Australian Government
Civil Aviation Safety Authority

Review of aviation safety regulation of remotely piloted aircraft systems

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Executive summary

The rapid adoption of remotely piloted aircraft systems (RPAS) technology in new and innovative ways has meant the RPA aviation sector is growing exponentially in Australia. At the request of the then Minister for Infrastructure and Transport, CASA has conducted a review aviation safety regulation of RPAS to ensure it is contemporary and appropriate to ensure an acceptable level of safety is maintained. Part of review process was to engage with industry and the Australian public to ascertain views on key issues such as mandatory registration of remotely piloted aircraft (RPA), education and training, and deployment of geo-fencing. Some technology associated with RPAs, such as geo-fencing is still evolving, whereas other elements are more mature, and allow for CASA to make findings.

The RPAS sector is multi-faceted. This report focuses on the review's terms of reference. CASA's findings are as follows:

1. CASA supports mandatory RPA registration in Australia for RPAs weighing more than 250 grams.
2. CASA should develop a simple online course for recreational and *excluded category* RPA operators on safe RPA operations, followed by a quiz that has a minimum pass mark.
3. CASA's education and training framework around the issue of a remote pilot licence should continue.
4. CASA should continue to support RPA manufacturers' efforts to utilise geo-fencing technology to prevent RPA operations in areas where operations are not permitted, including at or near major airports and certain classes of restricted airspace.
5. CASA should participate where appropriate in international forums to stay abreast of global trends and participate in trials of the technology where feasible.
6. CASA should work with Airservices Australia to ensure the development of standard data on airspace.
7. CASA should develop a RPAS roadmap to articulate how to safely integrate RPAs into the Australian airspace system, including content on unmanned traffic management (UMT) systems.

Policy statement

CASA's policy is to implement an effective aviation safety regulatory framework to enable the safe and efficient integration of RPAS into the Australian aviation system. To accomplish this, CASA will develop policy, standards, regulations and guidance material reflecting an appropriate and proportionate approach to the relevant levels of risk, that is consistent with international best practice.

On this basis, we will strive to achieve a level of safety that is acceptable to the Australian community. Integration of RPAS into the system of aviation safety, particularly into Australia's airspace, should provide sufficient flexibility for innovation in the RPAS industry, without adversely affecting other airspace users, the travelling public, or posing unacceptable risks to people or property on the ground.

CASA will continue to engage with relevant Commonwealth, state and territory authorities and agencies to address key policy issues, including the equitable access to airspace, privacy, national security and the environment.

Introduction

Few developments in the history of modern civil aviation have given rise to the number and complexity of challenges that have been generated by the emergence and proliferation of remotely piloted aircraft (RPA) and remotely piloted aircraft systems (RPAS). The most pressing, pervasive and persistent of these issues involves matters of safety, and the rational management of the risks the expanding use of RPA pose for other airspace users and for people and property on the surface.

These critical considerations fall squarely, and in many cases exclusively, within the Civil Aviation Safety Authority's (CASA) regulatory remit. The challenges inherent in the rational management and mitigation of the risk posed by the safety-related aspects of RPAS, however, are compounded by their inseparability from several complex and controversial social, economic, political and legal considerations, and the sometimes emotive advocacy of those representing different, legitimate and often competing interests.

Every government and every aviation safety regulatory authority in the developed world today is challenged by the growing number of still largely unanswered questions about the nature and magnitude of the risks associated with growing numbers of increasingly sophisticated RPAS technologies, coupled with effectively unfettered access to those technologies and devices, and the ease with which these can be used – responsibly and otherwise – in a variety of ways by virtually anyone.

Australia is not alone in facing these challenges. We first promulgated a coherent regulatory framework in 2002 within which all manner of RPAS activities might be (and clearly have been) undertaken responsibly and safely. With a predictable level of variation reflecting the settled international standards, key elements of Australia's measured regulatory approach to date can be discerned in the similar approaches our counterparts abroad are developing and implementing.

Terms of reference

In October 2016, the Former Minister for Infrastructure and Transport, the Hon Darren Chester MP, announced a review of aviation safety regulation of RPAS. In his announcement, Mr Chester said "The Australian Government is committed to fostering an environment that ensures the safety of commercial and privately owned aircraft, drone operators, and other people and property, while facilitating growth and innovation in the use of drones in Australia."

"We are already seeing drones being successfully used in agriculture, mining, infrastructure assessment, search and rescue, fire and policing operations, aerial mapping and scientific research."

"CASA will be mindful that any proposed new regulatory requirements should also support the potential of drone operations to improve productivity, reduce costs and improve workplace safety across a range of industries and applications."

"We want to gain an understanding of how registration, education and training, geo-fencing and shielding capabilities could potentially impact on both commercial and recreational drone operations within Australia," Mr Chester said.

"The review will also consider developments overseas, including work done by the International Civil Aviation Organization and other international aviation safety agencies."

The terms of reference were released on 15 June 2017:

> *To review the approaches undertaken by the Civil Aviation Safety Authority (CASA) to the regulation of RPA operations which are consistent with the primacy of air safety, and with particular reference to:*
>
> 1. *The relative safety benefits and cost effectiveness of:*
>   - *introducing mandatory registration, education and training for all RPAS operators*
>   - *the deployment of geo-fencing capabilities for RPAS*
>   - *any other mechanisms to enhance aviation safety associated with RPAS operations in Australian airspace and managing the relevant risks.*
> 2. *The effectiveness of CASA's operating model with respect to the regulation of RPAs to ensure it takes into account:*
>   - *technology growth of the RPAS community*
>   - *operational growth of the RPAS community*
>   - *developments in ICAO and other international aviation safety agencies.*

As part of its review of RPAS regulations, CASA published a discussion paper in August 2017 seeking the views of the aviation industry and the wider Australian community. The discussion paper presented a range of safety related issues in a way that examined CASA's approach, associated risks and information about actions by other jurisdictions.

The 2017 Discussion paper

CASA's discussion paper sought responses in relation to five topics, as well as enabling respondents to provide their views on any other issues they believed should be considered. The five topics were:

- registration of RPAS
- training and/or demonstration of proficiency in the safe and lawful operation of RPAS
- geo-fencing
- management of counter-drone technologies
- views on CASA's approach, and what will be required in future

Responses were received through an online questionnaire enabling respondents to respond through selection of pre-specified response check boxes, to provide commentary as free text and to upload a stand-alone submission document.

