.com/2017/03/31/uk-drones-near-misses-planes-heathrow/ (accessed 13 December 2017).

7 The Hon Marc Garneau, Minister for Transport, Government of Canada, 'Statement by Minister of Transport about a drone incident with a passenger aircraft in Quebec City', *Statement*, 15 October 2017.

8 'NTSB Investigating Collision Between Drone, U.S. Army Helicopter, *sUAS News*, 6 October 2017, https://www.suasnews.com/2017/10/ntsb-investigating-collision-drone-u-s-army-helicopter/ (accessed 17 October 2017).

9 Author unknown, 'Unmanned drones pose a tricky prospect for regulators', *The Week*, 3 November 2017, http://www.theweek.co.uk/81642/islamic-state-killer-drones-prompt-fears-of-future-attacks-abroad (accessed 6 November 2017).

10 The Hon Marc Garneau, Minister for Transport, Government of Canada, 'Statement by Minister of Transport about a drone incident with a passenger aircraft in Quebec City', *Statement*, 15 October 2017.

operator, and the US FAA launched an investigation into the incident.[11] Professor Ron Bartsch of the Asia-Pacific RPAS Consortium stated that the incident demonstrates that 'it's not a matter of if a drone is going to bring down a commercial airliner – it's simply a matter of when'.[12]

3.8 Another incident in the US involving RPAS occurred in February 2018. A student pilot and instructor flying a helicopter reported seeing a small RPAS appear directly in front of them whilst in the air. When the instructor took over the controls in an attempt to avoid a collision, the tail of the helicopter hit a tree or bush, triggering a crash landing.[13]

3.9 In addition to these incidents, reports of RPAS-related disruptions to ordinary aircraft services have also risen in number. The committee's attention was drawn to an incident on 9 July 2017 at Gatwick Airport in the UK, where an RPAS flying close to the airport caused the closure of a runway and diversion of five incoming aircraft.[14]

3.10 Further events were reported at Dubai Airport in June, September and October 2016 where 'unauthorised drone activity' caused flight delays and an approximate total financial loss of 16.62 million United Arab Emirates Dirham, equivalent to approximately AUD $5.6 million.[15]

RPAS incidents and encounters in Australia

3.11 Despite some fluctuations in the data, the ATSB provided evidence that 'there has been an increase in the number of reported RPAS sightings and near encounters with manned aircraft' in Australia. In its submission, the ATSB noted that the rise of such events was a 'cause for concern'.[16]

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11 Author unknown, 'Drone expert has dire warning after close call with US flight', *Nine News*, 3 February 2018, https://www.9news.com.au/national/2018/02/03/20/21/near-miss-as-drone-flies-above-passenger-plane-in-us (accessed 5 February 2018). Also see: Stephen Shankland, 'Drone hovers right above jet landing at Las Vegas airport', *Cnet*, 2 February 2018, https://www.cnet.com/news/drone-hovers-over-jet-landing-at-las-vegas-airport/ (accessed 15 February 2018).

12 Author unknown, 'Drone expert has dire warning after close call with US flight', *Nine News*, 3 February 2018 (accessed 5 February 2018).

13 Alan Levin, 'What may be U.S.'s first drone-linked aircraft crash is being investigated', *Bloomberg*, 16 February 2018, https://www.bloomberg.com/news/articles/2018-02-16/what-may-be-first-drone-linked-copter-crash-being-investigated (accessed 22 February 2018).

14 Author unknown, 'Drone causes Gatwick Airport disruption', *BBC News*, 3 July 2017, http://www.bbc.com/news/uk-40476264 (accessed 26 October 2017).

