

Part I

Chapter 1

Introduction

Referral and terms of reference

1.1 On 13 October 2016 the Senate referred the following matters to the Senate Rural and Regional Affairs and Transport References Committee (committee) for inquiry and report by 27 April 2017:

- (a) current and future regulatory requirements that impact on the safe commercial and recreational use of Remotely Piloted Aircraft Systems (RPAS), Unmanned Aerial Systems (UAS) and associated systems, including consideration of:
 - i. Civil Aviation Safety Regulation Part 101,
 - ii. local design and manufacture of RPAS and associated systems,
 - iii. importation of RPAS and associated systems,
 - iv. state and local government regulation, and
 - v. overseas developments, including work by the International Civil Aviation Organization (ICAO) and overseas aviation regulatory jurisdictions;
- (b) the existing industry and likely future social and economic impact of RPAS technology;
- (c) the international regulatory/governance environment for RPAS technology and its comparison to Australian regulation;
- (d) current and future options for improving regulatory compliance, public safety and national security through education, professional standards, training, insurance and enforcement;
- (e) the relationship between aviation safety and other regulation of RPAS for example, regulation by state and local government agencies on public safety, security and privacy grounds;
- (f) the potential recreational and commercial uses of RPAS, including agriculture, mining, infrastructure assessment, search and rescue, fire and policing operations, aerial mapping and scientific research;
- (g) insurance requirements of both private and commercial users/operators, including consideration of the suitability of existing data protection, liability and insurance regimes, and whether these are sufficient to meet growing use of RPAS;
- (h) the use of current and emerging RPAS and other aviation technologies to enhance aviation safety; and

- (i) any other related matters.¹

Conduct of the inquiry

1.2 The committee advertised the inquiry on its webpage. The committee invited submissions from interested organisations and individuals, and received 94 public submissions. A list of individuals and organisations that made public submissions, together with other information authorised for publication is at Appendix 1.

1.3 The committee held public hearings as follows:

16 March – Dalby, Queensland

16 June – Melbourne, Victoria

26 June – Sydney, NSW

28 June – Brisbane, Queensland

29 August – Canberra, ACT

17 October – Canberra, ACT

1.4 A list of witnesses who appeared at the hearings is at Appendix 2. Submissions and Hansard transcripts of evidence may be accessed through the committee's website.²

1.5 On 16 February 2017, the Senate granted an extension of time for reporting until 6 December 2017.³ On 16 November 2017, the Senate granted a further extension of time for reporting until 28 March 2018.⁴ On 22 March 2018, the Senate granted a further extension of time for reporting until 31 July 2018.⁵

Terminology

1.6 During the inquiry, the committee received evidence which used a range of terms to refer to remotely piloted aircraft systems (RPAS) technology, including 'unmanned aerial vehicles' (UAVs), 'unmanned aerial systems' (UAS) or 'drones'. While the preferred terminology used by the International Civil Aviation Organization refers to RPAS technology, the evidence gathered during the inquiry uses a number of terms to describe the broad range of technologies relevant to the inquiry. Therefore, the terms drone, UAV, UAS, RPA and RPAS may be used interchangeably throughout this report.

1 *Journals of the Senate*, No. 11–13 October 2016, pp. 331–332.

2 Parliament of Australia, *Regulatory requirements that impact on the safe use of Remotely Piloted Aircraft Systems, Unmanned Aerial Systems and associated systems*, https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Rural_and_Regional_Affairs_and_Transport/Drones (accessed 6 March 2018).

3 *Journals of the Senate*, No. 30–16 February 2017, p. 994.

4 *Journals of the Senate*, No. 71–16 November 2017, p. 2252.

5 *Journals of the Senate*, No. 91–22 March 2018, p. 2886.

Structure of the report

1.7 The report is divided into three parts, consisting of a total of eight chapters. Part I of the report comprises Chapters 1 to 3 and focuses on the current system and structure of RPAS regulations:

- the remainder of Chapter 1 considers the growing use and application of RPAS, and the respective opportunities and challenges that have emerged as a result;
- Chapter 2 sets out Australia's regulatory framework in relation to RPAS, including the 2016 amendments to the Civil Aviation Safety Regulations 1998; and
- Chapter 3 considers the evidence before the committee regarding RPAS incidents and regulatory responses both within Australia and worldwide.