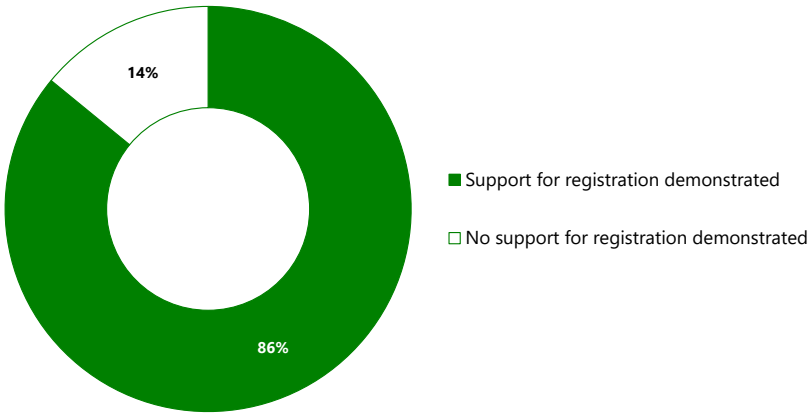
In total, there were 910 respondents, 81 per cent of whom were individuals, and 19 per cent of whom indicated they were responding on behalf of an organisation. Most respondents use RPAS commercially (~46%) or recreationally (~34%), though a significant number do not use RPAS (~19%). The discussion paper, publicly available submissions and analysis are available on CASA's online Consultation Hub.

Key findings of our discussion paper are as follows:

Strong support for registration

Proportionally more non-users advocated mandatory registration of all RPAS, with 36% recommending registration of all RPAS operators. By contrast, recreational and commercial users showed a clear preference for a more targeted approach to registration, with weight of the RPAS the most popular method of determining whether registration is required. Approximately 50% of recreational and 40% of commercial users supported registration of RPAS owners where weight of the RPAS is used to determine whether registration is required.

FIGURE 1 | DEMONSTRATED SUPPORT FOR REGISTRATION



Source: On-line feedback provided in response to CASA's Review of RPAS Operations Discussion Paper.
Notes: Support for registration is demonstrated by selection of any registration option.

Training and demonstrated proficiency are broadly supported, particularly for users of large RPAS

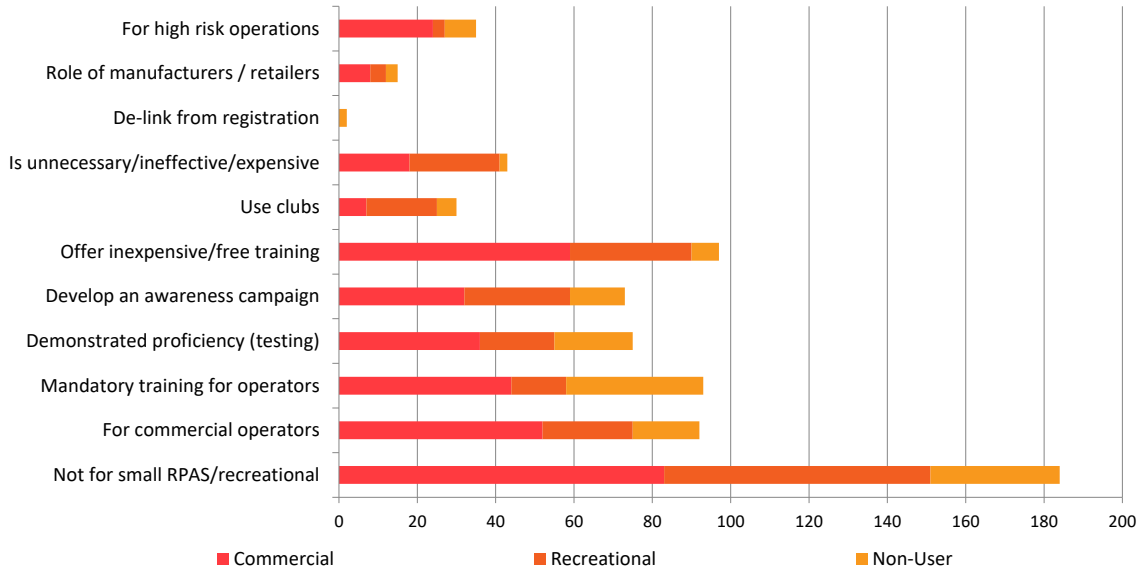
Recreational users, commercial users and non-users alike indicated a preference for both mandatory training and demonstrated proficiency requirements to be determined by the weight of the RPAS.

Recreational users were more likely than commercial and non-users to advocate no mandatory training or proficiency requirements.

Respondents indicated support for free or inexpensive online training to be made available and the need for development of an awareness campaign to help new users learn about the safe and responsible use of RPAS.

While there is broad support for large and small RPAS to be treated differently (for registration, training and demonstrated proficiency) there are divergent views on what size a "small" RPAS is.

FIGURE 2 | KEY THEMES OF COMMENTS IN RELATION TO TRAINING/PROFICIENCY



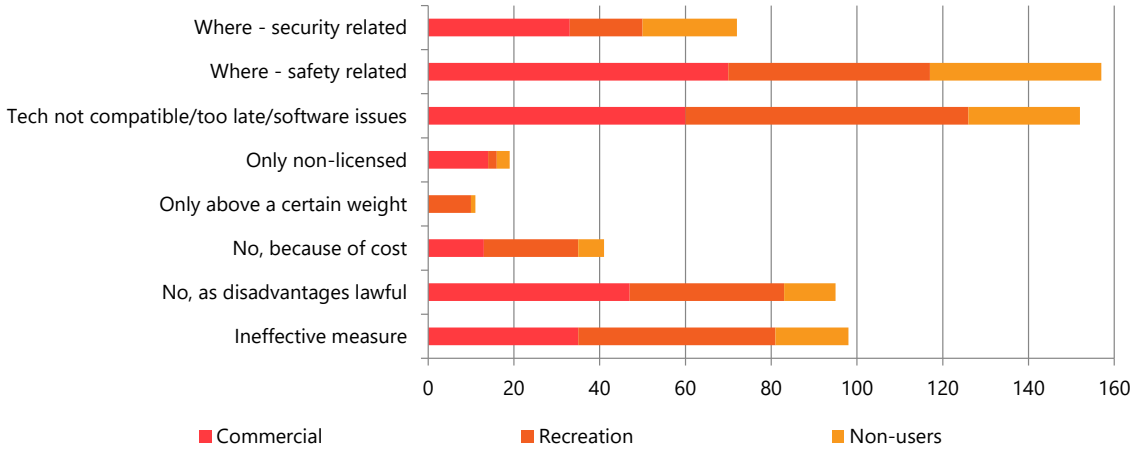
Source: On-line feedback provided in response to CASA's Review of RPAS Operations Discussion Paper

Figure two above shows that many responders do not support training and demonstrated proficiency for small/recreational RPAS. The next most common themes were around offering inexpensive training options, and mandatory training for commercial operators.

