Final report

Livestock Mustering with Drones and Pathways to Adoption

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Abstract

There is an opportunity for drones to eclipse traditional methods of helicopter mustering by making it cheaper, safer and more productive and have a positive impact on both the environment and animal welfare. Drone mustering is currently being practiced on Australian livestock operations, but the technology being used is in the main quite basic. It follows that results which showcase the full potential of this emerging technology have hitherto not achieved.

This project used the latest in drone hardware and software to highlight that this method of livestock mustering is a viable solution which will greatly benefit livestock producers and the industry at large. Nineteen different mustering trials on nine separate properties were conducted on a wide array of different land types and on the most common livestock species of sheep, cattle and goats. This project ultimately finds that aerial mustering using drones is highly effective and unlocks many opportunities and benefits, although certain regulatory and technological barriers exist which could hinder mass adoption. Notwithstanding, these barriers are not insurmountable and can be overcome in due course. It follows that opportunities for additional products and services can be created to supplement the solution.

Executive summary

The use of aerial aids to locate and muster livestock has long been proven to be highly effective. This project sought to validate claims that drones could outperform current methods by making it cheaper, safer, more productive and positively impact the environment and animal welfare. Leader of the project, SkyKelpie Pty Ltd, aims to be the first company in the world to enable and commercialise drone mustering. Founder Luke Chaplain is a grazier and 2022 Nuffield Scholar.

This research is broadly applicable to livestock producers nationally and globally. The results will inform livestock operators on how to achieve successful drone mustering operations under current regulations and within the technological parameters available. It will also provide recommendations of further lobbying and R&D required to see mass adoption in the solution.

The project has three key objectives:

- **Proving the solution**
  Nineteen different mustering trials on nine separate properties were conducted, representing a vast contrast of land types and the most common livestock species of sheep, cattle and goats. The latest and most relevant hardware and software was employed.

- **Develop best practice drone mustering workshop**
  The content of this workshop encompassed:
  - Introduction to technology
  - Benefits of the solution
  - Case studies – Drone mustering
  - Regulations – Landholder Rule and beyond (EVLOS, BVLOS)
  - Safety and compliance
  - Tools and services to get you flying and stay compliant
  - Drone mustering techniques – Practical flight exercise with livestock (if achievable)

- **Deliver five best practice drone mustering workshops**
  The locations were:
  - Cloncurry
  - Toowoomba
  - Tamworth
  - Rockhampton
  - MLA updates 2022

The success of this project can be attributed to the competency and experience of the personnel involved. This was a project developed and run by producers, for producers. The key finding of this research is that drones are highly effective for locating and mustering livestock. This report validates claims that drones are cheaper, safer and provides productivity advantages and benefits which outperform current methods, although further research is recommended. Other recommendations that will assist in the adoption of this solution include regulatory progression, hardware and software development, AI development, training and raising awareness.

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1. Background

There is opportunity for drones to eclipse traditional methods of helicopter mustering by making it cheaper, safer, more productive and have a positive impact on the environment/animal welfare. Drone mustering is currently being practiced on Australian livestock operations, but most of the technology being used is quite basic, therefore results are not being produced which showcase the true potential and possibility of this emerging technology. This project used the latest in drone hardware and software to prove this is a viable solution that will widely benefit livestock producers and the industry at large.

Full regulatory compliance of current operators performing drone mustering is not guaranteed. The development of a drone mustering workshop simplified the onerous regulatory and compliance framework that is a burden to the industry. The workshop gave technical insights about applying this technology for specific mustering activities and informed the risk and safety requirements for themselves, their animals, and other aircraft in the sky.

Leader of the project, SkyKelpie Pty Ltd, aims to be the first company in the world to enable and commercialise drone mustering. Founder Luke Chaplain is a grazier and 2022 Nuffield Scholar who aims to visit the UK, Israel, Germany, South Korea, Japan, China and USA for his research. SkyKelpie brought prior knowledge and learnings from previous self-funded, and government supported trials/case studies, to facilitate the best possible outcome for this project. Previous research included MVP trials on Luke's family property and a recent collaboration between SkyKelpie and DAF (QLD) where learnings included: *The process that is required under current regulatory framework for a livestock producer with no aviation background to become licenced and certified to operate a drone on their property for the purpose of mustering livestock. This also includes the land approval process to undertake such activities.*

2. Objectives

The project was split into three key objectives.

Proving the solution

As this was one of the first professional trials of its kind in the world, a range of different technologies over various land types were tested. The latest and most appropriate drone hardware and software was used for these trials. A variety of land types included thick timber country, semi open downs, open downs, rocky country and pulled scrub. The objective was to perform five official mustering trials, with the probability to document more. These included: one BVLOS operation, one EVLOS Class 2 operation, one EVLOS Class 1 operation and two VLOS operations. The extent of how valuable drones can be for mustering livestock was largely unknown. This objective was the backbone of the entire project, and the results would inform the direction of the rest of the project.

Develop best practice drone mustering workshop

SkyKelpie developed a one-day workshop that informed livestock operators on how they are legally able to perform drone mustering under the 3.2.10 Landholder Rule – *Remotely Piloted Aircraft Systems – Licencing and Operations* (Appendix 3) without the need of a Remote Pilot Licence (RePL). The workshop also explored what is required for 'Included RPA', which is a non-regulatory term for Remotely Piloted Aircraft (RPA) operations that require authorisation in the form of a Remote Operators Certificate (ReOC) and RePL. Key components of the workshop included:

- Introduction to technology
- Benefits of solution
- Case studies – Drone mustering
- Regulations – Landholder Rule and beyond (EVLOS, BVLOS)
- Safety and compliance
- Tools/services to get you flying and stay compliant
- Drone mustering techniques – Practical flight exercise with livestock (if achievable)

Deliver five best practice drone mustering workshops across suitable locations

Over and above writing a report, SkyKelpie felt it would be productive to 'get on the road' and showcase the results of these trials in person. The objectives of these workshops were to educate people and simplify the onerous regulatory and compliance framework that is a burden to the industry. The workshop gave technical insights about applying this technology for specific mustering activities and informed the risk and safety requirements for themselves, their animals, and other aircraft in the sky. They also sought to gauge the level of interest from the industry and use the knowledge and experience of attendees to learn of technology gaps and future opportunities for drone applications.

3. Methodology

Mustering trials were conducted over various land types and livestock, to represent the vast Australian livestock industry. Evidence of this can be seen under trial sites in section four of this report.

RPAS description

DJI Matrice M30T

The DJI M30T combines the powerful and intelligence of the DJI Matrice 300 RTK into a portable, foldable, and lightweight body. This new all-in-one solution allows organisations and pilots to gain new efficiencies with the new fully remote fleet management system and the autonomous docking and recharging station (sold separately). The future has arrived with DJI's latest transformational technology.

The DJI M30T is integrated with multiple high-performance sensors (12MP Wide Camera, 48MP Zoom Camera, 640 x 512px 30fps Thermal Camera and a 1200m Laser Range Finder) in an IP55 certified lightweight body. The M30T is controlled through the all new DJI RC Plus enterprise remote

controller with the newly upgraded DJI Pilot 2 which has undergone significant changes for efficiency and greater flight safety.

Image 1: DJI M30 RTK (unmodified)

Command and Control

The DJI RC Plus operates on the four antenna OcuSync 3 standard, (2.4 – 2.4835 GHz and 5.725-5.850 GHz), has a maximum control distance of up to 8 km (CE) and supports Wi-Fi and Bluetooth functions. The remote controller is equipped with a 7-inch bright, dedicated screen that has the DJI Pilot 2 app built in, significantly improving smoothness and stability. This controller can support RTK with an attached dongle or tether, however Sky Kelpie did not use RTK for this operation.

Image 2: DJI RC Plus

DJI Pilot 2 & DJI FlightHub 2

Pilot 2 works seamlessly with the DJI RC Plus. Screen side and customisable buttons are all within reach and enable quick operations, such as adjusting camera views and dropping Pinpoints. Drone and payload controls can be easily accessed with one tap. Clear presentation of flight details and navigational information improves user experience and flight efficiency.

FlightHub 2 is an all-in-one cloud-based drone operations management platform that helps you achieve comprehensive, real-time situational awareness. Access all the information you need to plan drone missions, supervise your fleet, and manage the data you create, now from a secure cloud-based environment. The powerful mapping capability can easily distinguish mustering zones and operations can be viewed live anywhere in the world with the software's livestreaming.

Link of video feed on drone

Image 3: DJI Pilot 2 & DJI FlightHub 2

LP12 Spotlight & Speaker

The LP 12 Searchlight and Broadcasting System takes the DJI M30T to the next level for day and night operations.

With a lightweight design of 270g, a streamline aesthetic, wind-resistant design, sound distance of 200m, and illumination of 100m, this small piece of technology proved to be extremely helpful in certain mustering situations. Through simply connecting the speaker to a computer, we uploaded customs sounds such as helicopter noise, dog bark, human voice and different types of music to aide our mustering operations.