1.8 Part II of the report comprises Chapters 4 to 6, with a focus on possible improvements to RPAS management in Australia:

- Chapter 4 considers the implementation of measures that allow for the identification and education of all RPAS operators. Measures discussed include a registration regime, and mandatory education requirements for all operators;
- Chapter 5 discusses a number of enforcement measures directed at the safe and lawful use of RPAS, including the restriction or prohibition of RPAS use in certain airspace, and the delegation of enforcement powers to local authorities; and
- Chapter 6 gives consideration to the use of technology-based solutions such as geo-fencing and 'detect and avoid' systems. The need for airworthiness standards for UAS and the potential for unmanned air traffic management is also discussed.

1.9 Part III of the report comprises Chapters 7 and 8 and draws together the evidence informing the committee's views and recommendations:

- Chapter 7 discusses the need for a holistic approach to RPAS management, with wide-ranging stakeholder consultation, and a whole of government framework; and
- Chapter 8 provides the committee's comments and recommendations.

Acknowledgement

1.10 The committee thanks the large number of individuals and organisations who made submissions to this inquiry, and to witnesses who offered their time to give evidence at public hearings and provide additional information. The committee is particularly grateful to those witnesses who travelled substantial distances to appear before the committee. Both submitters and witnesses contributed significantly to the committee's deliberations and report.

1.11 The committee started its evidence gathering for the purposes of the inquiry in Dalby, Queensland where it held an RPAS demonstration and public hearing on 16 March 2017. The committee would like to thank the operators for taking the time to demonstrate the use of their RPAS to the committee and to explain their operations and technology. The demonstration day in Dalby proved to be critical to the committee's understanding of the use and application of RPAS and informed its deliberations throughout the course of the inquiry.

1.12 The committee also acknowledges the 2014 House of Representatives Standing Committee on Social Policy and Legal Affairs' report, titled *Eyes in the sky: Inquiry into drones and the regulation of air safety and privacy*, and the subsequent Australian Government response provided in December 2016. As the focus of this Senate inquiry was on safety and regulation, the committee leaves the issues of privacy that were raised in the House of Representatives' report to the ongoing consideration of government.

192 ways to use RPAS ⁶

1.13 Early reports of RPAS use dates back to World War I. However, RPAS were reported to have been used commercially for the first time in Japan in the early 1980s to spray pesticides on rice fields.⁷

1.14 Since then, RPAS have increasingly been used not only in military operations but across a growing range of industries for a diverse range of purposes.⁸ This diversity is reflected in the growth of commercial, scientific and security applications.

1.15 Today, RPAS are used to perform hazardous work; conduct monitoring and aerial mapping; gather data and undertake surveillance; assist law enforcement and public safety agencies;⁹ monitor road conditions and telecommunications infrastructure; deliver humanitarian aid; carry medicines and urgent medical

6 In 2014, US Futurist Mr Thomas Frey published a list of 192 future uses for flying drones. 2 September 2014, <http://www.futuristspeaker.com/business-trends/192-future-uses-for-flying-drones/> (accessed 12 December 2017).

7 PwC, *Clarity from above, PwC global report on the commercial applications of drone technology*, May 2016, p. 4.

8 RPAS have reportedly been used in at least seven countries throughout the United States' ongoing war on terror. They have been used to gather information, provide battlefield intelligence and find and kill terrorists and insurgents. See: Author unknown, 'History of Drone Warfare', *The Bureau of Investigative Journalism*, <https://www.thebureauinvestigates.com/explainers/history-of-drone-warfare> (accessed 5 October 2017).

9 The Queensland Police Service has used RPAS 52 times in the last year. It was the first agency to use an RPAS operationally in Australia when the Special Emergency Service made use of an RPAS during a siege. See: Thomas Chamberlin, 'Drones become integral part of Queensland Police operations', *The Courier Mail*, 4 December 2017, <http://www.couriermail.com.au/news/queensland/crime-and-justice/drones-become-integral-part-of-queensland-police-operations/news-story/cd2cb6b8812c381b7a23278911f9837f> (accessed 12 December 2017).