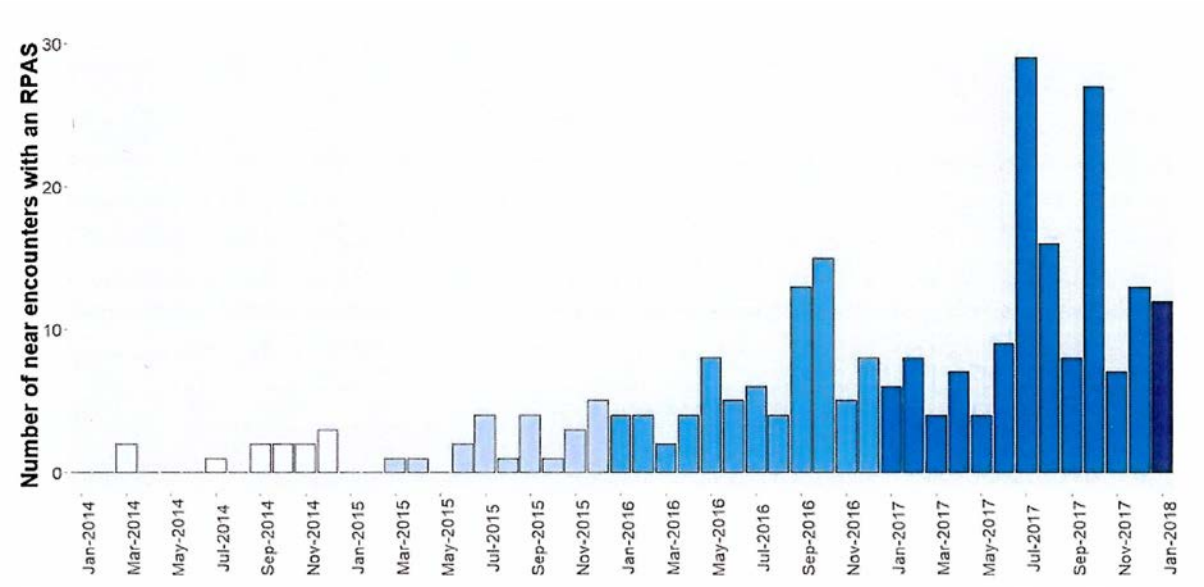
15 Parag Deulgaonkar, 'Shutting down Dubai International Airport due to a drone costs $100,000 a minute', *Arabian Business*, 9 July 2017, http://www.arabianbusiness.com/content/375851-drone-costs-100000-minute-loss-to-uae-airports (accessed 26 October 2017).

16 Australian Transport Safety Bureau, *Submission 62*, p. 27.

3.12 A safety analysis report published in March 2017 revealed that the number of RPAS-related safety occurrences reported to the ATSB has grown exponentially from 2012 to 2016. The ATSB further estimated that half of the 180 occurrences reported over this period involved near encounters with manned aircraft. Whilst there have been no direct collisions between RPAS and manned aircraft reported to date, approximately 52 occurrences have involved collisions with terrain.[17]

3.13 At an Additional Estimates hearing in February 2018, the ATSB provided updated data showing a jump in reported RPAS near-encounter occurrences from mid-2015. This is shown in Table 3.1 below:

Table 3.1: Reported near encounters involving a Remotely Piloted Aircraft System—January 2014 to January 2018



Source: Australian Transport Safety Bureau, tabled at an Additional Estimates hearing of the Rural and Regional Affairs and Transport Legislation Committee on 26 February 2018.

3.14 Reports of incidents involving RPAS and vehicles have also received attention. In May 2017, an RPAS crashed into a moving vehicle on the Sydney Harbour Bridge. The driver of the vehicle reported damage to the car's radiator, and parts of the RPAS were later found in the motor of the car.[18] A second incident on the

17 Australian Transport Safety Bureau, *A safety analysis of remotely piloted aircraft systems 2012 to 2016* (ATSB Transport Safety Report AR-2017–016), 16 March 2017, p. 1.

18 Matt O'Sullivan, 'Dashcam captures drone crashing into car on Sydney Harbour Bridge', *Sydney Morning Herald*, 11 May 2017, http://www.smh.com.au/nsw/dashcam-captures-drone-crashing-into-car-on-sydney-harbour-bridge-20170511-gw2h5q.html (accessed 21 November 2017).