Support for mandatory geo-fencing is divided

There is approximately even support for (47%) and against (53%) for the use of geo-fencing technology across all groups. Proponents noted it is most useful in situations where increased safety is required (for example, around airports), whilst those opposing said they believe the technology is ineffective and too costly, especially for recreational users of RPAS. When looking at the different groups in detail, there is clear variation, with 66% of non-users supporting geo-fencing, compared to just 36% of recreational users.

FIGURE 3 | KEY THEMES OF COMMENTS IN RELATION TO GEO-FENCING



Source: On-line feedback provided in response to CASA's Review of RPAS Operations Discussion Paper

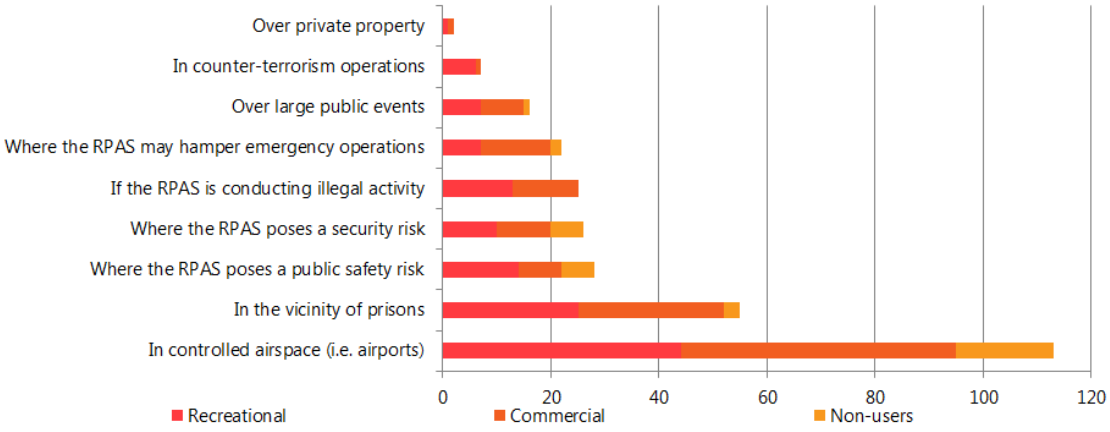
Figure three above shows the common themes around geo-fencing, with the greatest number of comments received that it should be implemented in locations where there is a safety-related reason, but in contrast, the other common theme is the technology is not mature.

There is broad support for the use of counter-drone technology by law enforcement personnel

Most respondents who commented on the use of counter-drone technology supported its use by trained law enforcement personnel where necessary to protect safety and security, especially in controlled airspace.

Radio-frequency counter drone technology was significantly more strongly supported than physical interventions such as nets or trained birds.

FIGURE 4 | VIEWS ON CIRCUMSTANCES FOR THE USE OF COUNTER-DRONE TECHNOLOGY (NUMBER OF COMMENTS)



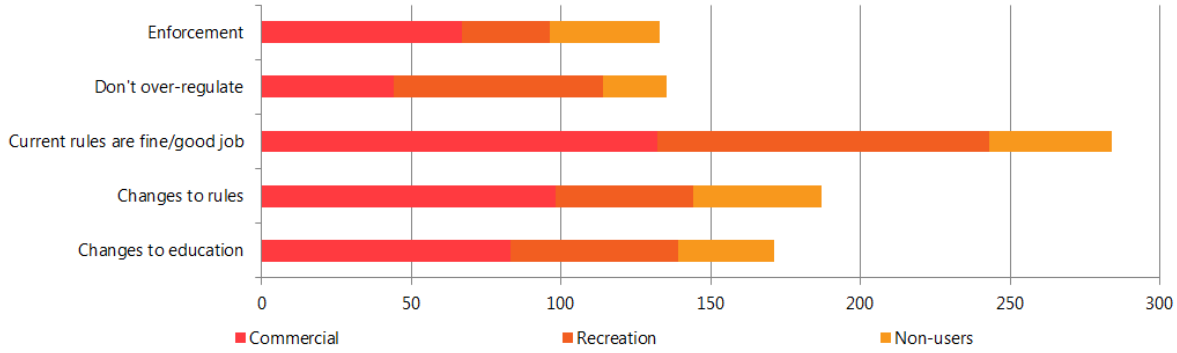
Source: On-line feedback provided in response to CASA's Review of RPAS Operations Discussion Paper

Figure four above shows that the two most common themes supporting counter-drone technology are for use in controlled airspace and in the vicinity of prisons.

There is a wide range of views regarding CASA's approach to regulation

The most common theme to emerge from respondents' in relation to CASA's approach to regulation is that the current rules are sufficient and/or CASA is doing a good job. However, respondents also raised suggestions to amend the rules either to strengthen regulation in areas of perceived greater risk (such as inexperienced recreational operators) or reduce regulation where there is a perception current rules are not keeping pace with technological change (recreational users raised height limits and visual line of sight restrictions in this context).

FIGURE 5 | KEY THEMES OF COMMENTS IN RELATION TO CASA'S APPROACH TO REGULATION (NUMBER)



Source: On-line feedback provided in response to CASA's Review of RPAS Operations Discussion Paper

Figure five above shows the most common theme from respondents about CASA's approach to regulation that the current rules are fine and/or that CASA is doing a good job. Comparatively, the second and third most common themes raised by respondents are around amending the rules and to make changes to education.

Mandatory registration

While there is demonstrated support for mandatory registration, the determination of what RPA should be registered and how, is less clear. CASA has examined the potential benefits and cost of RPA registration and how registration regimes operate in other countries. Discussion on these aspects and on the key elements of a RPA registration system in Australia is provided below.

Benefits

The introduction of a RPA registration system in Australia would provide benefits – some of which are clearly tangible, while others are less compelling.

In recent communication with CASA, the Australian Transport Safety Bureau (ATSB) advised that "*a requirement for RPAs to display registration and/or contact details would assist the ATSB in identifying the owners involved in a reportable incident or accident.*"

Data gathering

Registration provides a mechanism to gather data on total RPA numbers, RPA types, locations, and the operational categories (commercial versus recreational) RPAs are being used in. This data would be useful to determine the resources required to adequately oversight the safety of RPA operations in Australia and to more accurately determine the likely impacts of proposed legislative changes.