provisions including lifesaving blood supplies;¹⁰ perform search and rescue services; deliver resources to remote and geographically-isolated places; deliver takeaway in residential areas;¹¹ and in industries such as mining, aerial photography, media, and entertainment.¹² This list is not exhaustive, as the range of applications continues to grow at a rapid pace. At the same time RPAS have become the fastest growing segment of the civil aviation market.¹³

1.16 The RPAS economy, which is valued at \$137 billion a year, continues to grow at a rapid pace. United States (US) futurist Thomas Frey has predicted that by 2030, there will be one billion RPAS in the world.¹⁴ According to the Civil Aviation Safety Authority (CASA), there were 1283 remote operator certificate (ReOC) holders and 7380 remote pilot licence (RePL) holders registered as at 26 February 2018.¹⁵ This does not account for the much greater number of operators that are neither registered nor hold any form of licence or operating certificate.

1.17 The power of RPAS lies primarily in their software. Increasingly, RPAS are outfitted with business-grade software to serve as data-collecting platforms. RPAS have been referred to as the 'flying smartphone' for this reason.¹⁶ As a disruptive technological advancement, RPAS capability changes the cost and labour equation for many operational tasks.

1.18 In the agricultural sector, RPAS are recognised as integral to the next phase of innovation, given their capacity to change the way food and fibre are produced.¹⁷ To this end, Australian farmers are increasingly applying UAV technology to improve

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- 10 In 2016, Rwanda became the first country in the world to have a national RPAS delivery service which is used to deliver blood to patients in remote areas of the country. See: Amar Toor, 'Drones being delivering blood in Rwanda', *The Verge*, 13 October 2016, <https://www.theverge.com/2016/10/13/13267868/zipline-drone-delivery-rwanda-blood-launch> (accessed 29 September 2017).
- 11 Doug Dingwall, 'Project Wing to trial food delivery by drone to homes in Tuggeranong', *Canberra Times*, 22 February 2018, <http://www.canberratimes.com.au/act-news/project-wing-to-trial-food-delivery-by-drones-to-homes-in-tuggeranong-20180222-h0whll.html> (accessed 23 February 2018).
- 12 Brian Barrett, 'Inside the Olympics opening ceremony world-record drone show', *Wired*, 9 February 2018, <https://www.wired.com/story/olympics-opening-ceremony-drone-show/> (accessed 23 February 2018).
- 13 Dr Rob Weaver, Airservices Australia, *Committee Hansard*, 29 August 2017, p. 11.
- 14 Meghna Bali, '1 billion drones in world by 2030, US futurist Thomas Frey says', *ABC News*, 31 August 2017, <http://www.abc.net.au/news/2017-08-31/world-of-drones-congress-brisbane-futurist-thomas-frey/8859008> (accessed 5 October 2017).
- 15 Civil Aviation Safety Authority, *Review of aviation safety regulation of remotely piloted aircraft systems*, May 2018, p. 19.
- 16 Chris Anderson, 'The Drone Economy', *Harvard Business Review*, 7 June 2017.
- 17 National Farmers' Federation, *Submission 33*, p. 1; Dr Greg Leach, AgForce, *Committee Hansard*, 16 March 2017, p. 20.

agricultural techniques, manage large areas of land, improve risk management approaches, predict weather and yields with greater accuracy, and maximise returns.¹⁸

1.19 In coastal regions, the Little Ripper Lifesaver uses state of the art UAV technology to enhance existing search and rescue services. The Little Ripper Group is developing and integrating lifesaving devices into lightweight marine, land and snow pods that can be mounted and deployed from the Little Ripper UAV.¹⁹ In partnership with the University of Technology Sydney's School of Software, the group also developed best practice aerial detection of sharks using real-time sensor and pattern recognition algorithms.²⁰

1.20 In September 2017, Little Ripper UAVs equipped with the shark-spotting system began patrolling a number of Australia's beaches. The UAVs are able to detect a shark, with swimmers then warned by megaphone.²¹ In January 2018, in a world-first, the Little Ripper UAV was used to save two swimmers at Lennox Head, New South Wales. According to lifeguard supervisor, Jai Sheridan, who was piloting the UAV at the time, the use of a UAV shaved minutes off the time it would have taken a lifeguard to locate the swimmers and then reach them with a flotation device.²²

1.21 Throughout the inquiry, the committee heard that Australia is at the forefront of RPAS technology as we have been 'doing it longer, better and in more diverse ways than anyone else'.²³ This is primarily because Australia was the first country in the world to allow commercial RPAS activities.²⁴ However, as RPAS grow in popularity and application across the country, a number of opportunities and challenges have arisen as a result.