Harbour Bridge involving an RPAS and moving vehicle occurred in August 2016 and also resulted in vehicle damage.[19]

3.15 In addition to these events, RPAS have also been known to cause physical injury. An athlete suffered head injuries and was rushed to hospital after being hit by an RPAS during a West Australian triathlon race in April 2014. The operator reportedly lost control of the RPAS as it hovered approximately 10 metres above the competitors.[20] Following the incident, the Commonwealth Director of Public Prosecutions resolved that the incident was caused by radio interference from the event, rather than the operator's actions. However, as the RPAS was flown within 30 metres of people, thereby breaching the standard operating conditions for RPAs, CASA fined the RPAS operator $1700.[21]

International regulatory responses to RPAS

3.16 Combined with the lessons learned from major RPAS incidents around the world, a number of studies on the impact of an RPAS collision with aircraft have been conducted in other jurisdictions, resulting in regulatory and other reforms. This section considers the research conducted in the UK, US and Australia and notes how this research has informed those changes.

United Kingdom

3.17 In July 2017, the UK Department for Transport, the Military Aviation Authority, and British Airline Pilots' Association produced a report titled *Small Remotely Piloted Aircraft Systems (drones): Mid-Air Collision Study*. As part of the study, laboratory collision testing and computer modelling was used to identify the lowest collision speed at which critical damage could occur to aircraft components.[22]

3.18 The findings of the study reflect the concerns of a number of witnesses to this inquiry, particularly in relation to the damage that RPAS can cause to helicopters in the event of a collision. The UK study found that:

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19 Bev Jordan, 'Rogue drone dive-bombs Castle Hill dentist's car on Sydney Harbour Bridge', *The Daily Telegraph*, 23 August 2016, https://www.dailytelegraph.com.au/newslocal/hills-shire-times/rogue-drone-divebombs-castle-hill-dentists-car-on-sydney-harbour-bridge/news-story/56ca5de43e114966e8ea8ebdd19155d7 (accessed 21 November 2017).

20 Sarah Taillier, 'Triathlete injured as drone filming race falls to ground', *ABC News*, 8 April 2014, http://www.abc.net.au/news/2014-04-07/triathlete-injured-as-drone-filming-race-drops-to-ground/5371658 (accessed 21 November 2017).

21 Sarah Taillier, 'Drone operator fined after UAV crashed into Geraldton triathlete', *ABC News*, 13 November 2014, http://www.abc.net.au/news/2014-11-13/drone-operator-at-geraldton-marathon-fined/5887196 (accessed 10 January 2018).

22 Department for Transport and Military Aviation Authority (UK), *Small Remotely Piloted Aircraft Systems (drones): Mid-Air Collision Study*, 22 July 2017, https://www.gov.uk/government/publications/drones-and-manned-aircraft-collisions-test-results (accessed 4 October 2017), p. 1.

> The non-birdstrike certified helicopter windscreen proved to have a low resistance to all the classes of drones tested…For the fixed-wing drone, which is itself capable of a significant speed in flight, it was found that the drone could penetrate a helicopter windscreen of this type even if the helicopter was stationary.[23]

3.19 In the UK Government's response to the study, it acknowledged that the study had shown 'that very small drones of even 400g can pose a critical risk to the windscreens and tail rotors of helicopters'.[24]

3.20 The testing on airliners yielded similarly alarming results. The study indicated that 'fixed wing drones with metallic components can do significant damage' to larger passenger aircraft, with drones of around 2kg causing 'critical damage' to the windscreen upon collision.[25] The study also noted that 'drone construction plays a critical part in the severity of a collision'.[26]

3.21 The UK study found that RPAS components 'cause significantly more damage than birds of equivalent masses at speeds lower than required to meet birdstrike certification standards'.[27] This conclusion appears to contrast with information provided by CASA in May 2017 that engine ingestion of a drone 'would be treated similar to a bird strike' and is therefore 'not a catastrophic failure'.[28]

3.22 The UK study's findings were supported by Civil Air Australia which emphasised the point that a high volume of RPAS in the sky poses a significantly larger risk than a high volume of birds. Mr Thomas McRobert highlighted a key difference:

> …if you have a jet doing 120 decibels down the runway, the bird is going to try to move out of the way. Whereas, if you have 40 000 drone operators photographing something—they are not going to listen to the aircraft and

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23 Department for Transport and Military Aviation Authority (UK), *Small Remotely Piloted Aircraft Systems (drones): Mid-Air Collision Study*, 22 July 2017, p. 15.