Image 4: LP Searchlight & Broadcasting System

Safety features

The table below describes some of the safety features available on the DJI M30T incorporating the DJI RC Plus 3.0 RP interface:

Feature	Description
Failsafe RTH	Is automatically activated if the remote controller signal is lost for more than three seconds. The RPA will then return to the home point recorded when GNSS was acquired on start-up. If failsafe RTH is not enabled, the RPA will hover in place.
Battery warnings	Low battery warning is automatically displayed when the UA reaches a pre-determined remaining battery voltage and commences RTH. Critical low battery warning is automatically displayed on the controller when there is only enough remaining battery to land in place.
Obstacle avoiding sensors	Six dedicated sensors can detect obstacles from 0.7m to 30m in all directions from the RPA and, unless disabled, the RPA will not allow itself to be flown into a detected obstacle (including ground). Whilst these sensors are not expected to avoid all obstacles, they do also provide warnings to the RP so pilot awareness of potential obstacles (that may be detectable to the RPA but not the pilot through FPV camera) is heightened.

Table 1: M30 UAS Safety Features

DJI Mavic 3 Pro

The DJI Mavic 3 Pro is a multi-rotor drone with a maximum take-off weight of 895g. It has dual IMU and a single barometer and compass for positioning with an approximate position accuracy of 2.5cm. The Mavic 3 Pro also comes with a real-time FPV camera and ten obstacle avoidance vision sensors, that transmit potential obstacle locations and distances (approximated) back to the RP and, unless disabled, will automatically prevent the RPA being flown into a perceived obstacle. The Mavic 3 Pro has a diagonal wheelbase of 38cm. Quite a dynamic and nimble drone that easily gets under

the tree canopy to muster stock. The transmission link on this more affordable drone was at times better than the M30T.

Image 5: DJI Mavic 3 Pro

Command and Control

Offering powerful performance, DJI RC Pro is designed for professional-level aerial photography. Thanks to the next-generation processor and increased storage capacity, DJI RC Pro works more stably and smoothly. It comes with the powerful O3+ video transmission technology and adopts the same control sticks as DJI FPV, offering a precise, ultra-smooth control experience.

Image 6: DJI RC Pro

Safety features

The table below describes some of the safety features available on the DJI Mavic 3 incorporating the DJI app interface:

Feature	Description
Failsafe RTH	Is automatically activated if the remote controller signal is lost for more than three seconds. The RPA will then return to the home point recorded when GNSS was acquired on start-up. If failsafe RTH is not enabled, the RPA will hover in place.
Battery warnings	Low battery warning is automatically displayed when the UA reaches a pre-determined remaining battery voltage and commences RTH.

	Critical low battery warning is automatically displayed on the controller when there is only enough remaining battery to land in place.
Obstacle avoiding sensors and AI return to home	10 dedicated sensors can detect obstacles from 0.7m to 30m in all directions from the RPA and, unless disabled, the RPA will not allow itself to be flown into a detected obstacle (including ground). Whilst these sensors are not expected to avoid all obstacles, they do also provide warnings to the RP so pilot awareness of potential obstacles (that may be detectable to the RPA but not the pilot through FPV camera) is heightened. The RPA also uses AI to navigate return to home paths using obstacle sensors to avoid obstacles, allowing it to execute a RTH without the need to adjust a set altitude if set up before hand by the RP.

Table 2: Mavic 3 Pro UAS Safety Features

Flight Classes

VLOS (visual line of sight)

VLOS conditions means that the drone during the entire flight mission must be clearly visible by the drone operator without any additional aid-equipment such as binoculars, FPV goggles etc. The operator monitors the area and controls the UAV to avoid any collisions or obstacles.

EVLOS (extended visual line of sight)

EVLOS occurs when the drone is flown beyond the pilot's visual line of sight but at least one visual observer is VLOS with the drone or knows the exact location of it. Essentially, the observer must be able to clear the air and ground environment around the drone so careful selection of the observer's location is critical in the planning of any EVLOS operation. Unlike VLOS requirements, the observer can use devices such as binoculars to observe the operating area but must not use these devices as the primary means of keeping the surrounding airspace and ground insight. CASA has divided EVLOS operations into 2 classes:

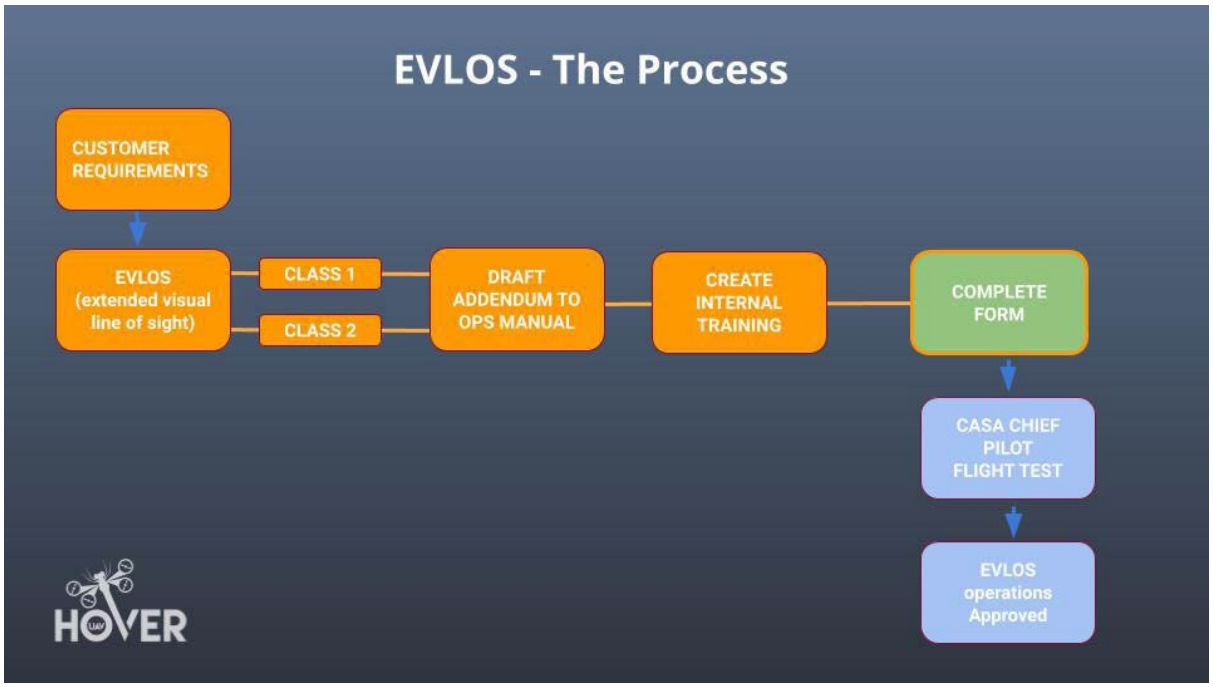
Class 1

Class 1 is where the pilot and visual observer are at the same location. This allows the pilot to use a first-person view (FPV) system to fly the drone while a visual observer clears the operating air and ground environments more accurately. A FPV system reduces the visual cues and restricts the user's peripheral vision, so for these reasons they cannot be used by the observer or in place of an observer. As the pilot and visual observer are standing next to one another, the increase in planning and operating workload should be easily managed. Communication between the operating crew is not reliant on any communication system as it must be verbal, and they can both view a common display, so knowing the exact location of the RPA is uncomplicated. In the event of a fault with the RPA, it should be possible to quickly bring the RPA back into VLOS operations. Hence class 1 is a

great introduction into EVLOS operations and will significantly extend the range of operations depending on the operating location characteristics. Class 1 operations would not be suitable where the observer's view of the ground environment is blocked by buildings, trees or other features.

Class 2

Class 2 is where the pilot and visual observer are in different locations. This allows the drone to be flown at much greater distances from the pilot as multiple observers can be used. It also allows greater flexibility over the observer location, thereby making it easier to position the observer where their view is not obstructed by buildings, trees, etc. However, this could now be the most complex operation with the need for all crewmembers to be highly trained and proficient in their duties. Communication between crewmembers will be performed over a radio or telephone system so there is a higher probability of miscommunication. Although crewmember's situational awareness can be aided by shared displays showing the drone's location, these can be subject to network outages and delays, so their accuracy needs to be constantly confirmed by good crew coordination. Drone faults and failures may now occur at much greater distances from the pilot so the time available to solve these issues may be significantly reduced. A well-thought-out and planned Class 2 EVLOS operation can provide efficiencies and significantly reduce the time taken to complete a task, but it carries more risks to mitigate than VLOS operations. EVLOS does not allow the drone to be flown in cloud or in visibility below 5000m, but it will also not require expensive detect and avoid systems. The pilot is still responsible for ensuring that the drone is not flown within 30 meters of non-consenting people or over populous areas.