Disincentive to operate unlawfully

Assuming a person registers an RPA properly, an argument may be made that a person would be less likely to operate unlawfully when their RPA is more readily identifiable by authorities in the instance were the RPA operator operates unlawfully. For example, where an RPA collides with a building and is recovered by law enforcement authorities, the RPA's owner could be identified through the registration database.

Direct access to educate and inform RPA owners

Currently, CASA uses its best efforts to target RPA education and safety campaigns to certain demographics, however this is, at best, a broad approach that is not cost effective. A data base of accurate contact details of RPA registration holders would allow for highly targeted safety

education campaigns, and direct engagement and consultation on proposed legislative changes. Direct access to RPA owners would result in more effective use of financial resources.

Future ready

Registration is an important element in the safe integration of RPA into Australia's airspace. Technologies such as electronic-identification, also known as remote or e-identification, where the RPA emits a unique identification code or similar that may be detected, could be coupled with registration. That is, as part of the registration process, the unique identification code of the RPA is linked to the RPA registration.

An application of this technology would potentially permit a law enforcement officer to detect the RPA unique identification code of a RPA that may be operating unlawfully, by using a hand-held device. The unique identification code could then be matched to a RPA registration holder, using a secure interface to the RPA registration database to determine who the RPA registration holder is.

The design and application of this capability would require significant technical design in addition to consultation with RPA manufacturers, RPA operators, law enforcement agencies, and the Australian public.

Cost

The implementation of a RPA registration system is likely to require some level of cost recovery or cost offset in accordance with Australian Government requirements. A tiered cost structure for registration may be required to apportion costs appropriately, relative to the type of RPA activity. For example, the cost to CASA (mostly in the provision of services) to adequately oversight commercial operations of a large RPA are greater that the oversight of a light-weight RPA used exclusively for recreational purposes.

CASA currently receives funding from three major sources: a Government annual appropriation; a 3.556 cent per litre excise on aviation fuel consumed by all domestic manned aircraft; and regulatory services fees. For the most part, RPA do not use aviation fuel and therefore, no funding for RPA oversight by CASA is received from this source on the basis of the operation of RPA. This means that as RPA numbers and use increases in Australia, there is no corresponding increase in funding from fuel excise. Similarly, regulatory services income is only generated from commercial RPA operators who seek authorisations from CASA. No regulatory services income is generated from recreational RPA operators. This is already placing a significant burden on CASA's funding and in turn, its people resources.

CASA's RPA efforts currently cost in excess of $3M per annum and this is expected to increase significantly in future years until RPAS technology is stable and fully integrated into the aviation system.

What are others doing?

RPA Registration regimes are used in other countries. The United States of America (USA) has two systems for registration, depending on the activity the RPA will be used for. A person flying solely for recreation or hobby must register the RPA under the 'Special Rule for Model Aircraft – Section 226' requirements where its weight is greater than 250 grams and less than 25 kilograms. Registration is US$5 and is valid for three years, with the single fee covering all RPA registered by the person under the model aircraft rule.

A person flying for recreational or commercial use must register the RPA under the 'Small UAS Rule – Part 107' requirements where its weight is greater than 250 grams and less than 25 kilograms. Registration is US$5 per aircraft and is valid for three years.

In Canada, an 'Interim Order Respecting the Use of Model Aircraft' requires that RPA weighing more than 250 grams but not more than 35 kilograms, and used for recreational purposes, do not have to be registered, however they must be clearly marked with the owner's name, address and telephone number.

In the United Kingdom, all RPA over 150 kilograms and some over 20 kilograms must be registered. The UK Government announced in July 2017 that RPA weight 250 grams and over will in the future, need to be registered. No date for the introduction of the registration system has been announced. An impact assessment titled 'Registration requirements for drones' has been conducted by the UK Government. The assessment proposes a registration fee of £5, with a requirement to renew each year free of charge.

The European Aviation Safety Agency (EASA) put forward recommendations on RPA registration that were agreed to, in principle, by the European Union member states in December 2017, requiring RPA that, in the case of impact, can transfer to a human kinetic energy above 80 joules need to be registered.

CASA's findings

CASA supports the requirement for mandatory RPA registration in Australia but notes that the benefits realised from the implementation from such a regime are not all related to aviation safety. With the large number of RPAs estimated to be in Australia, some sort of registration amnesty period should be established. CASA's findings are predicated on the following guiding principles for a RPA registration system:

- registration process must be simple and the system easy to use by the applicant
- data integrity is paramount – including a requirement for an applicant to confirm their identity by using the Australian Government's online document verification service
- each RPA to be registered and to include certain RPA specific details
- registration may only be completed by a person over a certain age – younger Australians must have the registration completed in the name of a parent or guardian
- registration to be time-based, requiring re-registration after a predetermined time.

The examination of regimes of other countries, combined with the feedback received on registration from CASA's discussion paper prompted the consideration of key elements of a registration system that could be adopted in Australia. These elements are discussed below.

Exclusions from mandatory registration

The *Civil Aviation Safety Regulations 1998* (CASR) defines different weight categories for RPA. These are:

- micro – RPA with a gross weight 100 grams or less
- very small – RPA with a gross weight of more than 100 grams but less than 2 kilograms
- small – RPA with a gross weight of at least 2 kilograms but less than 25 kilograms
- medium – RPA with a gross weight of at least 25 kilograms but not more than 150 kilograms
- large – RPA with gross weight of more than 150 kilograms

The USA and Canada RPA registration regimes exclude RPA weighing 250 grams or less from having to be registered. This is also proposed in the UK. EASA's proposal is to use a kinetic energy break of 80 joules based on how much kinetic energy is transferred to a human if impacted by a RPA. CASA

understands EASA's rationale to be that certain RPA weighing less than 250 grams may operate a high speed and can cause injury if the RPA impacted a human.

Based on the direction a number of other authorities mentioned above are taking, CASA is considering changing the existing weight categories for 'smaller' RPA to align to that of the USA and Canada (and that proposed by the UK); specifically, to replace the weight break between *micro RPA* and *very small RPA* from 100 grams to 250 grams.

CASA recognises that with the rapid advancement of technology, RPA weighing 250 grams or less can travel at significant speed. While a RPA registration regime in Australia should be simple, CASA must take into consideration the risk of injury to persons by RPA weighing 250 grams or less, particularly RPA capable of high speed flight, where the transfer of kinetic energy to a human may be serious enough to cause serious injury.