24 Department for Transport (UK), *Unlocking the UK's High Tech Economy: Consultation on the Safe Use of Drones in the UK – Government Response*, July 2017, p. 13.

25 Department for Transport and Military Aviation Authority (UK), *Small Remotely Piloted Aircraft Systems (drones) Mid-Air Collision Study*, 22 July 2017, p. 16; Department for Transport (UK), *Unlocking the UK's High Tech Economy: Consultation on the Safe Use of Drones in the UK – Government Response*, July 2017, p. 13.

26 Department for Transport and Military Aviation Authority (UK), *Small Remotely Piloted Aircraft Systems (drones): Mid-Air Collision Study*, 22 July 2017, p. 5.

27 Department for Transport and Military Aviation Authority (UK), *Small Remotely Piloted Aircraft Systems (drones): Mid-Air Collision Study*, 22 July 2017, p. 5.

28 Mr Graeme Crawford, Civil Aviation Safety Authority, *Budget Estimates Hansard*, 23 May 2017, p. 114.

> think to get out of the way for their own safety. It is not a like-for-like risk in that case.[29]

3.23 The UK study followed 2016 research undertaken by the UK Civil Aviation Authority in association with the industry to consider RPAS user behaviour and attitudes towards responsible RPAS use. The study considered the current level of awareness of the UK regulatory framework regarding RPAS.[30] In addition, a consultation on the benefits of RPAS to the UK economy was undertaken. These studies informed significant changes to UK RPAS laws that were announced in 2017.

3.24 In July 2017, the UK government announced that it would introduce new rules to better regulate the growing use of RPAS. Changes would include the mandatory registration of RPAS weighing over 250g and would require RPAS users to sit safety awareness tests in order to prove competency and an understanding of UK safety, security and privacy regulations.[31] The new requirements, which are expected to come into force in 2018, may include a ban on RPAS flights above 400 feet or near airports.

3.25 Along with registration and competency testing, police are to be given powers to prevent the unsafe or criminal use of RPAS under the new rules. As part of measures to increase police powers, officers will be able to investigate RPAS misuse, order operators to ground RPAS when appropriate, and seize device components where there is reasonable suspicion of the RPAS being involved in an offence.[32]

3.26 In addition to these measures, the UK government also announced plans to bring forward and expand the use of geo-fencing. It is currently working with RPAS manufacturers to use geo-fencing to prevent RPAS from entering restricted zones.[33]

Policy implications

3.27 At a hearing on 29 August 2017, the committee asked CASA whether the results of the UK study had led it to pursue any additional measures to minimise the

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29 Mr Thomas McRobert, Civil Air Australia, *Committee Hansard*, 16 June 2017, p. 27.

30 Drone Safe, *Consumer Drone Users*, 2016, http://dronesafe.uk/wp-content/uploads/2016/11/CAA_Consumer_Drone_Users_report.pdf (accessed 29 January 2018).

31 UK Government Department of Transport, *Drones to be registered and users to sit safety tests under new government rules*, 22 July 2017, https://www.gov.uk/government/news/drones-to-be-registered-and-users-to-sit-safety-tests-under-new-government-rules (accessed 29 January 2018).

32 The Rt Hon John Hayes CBE MP, UK Minister of State at the Department for Transport, 'Drones update, 27 November 2017', *Written statement*, 27 November 2017; UK Government, *New powers for police to address illegal and unsafe use of drones*, https://www.gov.uk/government/news/new-powers-for-police-to-address-illegal-and-unsafe-use-of-drones (accessed 28 November 2017).