(Hover UAV, 2018)

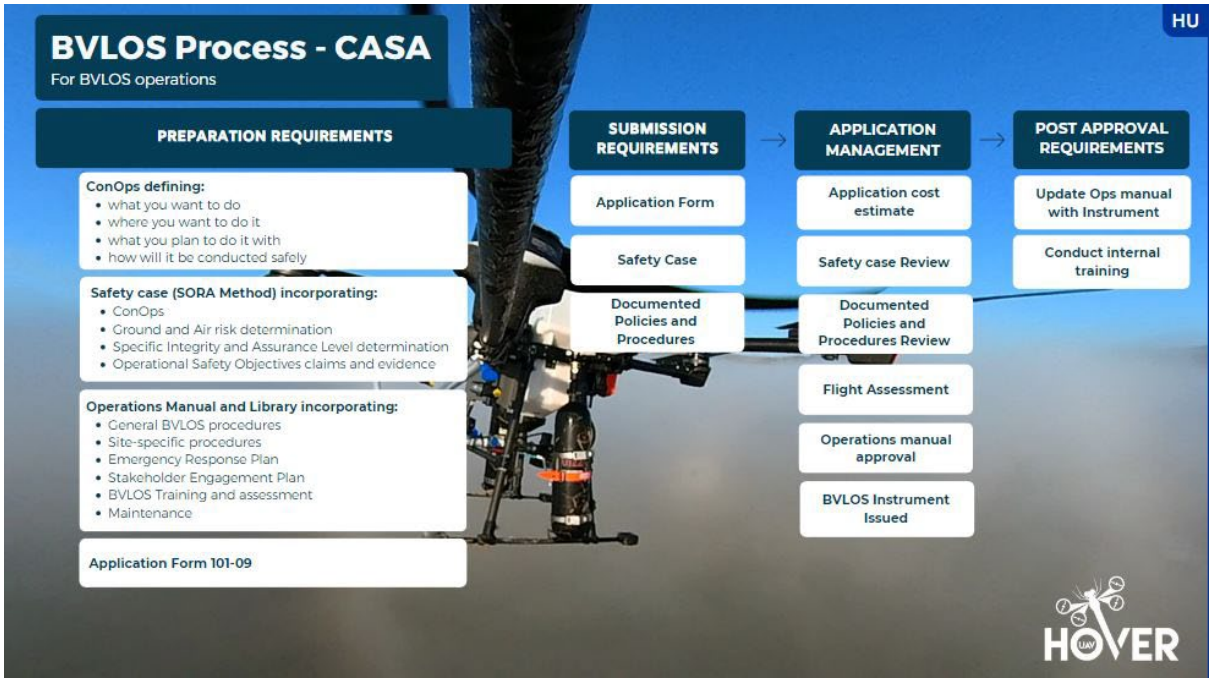
BVLOS (beyond visual line of sight)

Beyond Visual Line of Sight (BVLOS), refers to operations where the person or people responsible for operating the drone cannot physically see it during some or all of its flight. The process of obtaining permission to fly BVLOS in Australia is complex and time consuming. SkyKelpie successfully acquired approval under its Remote Operators Certificate (ReOC) to fly BVLOS operations at two sites,

Malakoff Station and Norlands Station. Some tasks that were required during this difficult process included:

- Develop a concept of operations
- Develop operational area
- Assess the airspace and population within and adjacent to the operational area
- Use the specific operational risk assessment (SORA) process to determine an overall risk level for the operation based on the air and ground risk, and implement strategic mitigations
- Use the overall risk level to determine the level of robustness required for the operational safety objectives that ensure the operation meets the required level of safety
- Create general and site-specific BVLOS operational procedures
- Create training as required (e.g., type of flight or ERP training)
- Submit an application to the National Aviation Authority (NAA) of your country (e.g., CASA)
- Conduct assessments with CASA as required, as this was an in-person flight test

Furthermore, there are licensing requirements for pilots conducting BVLOS operations. Like all operations under a ReOC, pilots must have acquired a Remote Pilots Licence (RePL). In addition to a RePL, pilots flying BVLOS operations must have completed a company training course and hold an Instrument rating (IREX) or be supervised by a pilot who holds an IREX. *(Hover UAV, 2022)*



(BVLOS Process, Hover UAV 2022)

Workshops

It was important when developing this workshop that participants stay engaged. SkyKelpie put together an informative and appealing workshop that taught what is possible now for drone mustering, and what the future may hold. It was free to attend, and lunch was provided as an extra incentive to attract good attendance. See *Appendix 1* for a detailed outline of the workshop that covered a range of suitable topics.

Locations for the workshops were carefully chosen to reach a broad range of producers and industry professionals. These locations were:

- Cloncurry
- Toowoomba
- Tamworth
- Rockhampton
- MLA updates 2022

4. Results

Trial sites

Under each trial site is information about the sites and operation that was conducted. There is also a rating for effectiveness of trials which are:

- Grazier's evaluation of trial, from a scale of 1 being not effective at all, to 10 being extremely effective
- Grazier's evaluation of trial, compared to current methods used. From a scale of 1 being not effective at all, to 10 being extremely effective
- SkyKelpie's evaluation of the mustering trial, from a scale of 1 being not effective at all, to 10 being extremely effective

Oakleigh

Location: Upper Pilton, Qld.
Property size: 490ha
Number of paddocks mustered for trials: 2
Size of paddocks mustered: 80ha, 100ha
Land type: Hilly, rocky, timbered, cultivation

Flight class: VLOS
RPAS: Mavic 3

Livestock type: Dry heifers, 18 months old

Oakleigh was the first property SkyKelpie mustered on as part of the trials. Using just the Mavic 3, while the M30T was on order and slightly delayed due to logistical problems with the manufacturer, the compact and nimble drone was ideal for the trial. Not being large paddock sizes, the 28x zoom worked well in locating the cattle. These cattle had never been mustered by a drone before and they moved quite well in the desired direction. The purpose of this muster was to move the animals onto new pastures for land and animal management purposes. The usual method for this practice at Oakleigh is by motor bike which can be quite dangerous given the terrain. Some surveillance of the property was also conducted such as checking dam levels, water troughs and fences.

Effectiveness of trial: 8
Compared to current methods used: 9

SkyKelpie rating: 8

"The country at Oakleigh can be quite dangerous on a bike, so it was amazing to see the drone could achieve the same outcome." – Jamie Ferguson, Manager.

What other purposes do you think drones could serve on your operation other than mustering?

"It would be great for surveillance of many things, crops, erosion and other land management, stock, waters, and fences. After our experience with this trial, I'm absolutely going to buy a drone." – Jamie Ferguson, Manager.

Footage of Oakleigh trial

Abbotsford

Location: Hughenden, Qld.
Property size: 8,093ha
Number of paddocks mustered for trials: 2
Paddock sizes: Redcliffe Paddock, 1,821ha | Shed Paddock, 2,428ha
Land type: Mitchell grass downs with heavy infestation of prickly acacia

Flight class: VLOS & EVLOS Class 1
RPAS: M30T & Mavic 3

Livestock type: Sheep

- Redcliffe Paddock, 1100 ewes and 850 lambs
- Shed Paddock, 170 ewes

Abbotsford was the first trial site that the M30T was used. The first paddock mustered was Redcliffe. Both drones were used and proved helpful in locating sheep. The drone operator went out with the rest of the mustering crew which was one of the key learnings of this exercise. The operator should have gone out earlier to get their bearings and start to locate the animals before ground crew arrived. There was a mixture of other elements that impeded the drone's effectiveness and therefore gave useful learnings at an early stage of the trials. These included knowledge gaps in technology and the operator's lack of experience with sheep and flight time limitations. Accounting for all these obstacles, the drone was still useful in bringing the sheep together as a mob and checking the paddock to make sure all stock were accounted for.

Shed Paddock was mustered after lunch on the same day using both drones. This was conducted with just two ground staff as we were cleaning up the paddock due to missing approximately 170 ewes when they mustered the week before. The landowners were quite impressed at how quickly the drones were able to scout the paddock and find the missing sheep. Once the sheep were located by the drones, ground staff walked the ewes to the yards.

Effectiveness of trial: Redcliffe Paddock 6/10. Shed Paddock 8.5/10.
Compared to current methods used: Redcliffe Paddock 7/10. Shed Paddock 9/10

SkyKelpie rating: Redcliffe Paddock 5/10. Shed Paddock 8.5/10

"It was helpful to know that Luke could do a sweep behind us to know that we hadn't missed a small mob. It was also helpful near the dam when I couldn't get buggy across a creek with thick trees in it and he could do a sweep and make sure sheep were still coming into the dam." - Anita McNamara, Landholder.

What other purposes do you think drones could serve on your operation other than mustering?

"Land condition scoring, monitoring maremma dogs, especially when they first go out into a paddock, looking for stragglers or small mobs of sheep or cattle in a large paddock." - Anita McNamara, Landholder.