CASA is considering excluding RPA weighing 250 grams or less and used for recreational or commercial purposes from the requirement to be registered. However, before doing so CASA intends to complete further research to determine if RPA weighing 250 grams or less and capable of transferring sufficient kinetic energy to cause serious injury when impacting with a human.

Information to be supplied during registration

CASA endorses an approach where the person completing the registration be required to confirm their identity. To make the registration process simple, and recognising that most registrations ought to occur online, CASA proposes to use the national online system known as the Document Verification Service, offered by the Australian Government[1], be used to confirm people's identity.

CASA also endorses an approach where the make, model and serial number of the RPA be provided. CASA has commenced discussions with RPA manufacturers to see whether barcodes may be affixed on RPAs (some manufacturers already affix barcodes). This would allow CASA to design a registration system capable of reading a barcode to automatically access the RPA make, model and serial number, without having the registrant enter such data manually.

Cost to register

CASA endorses an approach to the cost of registration of the RPA based on the weight of the RPA and the category of operation; i.e. commercial or recreational. Further, CASA endorses that a commercial RPA cost proportionally more to register, than RPA operated exclusively in recreational operations. CASA supports adoption of RPAS technology in new and innovative ways and recognises the importance of the fast-growing sector to multiple industries and to the Australian economy, and therefore proposes to continue research and consultation into the appropriate cost structure. The approach adopted should reflect the cost to CASA to oversight the commercial RPA sector, in the absence (for the most part) of aviation fuel excise of RPAs.

Validity period of registration

CASA is proposing an approach to the validity period of the RPA registration based on the weight of the RPA and the category of operation. For RPA weighing greater than 250 grams and used exclusively for recreational operations, CASA endorses a validity period of registration of 3 years. For RPA used at any time for commercial purposes, CASA endorses a shorter validity period of registration. CASA intends to conduct further research and consultation on the appropriate validity period of registration for commercial RPA.

[1] Further information on the Document Verification Service may be accessed online at www.dvs.gov.au

RPA registration for younger Australians, under the age of 18

It is reasonable to assume many younger Australians, under the age of 18, operate RPA. CASA's proposals for identity verification during RPA registration will require the registrant to have certain identity documents, such as a driver's licence and/or passport. Younger Australian's may not have such documentation. Similarly, younger Australians may not have ready access to payment forms such as credit card to pay the registration fee. It is likely that a guardian may need to sponsor or otherwise complete the registration and assume part of the responsibility for the safe operation of the RPA.

Education and training

With certain exceptions introduced under amendments to Part 101 of the *Civil Aviation Safety Regulations 1998* (CASR), commercial RPA operators and operators of large RPA (above 150 kilograms) must hold a remote pilot licence (RePL) and/or RPA operator's certificate (ReOC) when operating RPA in Australia. To obtain a RePL or a ReOC, a person must have successfully completed a specific training course and passed an examination. The exception to this requirement is when a RPA is being operated in the *excluded category* in compliance with Subpart 101.F of the CASR. Operations under the *excluded category* do not require a RePL, ReOC and do not impose a mandatory education or training requirement; however, the RPA operator must operate in accordance with the standard RPA operating conditions (see subsection 101.238 of the CASR). The standard operating conditions ensure that a person may not operate a RPA in such a way as to create a hazard to another person, another aircraft or property.

RPA operated in Australia for recreational purposes, weighing less than 150 kilograms, are not required to complete any mandatory education or testing.

Benefits

Commercial operations requiring a RePL or ReOC already require mandatory training and testing. Expanding mandatory education and training requirements to RPA operations under the *excluded category*, and recreational operations, should improve voluntary compliance with relevant RPA legislation, reducing the number of RPA-related breaches. Options are available for a mandatory education and training regime include both theory examinations and/or practical assessments.

CASA recognises that many recreational and *excluded category* RPA operators do so lawfully and have a sound understanding of the legislation application to their operation. Many responders to CASA's Review of RPAS Operations discussion paper indicated that they do not support training and demonstrated proficiency for small/recreational RPAS. However, through CASA's investigation of RPA related incidents and complaints, it is evident that there is an increasing number of RPA operators who are unaware of the legislation about the category of operation (i.e. commercial or recreational) they are undertaking, or who have a poor understanding of the RPA legislation, or have interpreted it incorrectly.

Cost

Mandatory education and training for recreational and *excluded category* RPA operators will require funding for the development of an education portal and to support its ongoing maintenance. In addition, ongoing education would be necessary particularly for recreational RPA operators to ensure they are aware of their obligations and to make new RPA owners aware of the legislative requirements.

What are others doing?

The approach to mandatory education around the world is diverse. There are currently no mandatory training or education requirements, or requirements to demonstrate knowledge about, or technical proficiency in, the operation of smaller RPA used *exclusively for recreational purposes* in the USA, Canada, the UK or New Zealand.

In the US, a person using an RPA weighing less than 25 kilograms for certain commercial purposes must pass an aeronautical knowledge test at an approved testing centre.

In Canada, a person using an RPA weighing up to one kilogram for certain commercial purposes does not require specified training, experience or demonstration of technical proficiency. There is, however, an expectation that the person will be familiar with, and abide by, the existing safety and operational requirements. The limited commercial use of RPA weighing more than one kilogram and up to 25 kilograms requires a special flight operations certificate, one of the conditions of which is that the pilot must have the knowledge and training for the operations.

Currently in the UK, permissions and exemptions from the specific training and examination requirements are available for the conduct of certain commercial operations when using an RPA weighing less than seven kilograms. To use an RPA weighing more than seven kilograms for such purposes, the person must have the competencies of a remote pilot licence holder, including the demonstration of adequate theoretical knowledge, successful completion of a practical flight assessment and completion of a minimum amount of recent flight experience. The UK government recently announced that it is considering the introduction of basic knowledge and safety testing for anyone operating a drone that weighs more than 250 grams.

In New Zealand, RPA weighing less than 15 kilograms may be used in certain commercial operations without requiring the completion of specified training or testing, so long as the operations are conducted in accordance with the applicable requirements. For commercial operations using RPA weighing 15 kilograms (but not more than 25 kilograms), the approval of the Civil Aviation Authority of New Zealand is required. In assessing applications for such an approval, consideration is given to the applicant's general aviation knowledge and their specific knowledge of how to remotely pilot the aircraft. Commercial operators using RPA weighing more than 25 kilograms require an operating certificate, with specified knowledge and experience requirements.