33 UK Government, *New powers for police to address illegal and unsafe use of drones* (accessed 28 November 2017). Geo-fencing is discussed further in Chapter 6.

risk of a mid-air collision in Australia. In response, CASA's Mr Graeme Crawford advised:

> Obviously, we're aware of some of the information…We're aware that helicopter windshields and [general aviation] windshields, which aren't bird-strike certified, wouldn't handle a drone either. So, we are considering that data as we consider our response to the safety risks…Yes, we are considering it and we are taking a sector view at CASA more so than we have perhaps done in the past…so, in agricultural applications, potentially.[34]

United States

3.28 The US Department of Transportation has been engaged in UAS integration planning since 2013. The publication of a comprehensive roadmap to achieve 'safe integration of UAS operations into national airspace' in November 2013 marked the beginning of civil RPAS regulation in the US.[35]

3.29 When the number of pilot sightings of RPAS doubled between 2014 and 2015, the US Department of Transportation established the Unmanned Aircraft Systems Registration Task Force Aviation Rulemaking Committee (the RTF) to consider if and how registration requirements could be implemented for RPAS. According to the FAA Administrator, Mr Michael Huerta, registration would mitigate the troubling trend of disruptive RPAS incidents by '[making] sure that operators know the rules and remain accountable to the public for flying their unmanned aircraft responsibly'.[36]

3.30 In November 2015, the RTF produced a report recommending registration apply to all RPAS over 250g. Before this time, registration was optional for hobby or recreational RPAS purposes.[37] A 'standard aviation risk assessment formula', and findings from a 2012 MITRE Corporation report were used to determine the impact of an RPAS collision and the probability of a lethal event occurring.[38]

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34 Mr Graeme Crawford, Civil Aviation Safety Authority, *Committee Hansard*, 29 August 2017, p. 30.

35 Department of Transportation, *Operation and Certification of Small Unmanned Aircraft Systems*, 21 June 2016, p. 24.

36 U.S. Department of Transportation. 'New Task Force to Develop Recommendations by November 20', *Press release*, 19 October 2015, https://www.transportation.gov/briefing-room/us-transportation-secretary-anthony-foxx-announces-unmanned-aircraft-registration (accessed 30 January 2018).

37 Federal Aviation Administration, FAA Announces Small UAS Registration Rule, *Press release*, 14 December 2015, https://www.faa.gov/news/press_releases/news_story.cfm?newsId=19856 (accessed 29 January 2018).

38 Unmanned Aircraft Systems Registration Task Force Aviation Rulemaking Committee, *Task Force Recommendations Final Report*, 21 November 2015, pp. 6–9.

3.31 At the weight of 250g, the RTF concluded that the probability of a catastrophic event occurring presented an acceptable risk level of $4.7x10^{-8}$. This decision was made given that general aviation actual risk levels are on the order of $5x10^{-5}$. The RTF report stated that the 250g or less exclusion provided a satisfactory weight threshold 'that is easy to understand and apply and would therefore encourage compliance'.[39]

3.32 As part of the UAS integration roadmap, a Notice of Proposed Rule Making was issued in February 2015.[40] In June 2016, following the consideration of over 4600 comments received, the FAA announced new rules for non-hobbyist UAS operations for RPAS weighing less than 25kg. The changes are laid out in Part 107 of the US Federal Aviation Regulations, and require that RPAS operators are at least 16 years old, hold a remote pilot certificate with a small UAS rating, or are directly supervised by someone with a certificate.[41] Operations must be conducted:

- within visual line of sight of the remote pilot in command;
- not over any persons not directly participating in the operation;
- in daylight or civil twilight;
- within 400 feet above ground level; and
- at a maximum speed of 100 mph (87 knots).[42]

Policy implications

3.33 When compared to the rules set out by Part 107 of the US Federal Aviation Regulations, submitters to the inquiry expressed concern that Australia's regulations appeared to be significantly more lenient. Interspacial Aviation Services suggested that the 'huge discrepancy' between the risk assessment of RPAS between 250g and 2kg between CASA and the FAA demands an explanation,[43] while Captain John Lyons of Virgin International Pilots Association (VIPA) issued praise for the US approach:

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39 Unmanned Aircraft Systems Registration Task Force Aviation Rulemaking Committee, *Task Force Recommendations Final Report*, 21 November 2015, pp. 6–9.