Abbotsford Footage

Rodgers Creek Feedlot

Location: Warwick, Qld.
Property size: 1,011ha
Number of paddocks mustered for trials: 1 + surveillance of 3
Paddock sizes: Sandalwood, 100ha
Land type: Hilly, rocky, scrubby

Flight class: VLOS
RPAS: M30T

Livestock type: Dry cattle

Being a small paddock, this mustering exercise was achieved under VLOS conditions with one set of batteries. The thermal camera was extremely useful in locating the cattle compared to the wide and zoom cameras due to the foggy and wet conditions. The livestock had never interacted with a drone before and responded well.

It was good to trial at such an intensive operation to discover what other use cases might be applicable to drones. The convenience of mustering small paddocks is certainly an application. Also, asset and livestock surveillance could be a legitimate use case. Checking waters, fences, sick animals and feed rations could save time, labour and provide valuable on-farm data. More drone testing should be trailed on similar operations, but SkyKelpie sees a place for them on intensive operations.

Effectiveness of trial: 9/10
Compared to current methods used: 7/10

SkyKelpie rating: 8/10

"Loved the thermal camera…I definitely would have missed cattle if I didn't use it." Ben Daley, Stockman.

Footage of trial

Avington

Location: Blackall, Qld.
Property size: 4,046ha
Number of paddocks mustered for trials: 3
Paddock sizes: Sandalwood, 1,214ha | Leopardwood, 275ha | Horse Paddock, 40ha
Land type: Open Mitchel grass plains, Gidgea channels, Buffel Grass Ridges with forest style timber

Flight class: VLOS
RPAS: M30T

Livestock type: Goats, 3000 head. Same mob in all paddocks, just at different stages.

The trials on Avington produced great results, with encouraging feedback from the landholders. Nat and Amy lean more towards low-stress stock handling, and they were pleased that the drone was able to achieve that. The goats moved off pressure from the drone well. A couple of times the speaker was engaged when the entire mob was moving in the wrong direction. They were quite responsive to the additional noise of the speaker, so it was important the operator didn't overdo it. The zoom camera was extremely useful in monitoring progress and allowed clear insights such as displaced kids and nannies stuck in the fence, without the drone needing to be close and further add stress to the animals. The horse paddock was the final paddock mustered before yarding up. When walking the mob along the fence, the drone handled most of the tail due to labour shortages that day. This was extremely useful as the drone could cover quite a lot of ground quickly and inform the other staff of any problems occurring with the rest of the mob. Goat handling experience of the drone operator was quite limited; but guided by the landholders and using basic stockmanship, the muster was conducted in a professional and timely manner.

Effectiveness of trial: 10/10
Compared to current methods used: 10/10

SkyKelpie rating: 9/10

"It was just as effective as usual mustering methods, but way easier and required less staff. The drone also put less stress on the animals than motorbikes." Natalie Curley, Landholder.

What other purposes do you think drones could serve on your operation other than mustering?

"Checking fences, flooded rivers, pumps, boats. Vermin location. Water checks. All sorts." Natalie Curley, Landholder.

Nat and Amy interview

Redland Park

Location: McKinlay, Qld.

Property size: 16,187ha
Number of paddocks mustered for trials: 1
Paddock sizes: River Paddock, 1,268ha
Land type: Mitchell Grasslands, Gilliat River Channels

Flight class: VLOS + EVLOS Class 1
RPAS: M30T

Livestock type: 500 cows and calves

This paddock was started at first light, meaning the thermal camera worked extremely well for the first few hours of locating the cattle. Approximately 60 head were located at the back of the paddock and once they were started, they kept moving into water well. While progress of the muster was easily monitored with the zoom camera, the drone would check the channels. At one stage when the drone came back to change batteries, some of the cattle were moving away from the nearby water. Before ground staff on a motorbike reached the lead of the small mob, the drone slowly turned them back and settled them back on the water, much to the landholder's surprise. Once all cattle were mustered together, ground staff walked them to the yards. SkyKelpie was told that was the earliest they have ever experienced that paddock in the yards.

Effectiveness of trial: 10/10
Compared to current methods used: 10/10

SkyKelpie rating: 8/10

"Amazing, the drone blew me away. We don't usually use helicopters, but the river paddock is extremely difficult to muster on the ground. Drone mustering is a real game-changer." – Angus Brodie, Landholder.

What other purposes do you think drones could serve on your operation other than mustering?

"Checking waters/cattle, checking the property during wet season when limited road accessibility, weed management / aerial spraying." Hannah Brodie, Landholder.

Redland Park footage

Norlands

Location: Julia Creek, Qld.
Property size: 10,117ha
Number of paddocks mustered for trials: 3
Paddock sizes: Prickly Paddock, 4,000ha | Shed Paddock 428ha | Channel Paddock, 1,400ha
Land type: Mitchell Grasslands, Open downs

Flight class: VLOS, EVLOS Class 1, EVLOS Class 2, BVLOS
RPAS: M30T

Livestock type: Dry cattle

- Prickly Paddock, 300 bullocks
- Shed Paddock, 80 bullocks
- Channel Paddock, 220 steers

It was great to be able to conduct EVLOS and BVLOS on Norlands as it was different land type and livestock to Malakoff, where those flight conditions were also conducted. Norlands has much more open downs, and the cattle are primarily older bullocks which can present more challenges. The cattle moved off the drone very well and congregated nicely into watering points. Three attempts at different locations were made to move cattle that were together as a mob off watering points and on their way to the yards. Two of these attempts were successful using the drone only, although it must be noted that one of those locations was assisted by a fence coming off the water. There was one failed attempt which meant ground staff needed to assist in successfully moving the cattle in the right direction. Attempts to do the same procedure with ground staff alone is historically difficult at this location, so compared against traditional methods, the drone performed well as the cattle responded well to both pressure from ground and air.

Effectiveness of trial: 7.5/10
Compared to current methods used: 9/10

SkyKelpie rating: 7/10

"We don't have a huge problem finding the cattle on this open country, but the drone certainly made it easier on us. It saved us bouncing over the rough paddocks all the way to the boundaries and I thought the cattle responded quite well." Patrick Chaplain, Landholder.

What other purposes do you think drones could serve on your operation other than mustering?

"Remote surveillance would be amazing as no one lives on the property. I understand there is remote monitoring technology currently on the market, but surveillance by a drone would give me a very broad view on assets, pasture, and livestock." Patrick Chaplain, Landholder.

Norlands footage

Malakoff Station

Location: Cloncurry, Qld.
Property size: 19,020ha
Number of paddocks mustered for trials: 6
Paddock sizes: Gidyee Paddock, 2,600ha | Top Paddock 5,000ha | River Paddock, 3,800ha | Mountain Bore Paddock, 2,000ha | Telephone Paddock 370ha | Horse Paddock, 230ha
Land type: Mitchell Grasslands, Open downs, timbered, rocky spinifex

Flight class: VLOS, EVLOS Class 1, EVLOS Class 2, BVLOS
RPAS: M30T & Mavic 3

Livestock type: Cows and calves, steers and heifers, weaners

- Gidyee Paddock, 600 steers and heifers
- Top Paddock, 600 cows and calves
- River Paddock, 500 cows and calves
- Mountain Bore Paddock, 500 cows and calves
- Telephone Paddock, 80 dry cows
- Horse Paddock, 12 stragglers, 8 horses

Malakoff was where the largest number of trials were conducted. This was due to the personal connection between SkyKelpie and the landholders and it being the site where BVLOS land approval was established.

Top, River and Mountain Bore paddocks were all breeder paddocks that had similar results. Cattle moved well off the drones and considerable time was saved. Being breeders there were some baby calves too young to walk to the yards. Traditionally when mustering, baby calves and their mothers are left in the paddock. The zoom camera was successful in determining calves being too small from far enough away that the cow/calf units were not disturbed. Night mustering was conducted in mountain bore paddock which saw all the cattle mobbed together at sunrise, ready to be walked to the yards in the cool of the morning. Top paddock had a laneway to the yards which meant the drone could also drive the cattle to the yards. It's quite common to have trouble yarding up with these larger mobs, but assistance from the drone was hugely beneficial.

Gidyee Paddock is heavily timbered where young cattle are held. With the gidyee being so thick, the drone had to fly directly over all the timber in grids to successfully check for stock. This was more time consuming than utilising the zoom camera like other paddocks, but still greatly beneficial. Starting cattle in the paddock worked well with the drone, although ground staff had some trouble holding the cattle at the water. When they galloped away the drone had some difficulty bending them all around, as they were quite spread out. The drone was certainly useful at bringing the cattle back together, but it would have been more successful if the cattle were more educated or multiple drones were available. Besides a few hiccups, a clean muster was achieved, and it saved the landholder time and money.

The Telephone and Horse paddocks are smaller in size where VLOS operations were possible. These are transactional paddocks where different cattle are held at different times. The M30T was used to bring in fresh weaners from the horse paddock one afternoon with great success. They were brought together as a mob and manoeuvred through a couple of gates which was not an easy task. This demonstrated the power and effectiveness of the drone.