Opportunities and challenges

1.22 Whilst providing considerable opportunities, the prospect of an RPAS-driven society raises a number of difficult questions not only for the committee but for all Australians.

18 National Farmers' Federation, *Submission 33*, p. 1.

19 Little Ripper Lifesaver, *ULB Lifesaving Pods*, <http://littleripper.com/innovation-technology/ulb-lifesaving-pods/> (accessed 19 September 2017).

20 Little Ripper Lifesaver Pty Ltd, *Submission 16*, p. 2.

21 James Redmayne and Darren Schuettler, 'Shark-detecting drones to patrol Australian beaches', *Reuters*, 25 August 2017, <https://www.reuters.com/article/us-australia-sharkdrone/shark-detecting-drones-to-patrol-australian-beaches-idUSKCN1B51KB> (accessed 19 September 2017).

22 Adella Beaini, 'Drone used to save two swimmers', *Sydney Morning Herald*, 19 January 2018, p. 1.

23 Dr Catherine Ball, Private capacity, *Committee Hansard*, 16 March 2017, p. 30.

24 Mr Scott Bush, Domino's Pizza New Zealand, *Committee Hansard*, 16 March 2017, p. 31.

1.23 The increasing application of RPAS, including for routine daily purposes such as the delivery of parcels and pizza,²⁵ together with the growth in the number of RPAS purchased and used in Australia, raises fundamental questions about safety, privacy and security. The use of RPAS by non-state actors to drop bombs or poisons, as well as the potential use of RPAS to traffic drugs, including into prisons, also highlights concerns about regulation and enforcement.²⁶

1.24 Across Australia, RPAS are used by an increasing number of recreational or hobbyist users. As RPAS have become more popular, affordable and accessible, the number of recreational RPAS users has skyrocketed. Having first been made available in retail stores in 2010, rapid advances in technology and falling prices have led to a substantial rise in off-the-shelf RPAS purchases. Reports suggest that recreational RPAS have been amongst the highest selling Christmas gifts in Australia every year since 2014.²⁷

1.25 While the total number of RPAS sales in Australia is difficult to determine, particularly given the rise of internet-based and second-hand sales, CASA estimates that there are now more than 50 000 users of recreational RPAS across Australia, as well as over 1000 commercial operators.²⁸ By way of comparison, in the US, 2.4 million hobbyist RPAS were purchased in 2016 alone, which was more than double the 1.1 million purchased the previous year.²⁹ These figures also do not

25 To provide an indicative figure on delivery, Australia Post currently delivers over one million parcels around the country on a daily basis by way of traditional forms of delivery. See: Mr Tien Ti Mak, Australia Post, *Committee Hansard*, 16 June 2017, p. 37.

26 Tim Johnson, 'Something Else to Fret About: ISIS Mounting Dirty Bombs on Drones', *In Homeland Security*, 8 September 2017, <http://inhomelandsecurity.com/isis-dirty-bombs-drones/> (accessed 5 October 2017); Nathan Stitt, 'Drone crackdown targets operators smuggling contraband into SA prisons', *ABC News*, 31 August 2017, <http://www.abc.net.au/news/2017-08-31/prison-drone-drops-could-lead-to-jail-time/8859402> (accessed 12 December 2017).

27 Tim Jeanes, 'Surge in drones as Christmas gifts will show need for greater regulation: peak body', *ABC News*, 24 December 2014, <http://www.abc.net.au/news/2014-12-24/christmas-gift-drone-pose-fire-risk-warn-peak-body/5986844> (accessed 28 September 2017); Jennifer Dudley-Nicholson, 'It's six months away yet drones already tipped to be the top gift for Christmas 2015', *News.com.au*, 19 June 2015, <http://www.news.com.au/technology/gadgets/its-six-months-waway-yet-drones-already-tipped-to-be-the-top-gift-for-christmas-2015/news-story/96c9cdc816f9297ee8ef01ec99f8b8eb> (accessed 28 September 2017); Jennifer Dudley-Nicholson, 'Drones expected to take off in Australia this Christmas, but experts warn of dangers', *The Courier Mail*, 10 December 2017, <http://www.couriermail.com.au/technology/techknow/drones-expected-to-take-off-in-australia-this-christmas-but-experts-warn-of-dangers/news-story/e7e9e9f065ee5b7b8e3e1715c1a4e4f9> (accessed 8 January 2018).