40 For a short period in 2016–17, the registration requirements were rescinded. A case brought before the US Court of Appeals challenged the FAA's authority to regulate non-commercial RPAS and was won. However, since this time, the requirement for civilian RPAS to be registered has been revived through the signing of the *National Defense Authorization Act 2018*.

41 According to the FAA website, qualification for the remote pilot certificate requires the individual to either pass an initial aeronautical knowledge test or have an existing non-student Part 61 pilot certificate.

42 Federal Aviation Administration, *Fact Sheet – Small Unmanned Aircraft Regulations (Part 107)*, 21 June 2016, https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=20516 (accessed 21 November 2017).

43 Interspacial Aviation Services Pty Ltd, *Submission 74*, p. 3.

> They have been very conservative in the capacity of their legislation allowing any form of flight at all because the Americans see UAVs can be used for both good and evil.[44]

3.34 Australian Certified UAV Operators submitted:

> [Australian Certified UAV Operators] maintain that CASA's risk assessments are flawed and are not supported by international research. Recent assessments from the United States, the United Kingdom, South Africa and Canada all tell an entirely different story to the CASA position. Most international assessments strongly suggest a weight limit of only 250 grams should be considered 'harmless', whilst everything above that weight has the potential to kill or seriously injure people if operated negligently, and should require mandatory registration and minimum knowledge and experience levels to operate them.[45]

Australian research

3.35 As noted in Chapter 2, a number of submitters raised questions about the due diligence undertaken by CASA to inform the Part 101 amendments. The committee was told that more research should have been undertaken to develop a comprehensive evidence base before the amendments were drafted. Furthermore, the point was made that such research could have provided a baseline on which to assess the effectiveness of the regulatory changes.[46]

3.36 AusALPA held the view that regulators in Europe and the US had undertaken more in-depth research before setting the rules for RPAS operators. It provided an overview to the committee of the differences with the Australian approach:

> Both [the European Aviation Safety Agency] and the FAA have taken the potential hazards into account in the development of their rules which require registration and licensing for drones above 250gms. Australian CASR Part 101 subpart G provides no clear distinction between a UAV/Drone and a model aircraft. The European and US legislation is backed by research which acknowledges the potential hazards posed by larger sub-2kg RPAs to both other aircraft and the community at large.[47]

3.37 In response to this assertion, CASA made note that, in developing the amendments, it commissioned research into the potential damage that a mid-air

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44 Captain John Lyons, Virgin Independent Pilots Association, *Committee Hansard*, 28 June 2017, p. 5.

45 Australian Certified UAV Operators, *Submission 73*, p. 21.

46 See, for example: Australian Airline Pilots' Association, *Submission 39*, p. 4; Maurice Blackburn Lawyers, *Submission 22*, p. 2; International Aerospace Law & Policy Group, *Submission 19*, p. 25; Civil Air Operations Officers Association of Australia, *Submission 21*, p. 2; Mr John Thynne, JT Aviation Consulting Pty Ltd, *Committee Hansard*, 28 June 2017, p. 34.

47 Australian Airline Pilots' Association, *Submission 39*, p. 4.

collision with a small RPA would cause to manned aircraft and to people on the ground.[48] The two resulting reports—*Potential damage assessment of a mid-air collision with a small UAV* and *Human injury model for small unmanned aircraft impacts*—were prepared by Mr Alexander Radi, a PhD candidate in aerospace engineering at Monash University.[49]

Commissioned studies

3.38 The first report by Monash University reviewed published experimental data and performed 'original computations using a semi-empirical model' to assess the likely results of a commercial airliner colliding with an RPAS weighing less than 2kg.[50] The author found that the collision is 'most likely to result in the ingestion of the UAV into one of the engines', assuming '[r]eduction or loss of engine thrust with potential debris'. The report concluded, based on 'past experience', that, 'engine loss and uncontained engine failure can be regarded as non-catastrophic events'.[51]