On 14 February 2018, the world's largest manufacturer introduced a mandatory quiz for Australian users of their RPA, through its mobile apps that interface with their RPA's control system. The app requires users to successfully answer nine multiple choice questions about CASA's recreational RPA rules before the app may continue to be used. CASA encourages all RPA manufacturers to utilise technology to assist in the user's understanding and compliance with RPA legislation in Australia.

CASA's findings

CASA finds that the current education and training requirements for the issue of a remote pilot licence are sound and should continue. In addition to existing requirements, CASA endorses an approach that requires recreational RPA operators to undertake a simple online course on safe recreational RPA operations, followed by a quiz that has a minimum pass mark. The endorsement is predicated on the following guiding principles:

- the course and quiz must be of short duration, and offered primarily in an online environment
- the course must hold the attention of users and be simple to follow
- the quiz must be designed so that the question sets change regularly to maintain integrity of the testing process

- the applicant must be shown what questions they answered incorrectly and if the mark is below the minimum, be provided with the option to re-sit the course before undertaking the quiz again
- if RPA registration and RPA training become mandatory, both should be contained in the one online system to make the process seamless for the applicant.

Similarly, CASA endorses an approach that requires *excluded category* RPA operators to undertake a simple online course on safe commercial RPA operations in compliance with the standard RPA operating conditions, followed by a quiz that has a minimum pass mark. The endorsement is predicated on the same guiding principles mentioned above for recreational RPA operators, albeit the course may be of longer duration given the greater breath of requirements in the *excluded category*.

Deployment of geo-fencing

Geo-fencing is a form of electronic containment or exclusion that uses Global Positioning System (GPS) or other radio frequencies to create a virtual boundary in two or three dimensions around and between certain areas. Geo-fencing may be used to contain a RPA within a fixed or dynamic area, to exclude RPA from designated areas, and/or to prevent RPA from exceeding certain altitudes.

Geo-fencing is employed by several RPA manufacturers. One manufacturer who has a large market share in Australia currently uses geo-fencing to prevent its RPA operators from flying at primary airports in Australia, however the excluded areas are a simple circle based on a singular geographic reference point, such as the aerodrome reference point, and a defined radius. The same manufacturer is working to develop a more situationally appropriate system of geo-fencing in Australia, which would allow for polygonal shapes that can more accurately represent restricted airspace boundaries, airport boundaries and other areas where RPA should not be operating.

The challenge with geo-fencing is that is not utilised by all manufacturers, and it generally relies on some sort of database of geo-fenced areas. Airservices Australia provides standard data on airspace information in Australia, as well as some information on certain aerodromes; however, this is not designed for or necessarily fit for purpose for RPA manufacturers and often requires the manufacturer to overlay the data with additional information for it to be used for geo-fencing purposes. In addition, certain commercial RPA operation may be lawful at a particular location, but unlawful for a recreational RPA user, adding a layer of complexity to the administration of geo-fencing, especially if geo-fencing were to me be made mandatory. Similarly, at this point it would be difficult be technically complex to administer geo-fencing parameters on home built or custom manufactured RPAS.

Benefits

Where available, geo-fencing may assist in the prevention of RPAs being operated unlawfully in certain locations, such as around primary airports or in restricted airspace. Geo-fencing is being used by one RPA manufacturer at the 2018 Commonwealth Games to prevent, where possible given the limitations of the system, unlawful RPA operations in restricted airspace setup for the event.

Costs

It is difficult to estimate the costs associated with mandating geo-fencing, as many RPA manufacturers do not have the technology and systems to implement geo-fencing capabilities in their RPA products.

In addition to the cost to the manufacturer, mandatory geo-fencing would require access to a dynamic dataset in a format readily usable by manufacturers and data service providers. Given that

airspace, particularly restricted airspace, is often dynamic, there would likely be a requirement for constant communication with the RPA, such that airspace data and any changes to geo-fenced areas can be updated in real time. This would likely require an active data connection on the RPA controlling device, such as over the 4G network, so that the latest geo-fencing data may be accessed.

What are others doing?

Research and development on the use and deployment of geo-fencing systems for RPA is proceeding around the world, within the industry and at universities and in conjunction with national governments and regional aviation authorities.

Currently, there are no geo-fencing requirements in place in the USA, Canada, UK or New Zealand, although the introduction of geo-fencing arrangements is being seriously considered.

EASA has proposed a system of geo-awareness – a system that informs the RPA user when the RPA is entering a prohibited zone.

CASA's findings

CASA acknowledges the advantages and potential applications of geo-fencing technology. We recognise, however, that the technology requires further development and broad adoption by manufacturers before a mandatory standard can be contemplated. CASA is aware that geo-fencing is linked to other safety-related RPA developments including unmanned traffic management (UTM) systems.

CASA endorses RPA manufacturers' efforts to utilise geo-fencing technology to prevent RPA operations in areas where operations are not permitted, including at or near major airports and certain classes of restricted airspace. For example, CASA worked with a manufacturer to create geo-fencing of temporary restricted airspace associated with the Commonwealth Games in Queensland. This prevents users of the manufacturer's RPAs from inadvertently entering temporary restricted airspace when the airspace restrictions are active.

CASA will continue to work with RPA manufacturers by recommending frameworks for appropriate geo-fencing in Australia. This includes providing advice on what areas to implement geo-fencing, and approval mechanisms to those RPA operators who are appropriately trained, and authorised by CASA, to operate in certain restricted areas. For example, CASA endorses the Australian Transport Safety Bureau (ATSB) to operate in accordance with its established and approved procedures at or near major airports when conducting investigations, which requires the manufacturer of the RPAs used by the ATSB to 'unlock' flight in geo-fenced areas that normally prohibit such flights.

In addition to CASA's encouragement of manufacturers to adopt geo-fencing capability, CASA will continue to carefully monitor technological developments in geo-fencing, particularly in relation to advancements in geo-fencing and its interaction with UTM systems. CASA should target its participation in international forums to ensure it stays abreast of global trends in this field and participate in trials of the technology where feasible.