Effectiveness of trial: 8.5/10
Compared to current methods used: 9/10

SkyKelpie rating: 8/10

"It was good to put the drone to the test over different land types. It was hard to get used to how accessible and convenient the drone was…we're usually forced to be organised and have the chopper booked in advance if we want to aerial muster." Patrick Chaplain, Landholder.

What other purposes do you think drones could serve on your operation other than mustering?

"Surveillance of the property when it's wet. Mapping out woody weeds." Patrick Chaplain, Landholder.

Footage of Malakoff

Tumbar Station

Location: Jericho, Qld.
Property size: 68,796ha
Number of paddocks mustered for trials: 1
Paddock sizes: 271ha
Land type: Sandy Loam, brigalow scrub soil, blade-ploughed 5 years ago

Flight class: VLOS
RPAS: M30T

Livestock type: 600 BrahX Weaner steers

It was a good opportunity to trial at Tumbar with Fred, as he has been a supporter of drone mustering for several years and represents genuine corporate interest in the solution. He was pleasantly surprised with how the cattle reacted to the drone, and how much control he had over them. These weaner steers have never been mustered by a drone before. The land type on Tumbar is well suited to drones as there is a lot of pulled scrub. This presents some safety concerns for ground staff, and efficiencies of musters are not always perfect as the animals usually have the upper hand. A very good result and don't be surprised if you see Georgina Pastoral Company rolling out this solution on their properties in the future.

Effectiveness of trial: 9/10
Compared to current methods used: 9/10

SkyKelpie rating: 9/10

"The drone was easy to operate, and I was surprised with how much control I had over the mob. I'm really impressed and firmly believe drones have a huge future in our industry". - Fred Hughes, Georgina Pastoral Company.

What other purposes do you think drones could serve on your operation other than mustering?

"Water runs, infrastructure planning, weed spraying, fence line/pipeline inspections." Fred Hughes, Georgina Pastoral Company.

Footage of Tumbar

Mustering components

Locating, starting, and bringing the animals together as a mob.

This component is what current aerial helicopter mustering is most used for. The benefits are substantial for graziers and the industry at large. The ability of drones during these trials to locate, start and bring livestock together was exceptional. Locating the animals was made easy by the thermal and zoom cameras, technology that helicopter pilots do not have the luxury of. Starting livestock was a success due to the operator's livestock experience and technological know-how. Most of the livestock during the trials had no experience being mustered by a drone before, so a calm approach was used when placing pressure on them. The process of starting the livestock usually began with curiosity from the animals working out what the airborne device was, followed by moving in the opposite direction as pressure was gradually applied. It is quite a natural response for domesticated livestock to move towards their watering point when pressure is put on them in the paddock, but animals have a mind of their own and do not always follow this process. The drone was effective in guiding them in the desired direction.

There was a small number of occasions where the drone was not able to be in complete control; these situations included stubborn bulls and young cattle with limited education. Cattle with limited education tend not to respond to pressure as well as educated cattle, especially when that form of pressure is new to them. These events were controlled by the assistance of ground staff. Like helicopters when dealing with challenged stock, the ground staff were notified without issue and located the animals successfully. If connectivity in rural Australia improves, software like FlightHub 2 will allow for extremely effective communication between the drone and ground staff.

Sheep – https://youtu.be/_jKJZNprgIE
Goats – https://youtu.be/bvwN6VrzM0s
Cattle – https://youtu.be/L9ZV13pzHQg

Driving the animals to and from the processing facility

SkyKelpie experienced success in driving livestock to and from the processing facility. The success of this component will doubtless differ from operation to operation depending on size of mobs, education level of animals, supporting infrastructure and skill level of the drone operator. These trials included several scenarios with different results. As can be expected, this component was more effective with supporting infrastructure such as fences and laneways. To some graziers' surprise, whole mobs were able to be controlled in open paddocks. SkyKelpie did not trial with multiple simultaneous drones but recommends this be considered for several mustering components to save time and increase efficiencies.

Using the drone to assist yarding up was trialled twice. The speaker was engaged at high volume playing the uploaded helicopter noise, which provided a noticeable difference when getting all the cattle in on the first attempt. The ability of the drone to keep the lead moving and making room for the incoming cattle was a significant help. Usually when yarding up a larger mob of cattle from that direction at Malakoff, several attempts are usually needed.

Cattle - https://youtu.be/4dFmtOlJRuk
Goats - https://youtu.be/eYyiiYhxusk
Yarding up - https://youtu.be/PwjufHszsLU

Settling the animals back in the paddock.

It is important to settle animals into a paddock, so they are familiar where the water is (if entering a new paddock) and keeping the young animals paired with their mothers. The drone allowed the operator to have a clear aerial view of the mob and could apply pressure when necessary. The drone operator was able to complete this task on their own, meaning ground staff were free to complete other tasks on the property.

https://youtu.be/pcXnCZoXuEM

Night mustering

The concept of mustering livestock in the dark (early morning) was possibly the biggest 'lightbulb' moment of this trial. This was trialled on Malakoff Station using the thermal camera on the DJI M30T. It was conducted in three different paddocks on a combination of wet and dry cattle. SkyKelpie questioned if the situational awareness of cattle in the dark would be clear enough to take themselves to their watering point, the point at which they generally congregate when pressure is put on them. It was evident in all three paddocks that the cattle knew where they were going. There is evidence that Cows' eyes are built with an extra reflective layer behind their retinas known as tapetum lucidum, which allows them to detect lower levels of light than animals without one *(Can cows see in the dark? (And how they do it), Fauna Facts 2021)*. For the three-night musters, there was approximately 50% moonlight.

The benefits of night mustering could be a game-changer for the livestock industry. Mustering in the early morning means livestock are being moved in the coolest part of the day. This will have a positive impact on animal welfare and productivity.

Although these initial trials seemed promising, SkyKelpie would encourage further research into this method before declaring it a complete success. Further research/trials may include mustering in complete darkness (no moon), different land types and locations, and different livestock types. There are regulation barriers to this method as night flying in EVLOS and BVLOS conditions requires further permits and licencing.

Footage of night mustering

Educating young cattle

SkyKelpie noticed a difference when working the same mob of freshly weaned young cattle with the drone over a week-long period. At first, they were quite flighty and confused by the drone, and by the end of the week they moved off pressure in a controlled and relaxed manner. Operations wanting to use drones for mustering should 'break in' their weaners with the drone to have a more controlled experience in the paddock.

Young cattle - https://youtu.be/nGz1_Pooigg

Asset and stock surveillance

This application was limited by our drone's flight endurance and regulatory requirements, but it was evident that drones have a place for asset and livestock surveillance in agriculture. This was trialled on a more intensive operation in Southeast Queensland during wet conditions. Even through it was a smaller property, it was very convenient that the drone could provide insights on water levels of tanks and feed rations, as the wet conditions made it very difficult to get there by traditional means.

This was also trialled at Malakoff. Flight endurance was a disadvantage as the M30T is more suited to mustering, however the zoom camera proved useful for monitoring from a hover position. The ability of drones to monitor important assets in the northern grazing industry certainly affords multiple benefits.

Footage - https://youtu.be/3ZvY9PlCnCE

Predator monitoring/detection

This application was only trailed once during this project, but with great success. A sheep grazing property in Northwest Queensland was experiencing an extremely disruptive and stressful week due to a wild dog. The family owned and operated property of 15,378ha has exclusion fencing, meaning once the dog managed to enter the property, it was difficult to leave. While the dog was there it killed several lambs and inflicted noticeable stress on the herd.

Wild dogs are quite active at night, so SkyKelpie decided to search for it at approx. 9pm using the thermal camera on the M30T. The landholders had a calculated idea of the area we might detect the predator, and within minutes of launching the drone the dog was found on the edge of a herd it had bailed up in a corner.

SkyKelpie is not an expert in destroying predators, so cannot give advice on how this may be done, especially at night. From a detection perspective, thermal imagery worked as a useful tool in our trial. Predators can also be detected with the drone in daylight hours, however some animals such as wild dogs will blend into the countryside and the thermal camera is not as effective during the day.
https://www.youtube.com/watch?v=Z_9IL_FfNwE

Workshop results

Over one hundred people attended the SkyKelpie drone mustering workshops and live demonstrations which is an encouraging sign for the adoption this solution. It was not just livestock operators that came along, but also researchers, livestock agents, aviation and UAV professionals, bankers, university students and other innovators. It became clear that the information these workshops provided is not readily available and participants took out significant value by attending. SkyKelpie received positive feedback about the content of the workshops, in particular the stockmanship element. It is possible that the quality of stockmanship by graziers in Australia could increase if we continue to teach low stress methods in the context of drone mustering. (NationalBQA, 2012)

Workshop video

5. Key findings

This project successfully fulfilled its mission, that was, to determine if drones can effectively be used to locate and muster livestock. Drones can be thought of as just another form of pressure, like a motor bike or helicopter. It is how the drone is used in relation to stockmanship methods which will determine the success of drone mustering operations. If graziers are operating drones over their own land, situational awareness while mustering paddocks should not be a problem. If service providers or new employees are operating on land unfamiliar to them, it is recommended they study the land with guidance from the landholder and make best use of mapping software compatible with the drone.