28 Civil Aviation Safety Authority, *Review of aviation safety regulation of remotely piloted aircraft systems*, May 2018, p. 19. Also see: Brett Williamson, 'How CASA drone laws apply to the fast-growing breed of new high-flyers', *ABC News*, 10 February 2017, <http://www.abc.net.au/news/2017-02-10/how-drone-laws-apply-to-a-new-breed-of-high-flyers/8258908> (accessed 19 September 2017).

29 April Glaser, 'DJI is running away with the drone market', *Recode*, 14 April 2017, <https://www.recode.net/2017/4/14/14690576/drone-market-share-growth-charts-dji-forecast> (accessed 28 September 2017).

account for the number of home-made RPAS, now made available through 3D printing technology.³⁰

1.26 One of the most attractive features of an RPAS is that it can be operated by almost anyone. However, this factor also raises a series of challenges. First and foremost, it means that anyone can fly an RPAS without any training, safety awareness or aviation experience. For this reason, the proliferation of the incidental recreational user was central to the committee's inquiry and a primary concern of many witnesses and submitters.³¹

1.27 Mr Mike Mrdak, then-Secretary of the Department of Infrastructure, Regional Development and Cities (DIRDC),³² and Chair of the Aviation Policy Group, noted some of the challenges at Budget Estimates on 23 May 2017:

...the whole aviation regulatory system has been built for the best part of a century on creating a regulatory structure where you have to reach certain qualifications to enter into the system. The system's safety is built on the qualifications and the protections built in around the airworthiness of the aircraft, the training of the pilot and the training of the air traffic controllers, as appropriate. What unmanned drones or unmanned aerial vehicles do is create a new category of operator that operates outside that closed system. That is the real challenge for policymakers and regulators.³³

1.28 The rapid rise of RPAS brings new challenges that were not considered in historical aviation regulatory frameworks. Civil aviation has historically been based on the notion of a pilot operating an aircraft from within it. Removing the pilot from the aircraft has thus raised serious technical and operational questions. The required shift away from an aircraft-centric approach to that of an operation-centric approach places responsibility directly onto the RPAS operator. As noted by the International Civil Aviation Organization:

The functions and responsibilities of the remote pilot are essential to the safe and predictable operation of the aircraft as it interacts with other civil aircraft and the air traffic management (ATM) system.³⁴

30 Mr Greg Hood, Australian Transport Safety Bureau, *Committee Hansard*, 29 August 2017, p. 19. Also see: DJI, *Submission 60*, pp. 2–3.

31 See, for example: Mr Ben Smart, Smart Air Services, *Committee Hansard*, 16 March 2017, p. 7; Australian Airline Pilots' Association, *Submission 39*, pp. 4–5; Mr Vince Sofia, *Submission 7*, [pp. 1–2]; Austec Aerial Solutions, *Submission 13*, [p. 1].

32 The Department of Infrastructure, Regional Development and Cities (DIRDC) was formerly known as the Department of Infrastructure and Regional Development. Whilst evidence provided by DIRDC is submitted under its former designation, the committee has chosen to identify DIRDC by its new title so as to make recommendations to the Department in its new form.

33 Mr Mike Mrdak, Department of Infrastructure, Regional Development and Cities, *Budget Estimates Hansard*, 23 May 2017, p. 30.

34 International Civil Aviation Organization, *Unmanned Aircraft Systems (UAS)*, Circular 328, 2011, p. 3, https://www.icao.int/Meetings/UAS/Documents/Circular%20328_en.pdf (accessed 29 September 2017).