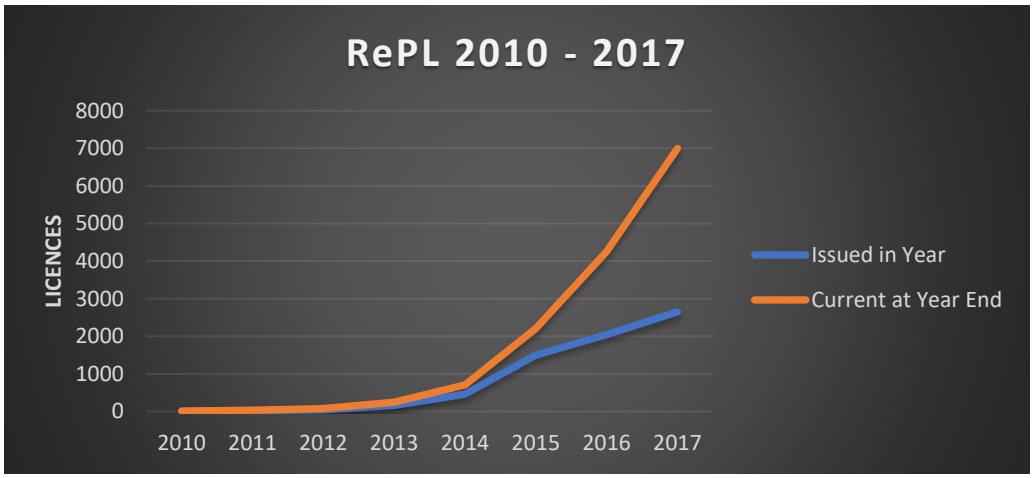
CASA recommends changes to improve the suitability of Airservices Australia standard data for use by RPA manufacturers in applications such as geo-fencing, noting that this represents an additional and sizeable body of work for Airservices Australia.

Growth of RPAs in Australia

Industry estimates provided to CASA suggest that there are well in excess of 150,000 RPA currently in Australia. Comparatively, the FAA recently reported that they have exceeded one million RPAs in their registration system.

CASA continues to see exponential growth in the number of remote pilot licences (RePL) being issued.

FIGURE 7 | NUMBER OF REPL IN AUSTRALIA 2010 - 2017



As at the 26 February 2018, there were:

- 1,283 RPA operator certificate holders
- 7,380 remote pilot licence holders
- 10,253 online notifications from commercial RPA operators intending to undertake RPA operations in accordance with the standard RPA operating conditions – since the introduction of the RPAS notification system for excluded category RPA operators in September 2016

RPA incidents

The ATSB reports that there have been no collisions between RPAs and manned aircraft in Australia.

The ATSB has published ten investigations into RPA incidents in the past five years, including two research investigations in 2017.

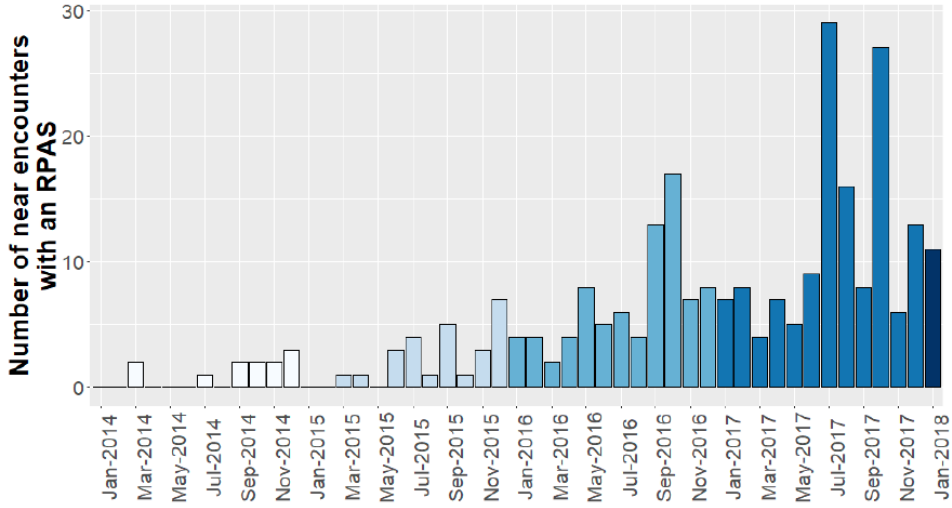
From information supplied by the ATSB to CASA, in January 2018, there were 11 reported RPA near encounters with manned aircraft, of which six occurred within 20 nautical miles of Sydney Airport.

In 2017, there were 151 reported RPA near encounters with manned aircraft, of which 72 occurred within 20 nautical miles of Sydney Airport.

In the five-year period 2012-2016, there were 127 reported RPA near encounters with manned aircraft:

- 53 occurred within 20 nautical miles of Sydney Airport
- 84 occurred in 2016
- more than 70% occurred above 1,000 ft, where the altitude is known

FIGURE 8 | RPA NEAR ENCOUNTERS



Source: ATSB, February 2018

The ATSB review occurrence data and RPAS collision research quarterly to assess whether RPAs pose an unacceptable risk to manned aircraft. ATSB indicates that, according to their data, RPAs are safer than other aircraft conducting survey and photography aerial work.

CASA's enforcement activity

In accordance with CASA's Regulatory Philosophy, CASA ensures that its actions and responses are appropriate and proportional to the circumstances. To that end, in addressing RPA-related complaints, CASA adopts an approach to regulatory compliance based on the encouragement of training and education, with a view to remedying identified shortcomings and correcting specified deficiencies. Where there are more serious, safety-related implications relating to a complaint or incident, CASA instigates a coordinated enforcement process, to identify the most appropriate response (which may or may not involve enforcement action).

In 2017, of the more serious matters escalated through the coordinated enforcement process, CASA issued 43 aviation infringement notices and 38 formal counselling letters.

Of the 465 complaints received during the period September 2017 to mid-February 2018:

- 84 complaints were found to have insufficient evidence to proceed with further review or investigation
- 146 complaints were closed as no breach was detected
- 235 complaints were found to contain sufficient information about an alleged breach of legislation. Of these:
    - 29 complaints were escalated to coordinated enforcement due to the seriousness of the matter, and
    - the remainder resulted in education sessions being conducted.

In November 2017, CASA facilitated a forum with state, territory and federal law enforcement agencies to develop and extend a standardised approach to instances and/or reports of local RPA-related breaches. This body of work is ongoing and is strongly supported by participating law enforcement authorities.

CASA's activities in response to the growing RPA sector

A number of initiatives have been instigated by CASA in response to growing RPA sector, to ensure CASA's operating model remains effective in the regulation and oversight of RPA activity.

Dedicated RPAS Branch

In August 2017, the CASA Director of Aviation Safety and Chief Executive Officer created a new branch in CASA, dedicated to the RPAS sector, appointing an experienced CASA senior manager to lead the branch. The RPAS Branch is responsible for policy and standards developments for RPAS, regulatory services for RPA operators, oversight and enforcement of the RPA sector, engagement and building effective relationships with RPA operators, manufacturers and industry associations, and effective safety education for RPA operators and public awareness of RPAS operations.