The report finds that not only is drone mustering effective but provides benefits that outperform traditional methods. The use of thermal imaging for locating and mustering in low light conditions is a game-changer. The convenience of the drone rivals manned aircraft due to access, quick setup and opportunity for more pilots. Software such as mapping, automated flight routes and artificial intelligence unlocks opportunities for further use cases beyond mustering.

In collaboration with DAF, an economic evaluation was completed to explore the costs and benefits of mustering livestock with a drone. It assumes a drone is purchased by a grazier to replace helicopter mustering (contracted services) and assumes the same efficacy. See *Appendix 2* for results.

Key findings from the workshops shows there is a genuine interest in this solution. The broad range of people representing many parts of the industry attended with enthusiasm, critical thought and creativity. Whether it be workshops, online training modules or something similar, it is clear that future adopters will require training and support to successfully and confidently use this technology.

6. Conclusion and recommendations

Regulations

The regulatory requirements to conduct these trials were extremely complex and time consuming. The difficulty level of navigating this framework was increased due to SkyKelpie's lack of UAV regulatory experience, but this was relevant and constructive as very limited graziers have this knowledge also.

The Landholder Rule *(Appendix 3, 3.2.13)* is a section in the regulations that allows a landholder to fly their own drone on their own land without requiring licencing and permits. This is beneficial to certain applications but has certain conditions that limits the capability of livestock drone mustering.

SkyKelpie recommends industry works towards progression of the 'Landholder rule' for EVLOS and BVLOS operations.

The conduct of mustering/farming activities under the excluded category landowner permissions currently allows operations, with a UAV weighing up to 25 kg, to be conducted in compliance with the drone safety rules and standard RPA operating conditions requiring the RPA operator to hold an operator accreditation *(Appendix 3, 3.2.13).*

The current RPAS regulatory framework restricts the conduct of operations beyond the visual line of sight (BVLOS), including extended visual line of sight (EVLOS), of the remote pilot under the excluded category and therefore requires an RPA operator to hold an operator certification and obtain additional qualifications and implement administration requirements that (from a safety perspective) could be considered grossly disproportionate to the risk being treated, particularly in areas where the air and ground risk would be considered as 'very low'. The additional requirements include, but are not limited to:

a. For EVLOS Class 1:
(1) The RPA operator must hold a Remote Operator's Certificate (ReOC) *(Appendix 3, Chapter 6)*,
(2) The Remote Pilot (RP) must hold a Remote Pilot's Licence (RePL) *(Appendix 3, Chapter 7)*

b. For EVLOS Class 2 and BVLOS (in addition to subpara a):
(1) The Remote Pilot must hold or must be under the direct supervision of a person who holds an instrument rating qualification or accepted equivalency *(Appendix 3, Chapter 5)*

SkyKelpie (in consultation with key stakeholders) are proposing a phased approach to developing and validating a flexible and safe RPAS framework to enable landowners (for mustering/farming purposes) to conduct operations beyond the visual line of sight of the remote pilot under a revised excluded category framework. Achievement of this may include:

a. Developing a standard scenario for excluded landowner beyond visual line of sight operations
b. Defining training and assessment requirements to achieve operator accreditation to conduct excluded landowner BVLOS operations (based on an approved standard scenario)
c. Development of automatic excluded landowner BVLOS area approvals through CASA approved flight safety applications
d. Development of CASA approved documented policy and procedures for the conduct of excluded landowner BVLOS operations
e. Development of a plain English Guides and checklists to assist landowners in applying for operator accreditation to conduct BVLOS operations

These proposed developments would occur in consultation with CASA. SkyKelpie respects and abides by all current regulations when conducting trials and flight operations.

Technology

The largest technological challenge in these trials was the battery life/endurance of the drone. SkyKelpie is aware of numerous drones on the market that have a flight time of 2+ hrs, but a decision was made to trial with the Mavic 3 and M30T due to their user-friendly nature, safety, sensors, camera quality and sophisticated software and payload options. DJI are often referred as the 'Apple' of the drone world as they are world leaders in the drone hardware and software space. SkyKelpie managed this challenge quite effectively by having multiple batteries on standby and using a generator to charge flat batteries during operations.

Limited flight time was more of a challenge when conducting BVLOS & EVLOS Class 2 operations. Operational areas were larger in these flight classes, as well as the time and distance it took to taxi out to the area from the take-off zone. When conducting VLOS operations, the operator is never a great distance from the drone, meaning the process of changing batteries was quite fast. Mustering operations can be somewhat disrupted by the drone requiring a battery change at unsuitable times.

Helicopters also face this challenge but less frequently than we did during these trials. It is quite clear that the ideal mustering drone will have a flight time of 2+ hrs.

It is important that the transmission link between the drone and controller is and remains strong. The nature of mustering means putting the drone under trees and behind objects that may affect this link. It is of further importance when choosing a drone for this purpose that the related functionality is adequate.

Adoption

With this solution and technology, it is important that livestock operators visually see that it is possible. Whether through live demonstrations or video evidence, the operational requirements will seem less intimidating when the success of livestock drone mustering can be viewed. The results of these trials should contribute positively towards the validation that this solution is both possible and delivers numerous benefits towards grazing operations and the industry at large.

Industry and Government bodies can assist adoption of this solution in numerous ways. Assisting the UAV industry to lobby for more practical regulations would be beneficial. Furthermore, support towards awareness, training, research, and development of home-grown technology would accelerate adoption.

Research gaps

More research and credible scientific evidence on the benefits of livestock drone mustering would greatly impact on future take-up. These benefits include animal welfare, environment, economics and increased productivity.

Operator's skill level

The skill level of the person operating the drone significantly influences the success of livestock drone mustering. Firstly, the operator needs to have a high level of stockmanship. Quality of stockmanship in a person can be subjective, as methods and ideology of how to work livestock varies. It was clear during these trials that drones are just another source of pressure for livestock to move off. To be successful with drones, the operator must understand how to correctly position around the mob and apply and release pressure, so the animals remain agile and responsive to the drone. They also need to strategically outthink the animals and have smart infrastructure and design to support the muster.

Technological skill will be important for the operator, but the technology itself should not be overly complex. The nature of isolation for livestock graziers with limited internet connection and other factors means the skill level with various technologies is lower than people in urban areas. With better connectivity and generation change, this is shifting, but adopting a new solution should not be difficult or confusing.

Training will ensure any gaps in these required skills can be closed. Face-to-face and online tutorials will complement each other for initial and ongoing learning.

Further use cases

Feedback from workshops suggests there is a desire in the industry to explore the variety of other use cases drones can offer on livestock operations. These include:

- Bird and other pest management from cropping areas
- Dingo, pigs and other pest detection
- Woody weed detection
- Multi-drone musters
- Fixed wing or VTOL drone mustering
- Surveillance e.g., waters, fences, stock.

7. References

Drone experts: Hover UAV: Helping you get off the ground (2022) *Hover UAV*. Available at: https://hoveruav.com.au/ (Accessed: December 14, 2022).

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Cattle Handling Tips - Why Low Stress? (2012) *YouTube*. YouTube. Available at: https://www.youtube.com/watch?v=fTOeDkuw1ic (Accessed: January 6, 2023).

DJI - official website, *DJI Official*. Available at: https://www.dji.com/au

8. Appendix

8.1 Guide to Key Words

Key word/Term	Definition
Drone	A drone is an unmanned aircraft. Drones are more formally known as unmanned aerial vehicles (UAVs) or unmanned aircraft systems.
UAV	Unmanned Aerial Vehicles
CASA	Civil Aviation Safety Authority
Drone hardware	Unmanned aerial vehicle (UAV), powered, aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely.
Drone software	Drone programming/software that enables drones to be operated remotely and/or autonomously.

RPAS	Remotely piloted aircraft system
Artificial Intelligence (AI)	(AI), the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.
Command and control link	The data link between the remotely piloted aircraft and the remote pilot station for the purpose of managing flight.
VLOS	(Visual Line of Sight) - You can always see the UAV when flying with your unaided eyesight.
EVLOS	(Extended Visual Line of Sight) - You can operate the drone beyond your visual range for this mission type. But you'll need the help of trained visual observers.
BVLOS	(Beyond Visual Line of Sight) - BVLOS allows you to operate the UAV while it is not in your line of sight and there is no visual observer.
Dry cattle	In this report dry cattle refers to any cattle that are not nurturing their offspring through lactation. E.g. steers, weiners, bulls, non-lactating cows.