1.29 Mr Mrdak observed that the current regulatory structure is designed to prevent the operator of an RPAS interfering with the operations of an aircraft. However, noting that the number of recreational RPAS users in Australia continues to rise, he also acknowledged that questions remain as to whether the current regulatory requirements are adequate and balanced.³⁵ Dr Rob Weaver of Airservices Australia highlighted the rapid pace at which the RPAS sector is moving, and the challenges associated with 'responding to the changing environment in terms of both the number of drones and the technology that's available'.³⁶

1.30 The question of how to facilitate and integrate RPAS into a pre-existing, conventionally piloted aviation system is central to the challenge.³⁷ Although many submitters raised the question of how to safely integrate RPAS into Australia's national airspace system, whilst keeping RPAS out of controlled airspace, those within the aviation sector brought forward key concerns about unregulated RPAS which pose a growing threat to aviation security.

1.31 A primary and growing concern of aviation authorities and experts is that of the number of incidents whereby RPAS have come into contact with or within close range of aircraft.³⁸ According to the Australian Airline Pilots' Association (AusALPA) there were over 160 'air proximity events' involving RPAS reported from 2015 to 2016.³⁹ The Australian Transport and Safety Bureau (ATSB) provided a figure of 180 near-encounters with RPAS reported to air traffic control between 2012 and 2016. It informed the committee that none of the involved RPAS were operated by commercial operators.⁴⁰ In 2017, there were 151 reported near-encounters with manned aircraft, representing a 119 per cent increase from the previous year.⁴¹

1.32 As the rate of incidents continues to increase, there are growing concerns that an RPAS will eventually be ingested into an aircraft engine or helicopter rotor and cause a catastrophic aviation accident. Australian aviators are not alone in their concerns, with the number of RPAS-related incidents and complaints increasing throughout the US, United Kingdom (UK), Canada and New Zealand.

35 Mr Mike Mrdak, Department of Infrastructure, Regional Development and Cities, *Budget Estimates Hansard*, 23 May 2017, p. 31.

36 Dr Rob Weaver, Airservices Australia, *Committee Hansard*, 29 August 2017, p. 16.

37 Dr Rob Weaver, Airservices Australia, *Committee Hansard*, 29 August 2017, p. 11.

38 Australian Airline Pilots' Association, *Submission 39*, p. 3; Mr Simon Bourke, Australian Airports Association, *Committee Hansard*, 29 August 2017, p. 2.

39 AusALPA further noted that in the US, where there is a larger RPAS market, there are approximately 100 reports per month from pilots who have sighted RPAS flying near aircraft and airports. See: Australian Airline Pilots' Association, *Submission 39*, p. 3.

40 Mr Greg Hood, Australian Safety Transport Bureau, *Committee Hansard*, 29 August 2017, p. 20.

41 Civil Aviation Safety Authority, *Review of aviation safety regulation of remotely piloted aircraft systems*, May 2018, p. 19.

1.33 At the same time, the committee was made acutely aware of growing public anxiety regarding RPAS. This anxiety is stimulated by reported incidents of RPAS coming into close range of buildings and events, and over people on their own property as well as in public spaces. According to CASA, on average, 15 people are prosecuted for flying RPAS dangerously in Australia every year alongside scores of others who are subject to monetary penalties.⁴² Between 1 November 2015 and 8 November 2017, CASA issued 23 counselling letters to individuals in relation to apparent breaches of the regulations relating to the operation of RPAs.⁴³ However, these figures do not reflect the large number of illegal drone operations that remain unreported.

1.34 In light of these concerns, the committee has focused its attention on the impact of relaxing the regulations regarding RPAS use, and how the regulations contribute to keeping Australia's skies and the Australian public safe. Throughout the course of the inquiry, the committee considered the various challenges arising from the proliferation of RPAS in Australia. Key amongst them is the question of balance between safety, privacy, security, social benefits and economic impost.

1.35 The challenge is in establishing a regulatory regime which does not impede continued innovation, whilst also instilling community confidence and providing assurances with regard to safety and privacy. During the inquiry, the committee considered these matters and the fundamental question of whether current regulations have kept up with the growth and increasing application of RPAS technology in Australia.

42 Brett Williamson, 'How CASA drone laws apply to the fast-growing breed of new high-flyers', *ABC News*, 10 February 2017, <http://www.abc.net.au/news/2017-02-10/how-drone-laws-apply-to-a-new-breed-of-high-flyers/8258908> (accessed 29 September 2017).

43 Civil Aviation Safety Authority, answers to questions on notice, *Supplementary Estimates*, 27 October 2017 (received 22 February 2018).