Direction

A direction, dated 17 October 2017, was issued under regulation 11.245 of the CASR to strengthen and clarify the operations of certain unmanned aircraft, including RPA.

The direction provides a common set of rules that are applicable to recreational RPA operators, as well as those operating a RPA in the sub-2kg *excluded category*. The following is a summary of the rule set:

- operate during the day and within (unaided) visual line of sight;
- no operations anywhere above 400 feet;
- no operations closer than 30 metres to people;
- no operations over or near an area affecting public safety or emergency operations;
- operate only one RPA at a time;
- no operations over or above people;
- no operations within 3NM (5.5km) of a controlled aerodrome (excludes micro);
- operations within 3NM (5.5km) of a non-controlled aerodrome or helicopter landing site is possible, but only if no manned aircraft are operating to or from the aerodrome/HLS. If an RPA operator becomes aware of manned aircraft operating to or from the aerodrome/HLS, the operator must manoeuvre away from the aircraft and land as soon as safely possible (excludes micro).

Holders of a remote pilot licence operating in accordance with the procedures of a RPA operator certificate and certain holders of CASA authorisations – including designated model aircraft associations – may continue to conduct their operations, as these holders have been exempted from the conditions contained within the instrument.

'Can I Fly There?' app

Using a simple graphic interface, the 'Can I fly there?' app targets sub-2kg commercial and recreational RPA operators to raise awareness of the simple rules and areas where drones cannot fly. Since its launch in late May 2017, the smartphone app has been downloaded over 94,000 times and the web version has had an average of over 22,000 unique users per month.

The current version displays a 5.5km circular area around fire-affected emergency areas and reflects the strengthened RPA rules enhanced by the Direction mentioned above.

Dedicated websites

CASA recognises that its webpage – www.casa.gov.au/drones - is consistently in the top five pages visited on the CASA website. The page has been redesigned to guide RPA operators through to the right information easily.

Based on feedback, CASA created a stand-alone website for recreational RPA operators – www.droneflyer.com.au – containing simple rules, helpful educational videos and an online quiz.

RPA safety promotion and education

CASA continues its RPA safety awareness campaigns and education through a multi-channel approach. CASA is active on multiple social media platforms, raising RPA safety awareness. Campaign highlights include:

- advertising targeting amateur and semi-professional RPA operators through multiple media channels, online and print, including photography and real estate magazines
- advertisements on sites specifically discussing rules for recreational and excluded category RPA users
- providing leaflets about RPA safety for manufacturers to place inside packaging
- engaging with RPA retailers, resulting in retailers placing RPA safety flyers with RPAs and the printing of taglines about the RPA rules on sales receipts
- cinema advertising targeting movies that appeal to the RPA user target demographic; i.e. males aged 16-34
- targeted advertising campaigns in the lead up to the bushfire season to promote RPA safety awareness
- sponsorship of, and attendance at, industry events to support RPA safety awareness-raising efforts
- production of a suite of printed brochures and guidance material
- production of targeted short videos promoting awareness of the rules– including not flying near bushfires, buying a RPA over the Christmas season, and other educational videos.

Developments in ICAO and other aviation safety agencies

CASA regularly interacts with its counterpart agencies – the FAA, Transport Canada, Civil Aviation Authority New Zealand and UK Civil Aviation Authority. These exchanges are highly beneficial, allowing the latest information on regulatory developments, incidents and trends, as well as technology developments to be shared. CASA is hosting representatives of the FAA Unmanned Aircraft Systems (UAS) Integration Office team in April 2018.

CASA supports the RPAS development work undertaken by member states and ICAO. CASA is a panel member on Working Group 5 Operations on the RPAS Panel – one of seven working groups dedicated to the development of standards and recommended practices in RPAS. CASA recognises the importance of this foundational work and would support the participation of additional Australian attendees if funding were made available.

Complementing this important ICAO work, CASA is a member of the Joint Authorities for Rulemaking on Unmanned Systems (JARUS). JARUS is a group of experts from the National Aviation Authorities and regional aviation organisations, whose purpose is to recommend a single set of technical, safety and operational requirements for the certification and integration of unmanned aircraft systems into airspace and at aerodromes. JARUS aims is to provide guidance material so that individual authorities can develop their own requirements and avoid duplicating effort. Currently, 52 countries contribute to JARUS. CASA has already commenced leveraging the development work of JARUS members with CASA's recent adoption of the specific operations risk assessment methodology in its assessment of RPA operator applications for complex permissions and approvals. CASA will continue to contribute and leverage the work of JARUS in areas including certification standards, unmanned traffic management systems, and risk management.

CASA's RPAS roadmap

CASA recognises the importance of developing a comprehensive roadmap that underpins CASA's policy statement to implement an effective regulatory framework to enable the safe and efficient integration of RPAS into the Australian aviation system.

EASA and FAA have established regulatory roadmaps that detail how each of the respective jurisdictions will safely integrate RPAS into the airspace system.

A CASA roadmap is currently in development and will provide the iterative steps required to move from the current state of RPAS operations in Australia, to the desired state of safe integration of RPAS into the Australian aviation system, particularly into Australia's airspace. Elements of the roadmap are expected to include:

- airspace integration
- risk and safety management
- unmanned traffic management
- operations near and to/from aerodromes
- initial airworthiness and certification standards
- continuing airworthiness and maintenance
- detect and avoid
- command and control
- communication protocols, ground station requirements, RPA communication requirements
- autonomy, autonomous systems and automation
- registration
- e-identification
- training and competency
- geo-fencing
- human factors
- safety management systems

The roadmap will build on the work conducted by the previous Unmanned Aircraft Systems Sub Committee. The roadmap is estimated to be completed by end of 2018.

Conclusion

CASA is committed to implementing an effective aviation safety regulatory framework to enable the safe and efficient integration of RPAS into the Australian aviation system. CASA supports adoption of RPAS technology in new and innovative ways and recognises the importance of the fast-growing sector to multiple industries and to the Australian economy. Through this review process, CASA has made a number of findings for further consideration that would enable the RPAS sector to continue to innovate within an appropriate regulatory framework. With the revolutionary pace at which RPAS technology is evolving, it remains incumbent on CASA to be regularly reviewing the aviation safety regulatory framework to ensure that is contemporary, effective, and does not inadvertently stifle innovation.