8.1 Appendix 1 - Drone mustering workshop outline

8.2 Appendix 2 - Drone mustering – Economic factsheet

8.2 Appendix 3 - CASA 101-01v4.0 Remotely piloted aircraft systems - Licensing and operations

SkyKelpie Drone mustering school

TIME	CONTENT
9.00am- 9.20am	**Introduction** Presenters Background, experience, etc The SkyKelpie story ***To give an outline of the knowledge and general idea of the principals of livestock handling with drones***
9:20 am – 9:50	**Introduction to technology** • Different types of drones • Controllers, cameras, FPV screens, goggles etc • Software and mustering aids
9:50 am- 10:20 am	**Regulations** • Current Standard operating procedures • Landholder Rule • EVLOS, BVLOS • Night flying • RPL. ReOC • The solution SkyKelpie is proposing to CASA
10:20 – 10:50 am	**Smoko**
10:50 – 12:20	**Stockmanship** • Understanding how to use a systems approach to implementing a drone for livestock handling in a livestock enterprise • The importance of Stockmanship • How to correctly apply and release pressure to keep animals responsive. • Positioning • Understanding Mob psychology ***"With a drone, you are not going to be able to out fly them and the drone hasn't any teeth, so you need to be able to outthink them, build a A grade herding culture in the cattle and sheep and think about infrastructure***

	design and approach's that will assist.
12:20 – 1:20	**LUNCH**
1:20 – 2:20	**Operational use cases** • Benefits of Arial mustering • Economic cases • Early morning musters • Different Stock Cattle/sheep/goats • Starting Stock • Settling stock • Weaning
2:20- 3:00 pm	**Skills Development** • Flying skills Development • Training currently available • Where to in the future • Questions and wrap up
3.00 – 3:30 pm	Smoko and FINISH

Australian Government
Civil Aviation Safety Authority

ADVISORY CIRCULAR
AC 101-01 v4.0

Remotely piloted aircraft systems - licensing and operations

Date	September 2022
File ref	D19/20218

Advisory circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.

Advisory circulars should always be read in conjunction with the relevant regulations.

Audience

This advisory circular (AC) will be of interest to:

- remotely piloted aircraft (RPA) operator's certificate (ReOC) holders and applicants
- remote pilots (RePL) and other remote crew members
- other support personnel involved in remotely piloted aircraft systems (RPAS) operations.

Purpose

This AC was developed by the Civil Aviation Safety Authority (CASA) to provide guidance to RPA operators, remote crew, manufacturers, and maintainers. It describes the categorisation of RPA and general requirements for use of RPAS. It also provides guidance to operators and crew on the safe and legal operation of RPA in all classes of airspace.

Although this AC may be of interest to all operators of unmanned aircraft, it is essential that operators of excluded RPA operate in accordance with the applicable regulations and read the guidance contained in AC 101-10 and the Micro and excluded RPA Plain English Guide. Model aircraft/ recreational operators please read and follow the guidance in AC 101-03.

Unless specified otherwise, all subregulations, regulations, Divisions, Subparts and Parts referenced in this AC are references to the *Civil Aviation Safety Regulations 1998 (CASR)*.

Notice

It is essential that operators and crew involved in RPAS operations understand they are operating within the national aviation system and have an obligation to be aware of and follow, information and regulatory requirements relating to aviation operations. Such information includes, but is not limited to:

- Part 47 and 101 of the *Civil Aviation Safety Regulations 1998 (CASR)*
- requirements listed in the regulations table at section 1.3 of this AC
- AIP, ERSA, and aeronautical charts issued by Airservices Australia.

For further information

For further information, or to clarify if proposed operations require a ReOC, contact CASA via the website.

Status

This version of the AC is approved by the Branch Manager, Remotely Piloted Aircraft Systems.

Note: Changes made in the current version are not annotated. The document should be read in full.

Version	Date	Details
v4.0	September 2022	Changes arising from the 2019 and later amendments to Part 101 of CASR, the issuing of the Part 101 Manual of Standards (and later amendments) and CASA Direction 22/22 and sundry editorial changes and clarifications. Changes arising from amendments to the *Air Navigation (Aircraft Noise) Regulations 2018* and *Transport Safety Investigation Regulations 2021* in respect of Noise Approvals and reportable matters to the ATSB. Amendment to approach and departure diagrams for controlled aerodromes depicted in Appendix A to support revised diagram. Annex A is not being published as part of this new version and is currently under review.
v3.0	December 2019	New Annex A - Remote Pilot Licence (RePL) Training Course - CASA guidance added.
v2.1	July 2018	Removal of the approach and departure diagrams for non-controlled aerodromes. Changes to the dimensions of the approach and departure paths for controlled aerodromes depicted in Appendix A and several textual changes to support the revised diagram and to reflect the latest legislative instruments. Inclusion of advice relating to legislative instruments made in 2017.
v2.0	December 2016	This is the second AC to be published on this subject and replaces AC 101-1(0). This AC has been completely re-written to take into account amendments to Part 101 and to bring it up to date with current CASA procedures.
v1.0(0)	July 2002	Initial AC on this subject.

Contents

1 Reference material

1.1 Acronyms

This AC describes the general requirements for non-recreational use of RPA. It is consistent with the work currently being developed by the International Civil Aviation Organization (ICAO) and that of other regulatory bodies; the terms and definitions are consistent with those used by ICAO as found in Annex 2, Rules of the Air, to the Convention on International Civil Aviation (the Chicago Convention).

The acronyms and abbreviations used in this AC are listed in the table below. Other acronyms in general use within the aviation industry can be found in the Aeronautical Information Publication (AIP) at General (GEN) 2.2. All operators, remote pilots and crew associated with RPA operations should familiarise themselves with that information.

Acronym	Description
AC	advisory circular
ADF	Australian Defence Force
ADS-B	automatic dependent surveillance - broadcast
AIP	Aeronautical Information Publication
AIP-ENR	AIP – En Route (a section of AIP-Book)
AIP-ERSA	AIP – En Route Supplement Australia
AIP-GEN	AIP – General (a section of AIP-Book)
AGL	above ground level
ANSP	air navigation service provider
AOC	air operator's certificate
ARN	aviation reference number
ATC	air traffic control
ATS	air traffic services
ATSB	Australian Transport Safety Bureau
BVLOS	beyond visual line of sight
CAO	Civil Aviation Order
CAR	*Civil Aviation Regulations 1988*
CASA	Civil Aviation Safety Authority
CASR	*Civil Aviation Safety Regulations 1998*
CofA	certificate of airworthiness
CRP	chief remote pilot
CTAF	common traffic advisory frequency
DAMP	drug and alcohol management plan

Acronym	Description
EVLOS	extended visual line of sight
FPV	first person view
FRE	flight radio endorsement
GCS	ground control station
HF	high frequency
HLS	helicopter landing site
ICAO	International Civil Aviation Organization
IREX	instrument rating exam
LAT	latitude
LONG	longitude
MOS	manual of standards
NAA	National Aviation Authority
NOF	NOTAM office
NOTAM	notice to airmen
OAR	Office of Airspace Regulation
OEM	original equipment manufacturer
ReOC	RPA operator's certificate
RePL[1]	remote pilot licence
RPA	remotely piloted aircraft
RPAS	remote piloted aircraft system
RPS	remote pilot station
RTCA	radio technical commission for aeronautics
SOC	standard RPA operating conditions
SSR	secondary surveillance radar
TAC	terminal area chart
UAS	unmanned aircraft system
UHF	ultra-high frequency
VHF	very-high frequency
VLOS	visual line of sight
VNC	visual navigation chart

[1] The acronym 'RePL' is used by CASA in its guidance and safety promotional materials to distinguish it from the conventional aviation recreational pilot licence (RPL) acronym. As such, a reference to an RPL training course in the Part 101 of CASR regulations should be read as a reference to a RePL training course.

Acronym	Description
VTC	visual terminal chart
WAC	world aeronautical chart

1.2 Definitions

Terms that have specific meaning within this AC are defined in the table below. Where definitions from the civil aviation legislation have been reproduced for ease of reference, these are identified by 'grey shading'. Should there be a discrepancy between a definition given in this AC and the civil aviation legislation, the definition in the legislation prevails.

Term	Definition
aeronautical data originator	An organisation that can submit notice to airmen (NOTAM) information to Airservices Australia.
Australian flight information region	The region for which Australia provides flight information and search and rescue services.
autonomous aircraft	An unmanned aircraft that does not allow pilot intervention in the management of the flight of the aircraft
autonomous operation	An operation of an unmanned aircraft that does not allow pilot intervention in the management of the flight of the aircraft.
beyond visual line of sight operation	An operation in which the remote crew does not have direct visual contact with the aircraft.
command and control link	The data link between the remotely piloted aircraft and the remote pilot station for the purposes of managing the flight.
contracting State	A country that has signed the Convention on International Civil Aviation.
controlled airspace	Airspace of defined dimension within which an air traffic control service is provided to flights in accordance with the airspace classification.
conversion training	The training that the aircraft operator requires remote pilots to complete before assigning them to duty on an RPA.
detect and avoid	The capability to see, sense or detect conflicting traffic or other hazards and take the appropriate action to comply with the applicable rules of flight.
excluded RPA	An RPA operated under prescribed conditions for commercial purposes that does not require a CASA authorisation in the form of an RPA operator’s certificate (ReOC) and/or a remote pilot licence (RePL) in some circumstances (See regulation 101.237 of CASR for details).
extended visual line of site operation	An operation, available to approved operators and remote pilots only where, at times, the remote pilot does not have direct visual sight of the RPA; however, with assistance from trained RPA observers, the remote pilot is able to ensure safe operation of the RPA.
first person view	A visual method for controlling an RPA from the remote pilot station via an on-board camera. FPV equipment can only be used as an adjunct to visual observation during visual operations.
handover	The act of passing piloting control from one remote pilot station to another, or to another remote pilot at the same remote pilot station.