3.39 When asked in May 2017 about the results of the study, Mr Graeme Crawford of CASA explained that:

> Aeroplane engines do have failures that are typically contained. It is not a catastrophic failure because [pilots] can shut down the engine and they are able to land the aircraft. What I am suggesting to you is that, if a sub-two-kilogram drone goes into a large gas turbine engine, it is likely to go down the bypass. The engine would most likely have to be shut down then, I agree, because it will be treated similar to a bird strike. But it is not a catastrophic failure.[52]

3.40 Considering the impact of a similar sized RPAS on a windscreen at cruise velocity, the report stated that an RPAS was 'likely to be deflected without penetration'. However the report also stated that:

> No experimental data exist to validate the predictions of windscreen penetration by a solid object. It is recommended to commission an experimental study, impacting actual UAV parts into common windscreen

48 Civil Aviation Safety Authority, *Submission 17*, pp. 8–9; Captain Murray Butt, Australian Airline Pilots' Association, *Committee Hansard*, 26 June 2017, p. 8.

49 Civil Aviation Safety Authority and Monash University, *Potential damage assessment of a mid-air collision with a small UAV*, 12 June 2013, p. 5.

50 Civil Aviation Safety Authority and Monash University, *Potential damage assessment of a mid-air collision with a small UAV*, 12 June 2013, p. 2; Civil Aviation Safety Authority and Monash University, *Human injury model for small unmanned aircraft impacts*, 23 December 2013, p. 2.

51 Civil Aviation Safety Authority and Monash University, *Potential damage assessment of a mid-air collision with a small UAV*, 12 June 2013, p. 18.

52 Mr Graeme Crawford, Civil Aviation Safety Authority, *Budget Estimates Hansard*, 23 May 2017, p. 114.

> materials. Until then, the results presented in this report should be treated as rough estimates.[53]

3.41 The second report concluded that 'practically any RPA mass is likely to cause unacceptably severe injuries' in a 'loss-of-control scenario, in which the RPA descends from altitudes over 60 metres reaching its terminal velocity'.[54]

3.42 Whilst CASA submitted that 'the regulations, supported by published guidance and safety educational material, assist in minimising the likelihood of a person or another aircraft being hit by an unmanned aircraft',[55] it remains unclear how the two commissioned reports supported the development of the Part 101 regulations.

ATSB Safety Analysis

3.43 In March 2017, the ATSB released a safety analysis study, which drew on five known collisions, and one suspected collision, that occurred outside of Australia.

3.44 In its report, the ATSB noted the lack of data available with regard to actual collisions, and explained that, as minimal testing has been conducted, mathematical models are the prime method for predicting the damage expected from RPAS-related incidents. These models are informed by birdstrike data, with approximately 2000 birdstrikes being recorded in Australia in 2015.[56] However, the ATSB acknowledged the limitations of birdstrike data in determining the impact of RPAS:

> As remotely piloted aircraft are rigid and generally heavier than most birds, the overall proportion of collisions resulting in aircraft damage is expected to be higher than for birdstrikes, and the distribution of damage across an airframe will probably also differ.
>
> Without more information, it is difficult to thoroughly assess the risk of occurrence and the severity of the outcome for an RPAS collision.[57]

3.45 Despite this, the ATSB report concluded that a number of observations could be made, including that RPAS collisions with manned aircraft are likely to:

- penetrate the wing or fuselage of an air transport aircraft;
- cause engine damage and engine shutdown resulting from ingestion in high capacity air transport aircraft;

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53 Civil Aviation Safety Authority and Monash University, *Potential damage assessment of a mid-air collision with a small UAV*, 12 June 2013, p. 18.

54 Civil Aviation Safety Authority and Monash University, *Human injury model for small unmanned aircraft impacts*, 23 December 2013, pp. 4–5, 25.

55 Civil Aviation Safety Authority, *Submission 17*, p. 8.

56 Australian Transport Safety Bureau, *A safety analysis of remotely piloted aircraft systems 2012 to 2016* (ATSB Transport Safety Report AR-2017–016), 16 March 2017, p. 2.

57 Australian Transport Safety Bureau, *A safety analysis of remotely piloted aircraft systems 2012 to 2016* (ATSB Transport Safety Report AR-2017–016), 16 March 2017, p. 2.

- pose a high risk of penetration to a general aviation aircraft's windscreen;
- damage a general aviation aircraft's flight surfaces, including wings and tail, potentially resulting in a loss of control; and/or
- cause a degree of propeller damage resulting in a precautionary or forced landing, if contacted.[58]

3.46 The committee consulted CASA as to whether these conclusions were to be taken into account by CASA in the development of its regulatory framework. In response, Mr Crawford acknowledged that CASA was aware of the information and was 'considering' its implications for the RPAS sector.[59]

CASA Review into RPAS operations

3.47 In October 2016 the then-Minister for Infrastructure and Transport, the Hon Darren Chester MP announced a review into RPAS safety to be undertaken by CASA. The terms of reference were released on 15 June 2017.

3.48 On 11 August 2017, CASA published a discussion paper (DP1708OS) presenting a range of safety related issues and solutions to RPAS management. These included registration of RPAS, training and/or demonstrated proficiency requirements, geo-fencing, counter-drone technology, and CASA's overall approach. Reponses were received through an online questionnaire, and enabled respondents to provide additional commentary as free text. A total of 910 responses were received.

3.49 After publishing an initial analysis of responses in late 2017, CASA published its final review paper on 11 May 2018.

Concerns about the research base

3.50 Submitters to the inquiry raised concerns not only about the lack of a comprehensive research approach but also of the way in which the research had been interpreted for the development of the regulations. Captain David Booth of AusALPA told the committee that 'no impact study has yet been completed' that supports the current regulations. AusALPA argued that:

> The 2 kg limit was justified on the basis of [a] single research project which acknowledges that there is little specific research data regarding the consequences of a collision between an aeroplane or helicopter and one of these devices, while focusing on a highly contestable approach to health consequences for persons on the ground.[60]

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58 Australian Transport Safety Bureau, *A safety analysis of remotely piloted aircraft systems 2012 to 2016* (ATSB Transport Safety Report AR-2017–016), 16 March 2017, pp. 2–3.

59 Mr Graeme Crawford, Civil Aviation Safety Authority, *Committee Hansard*, 29 August 2017, p. 30.

60 Australian Airline Pilots' Association, *Submission 39*, p. 4.

3.51 Suggestions were also made that the assessment of kinetic energy in NPRM 1309OS was misinterpreted to report only minor consequences, rather than a fatal injury. For these reasons, a number of submitters called for more comprehensive research to be undertaken. Captain Booth suggested that 'a rigorous damage assessment exercise' be funded by the Australian Government and other regulators to determine the possible extent of damage.[61]

3.52 Maurice Blackburn Lawyers submitted that international research has now superseded the commissioned reports by Monash University, rendering Australia's definition of 'low-risk' RPAS inconsistent with other jurisdictions. The point was made that:

> …the rest of the world has pursued further research on this area and come up with rules which suggest that only very small (micro-or under-250g drones) pose little risk and can be operated under more relaxed rules.[62]

3.53 Civil Air Australia suggested that a rigorous evaluation of Australia's regulations against those of regulators worldwide should be undertaken. It argued that:

> …the risk analysis performed by CASA, and assumptions that underlie them, should be tested against the research by other regulators. This will not only provide more confidence that Australian regulations will be strong and suited to their purpose, but will also ensure that Australia can influence international debates and rule-making thereby reducing transition issues when ICAO implement universal standards.[63]

61 Captain David Booth, Australian Airline Pilots' Association, *Committee Hansard*, 26 June 2017, p. 9.

62 Maurice Blackburn Lawyers, *Submission 22*, p. 2.

63 Civil Air Operations Officers Association of Australia, *Submission 21*, p. 2.