Term	Definition
included RPA	A non-regulatory term for RPA operations that require authorisation in the form of a ReOC and RePL.
large RPA	An RPA (other than an airship) with a gross weight of more than 150 kg or a remotely piloted airship with an envelope capacity of more than 100 m^3.
landowner or occupant	The person or organisation that has control over access to an area of land on an ongoing basis.
lost link	The loss of a control link between controller and the remotely piloted aircraft.
medium RPA	An RPA with a gross weight of more than 25 kg but not more than 150 kg or a remotely piloted airship with an envelope capacity of not more than 100 m^3.
micro RPA	An RPA with a gross weight of not more than 250 g.
model aircraft	An aircraft that is used for sport or recreational purposes and which cannot carry a person with a maximum gross weight of no more than 150 kg.
operational control	The exercise of authority over the initiation, continuation, diversion, or termination of a flight in the interest of safety of the aircraft and the regularity and efficiency of the flight.
operator (the ReOC holder)	A person, organisation or enterprise engaged in, or offering to engage in, an RPAS operation.
outside controlled airspace	Airspace of defined dimensions within which an air traffic control separation service is not provided to pilots (Class G airspace).
pilot (verb)	To manipulate the flight controls of an aircraft during flight time.
populated area	Generally, a built-up, urban, or suburban area where people live and work
populous area	An area in relation to the operation of an unmanned aircraft that has a sufficient density of population for some aspect of the operation, or some event that might happen during the operation (in particular, a fault in, or failure of, the unmanned aircraft) to pose an unreasonable risk to the life, safety or property of somebody who is in the area, but is not connected with the operation (see section 4.2.11).
pre-flight inspection	A set of manufacturer-recommended functional tests of systems and components to be performed before any launch.
protected airspace	Prohibited, restricted and danger areas (refer to *Airspace Regulations 2007*).
radio line of sight	An operation where the remote crew maintains control of the RPA by a direct electronic point-to-point contact between a transmitter and a receiver.
remote crew member	A crew member charged with duties essential to the operation of a remotely piloted aircraft system during flight time.
remote pilot	The person who manipulates the flight controls of a remotely piloted aircraft, or who initiates and monitors the flight, and is responsible for its safe conduct during flight time.
remotely piloted	Controlling an aircraft from a pilot station that is not on board the aircraft.
remotely piloted aircraft (RPA)	A remotely piloted aircraft, other than a balloon, a kite, or model aircraft where the pilot flying is not on board the aircraft.

Term	Definition
remotely piloted aircraft system	A set of configurable elements consisting of a remotely piloted aircraft, its associated remote pilot station(s), the required command and control transmitters and receivers, and any other system elements as may be required at any point during flight operation.
remote pilot station	The station at which the remote pilot manages the flight of an unmanned aircraft.
RPA observer	A remote crew member who, by visual observation of the RPA and the adjacent airspace, assists the remote pilot in the safe conduct of the flight.
RPAS aerial work	Any flight activity carried out by an RPAS other than the carriage of passengers.
state aircraft	Aircraft of any part of the Defence Force (including any aircraft that is commanded by a member of that Force during duties as such a member and aircraft used in the military, customs, or police services of a foreign country).
segregated airspace	Airspace of specified dimensions allocated for exclusive use to a specific user(s).
small RPA	An RPA with a gross weight of more than 2 kg but not more than 25 kg.
squawk identification	A secondary surveillance radar (SSR) transponder function that air traffic control uses to positively identify aircraft.
unmanned aircraft system	An aircraft and its associated elements that are operated with no pilot on board, including both remotely piloted and autonomous aircraft systems.
very small RPA	An RPA with a gross weight of more than 250 g but not more than 2 kg.
visual line-of-sight operation	An unmanned aircraft operation in which the remote pilot operating the remotely piloted aircraft can continually see, orient, and navigate the aircraft to meet their separation and collision avoidance responsibilities, with or without corrective lenses, but without the use of binoculars, a telescope or other similar device.

1.3 References

Legislation

Legislation is available on the Federal Register of Legislation https://www.legislation.gov.au/

Document	Title
Primary	
Airspace Act 2007	
Airspace Regulations 2007	
Civil Aviation Act 1988	
Part 21 of CASR	Certification and airworthiness requirements for aircraft and parts
Part 47 of CASR	Registration of aircraft and related matters
Part 45 of CASR	Display of nationality marks, registration marks and aircraft registration identification plates

Document	Title
Part 61 of CASR	Flight crew licensing
Part 92 of CASR	Consignment and carriage of dangerous goods by air
Part 99 of CASR	Drug and alcohol management plans and testing
Part 101 of CASR	Unmanned aircraft and rockets
Part 117 of CASR	Representations and surveys
Regulation 2 of the *Civil Aviation Regulations 1988 (CAR)*	Interpretation
Part 4A of CAR	Maintenance
Regulation 42CA of CAR	Maintenance schedule—primary, intermediate, restricted, or limited category aircraft
Regulations 42CB of CAR	Maintenance—experimental aircraft
Air Navigation (Aircraft Noise) Regulations 2018	
Transport Safety Investigation Act 2003	
Transport Safety Investigation Regulations 2003	
Instruments	
CASA Instrument 01/17	*Approval – Operation of RPA at night*
CASA 22/22	Operation of Certain Unmanned Aircraft – Renewal of Directions Instrument 2022
Civil Aviation Order (CAO) 20.18	Aircraft equipment – basic operational requirements Instrument 2014
Part 101 Manual of Standards	Unmanned aircraft and rockets
Part 172 Manual of Standards	Manual of Air Traffic Services
Other Legislation	
Environment Protection and Biodiversity Conservation Act 1999	
Privacy Act 1988	

Advisory material

CASA's advisory materials are available at https://www.casa.gov.au/publications-and-resources/guidance-materials

Document	Title
AC 21-10	Experimental Certificates
AC 21-13	Australian-designed aircraft - type certification
AC 101-03	Unmanned aircraft and rockets – model aircraft
AC 101-10	Remotely piloted aircraft systems – operation of excluded RPA
CAAP 92-2	Guidelines for the establishment and operation of onshore Helicopter Landing Sites

ICAO and other documents

Document	Title
ICAO Document 10019	Manual on Remotely Piloted Aircraft Systems (RPAS)
Convention on International Civil Aviation (the Chicago Convention)	Article 8, Pilotless aircraft
Chicago Convention	Annex 2, Rules of the Air
Chicago Convention	Annex 8, Airworthiness of Aircraft
ISO 31000	Risk management
Radio Technical Commission for Aeronautics (RTCA) DO-320	Operational Services and Environmental Definition (OSED) for Unmanned Aircraft Systems
RTCA DO-304	Guidance Material and Considerations for Unmanned Aircraft Systems
En Route Supplement Australia (ERSA)	En Route Supplement Australia (ERSA) (http://www.airservicesaustralia.com/aip/aip.asp)
CASA Office of Airspace Regulation (OAR)	OAR Operations Manual
CASR Part 101 Plain English Guide (PEG)	Micro and excluded Remotely Piloted Aircraft operations

Advisory websites

Title
CASA Drug and alcohol management plan (DAMP) (https://www.casa.gov.au/operations-safety-and-travel/safety-advice/drug-and-alcohol-management/drug-and-alcohol-management-plans-damps)
CASA safety management (https://www.casa.gov.au/safety-management)
Office of the Australian Information Commissioner (www.oaic.gov.au)

1.4 Forms

CASA's forms are available at http://www.casa.gov.au/forms

Form number	Title
Form 101-01	Remote Pilot Licence (RePL)
Form 101-02	Application for RPA Operator's Certificate (ReOC) (initial issue/variation/renewal)
Form 101-05	RePL Training - Notification of Results
Form 101-09	RPA Flight Authorisation
Form 1162	Aviation Reference Number (ARN) Application (Individuals)
Form 1170	Aviation Reference Number (ARN) Application (Organisations)
	RPAS Multi-purpose Form
	Application for Extended Visual Line-of-sight (EVLOS) Form

Note: ARN and other applications can be made through the *my*CASA portal. See section 7.2.2 for advice.

2 Introduction

2.1 Classification of unmanned aircraft

2.1.1 The International Civil Aviation Organization (ICAO) defines unmanned aircraft as:

- unmanned aircraft systems (UAS)
- model aircraft
- rockets
- unmanned free balloons.

2.1.2 CASA classifies unmanned aircraft as:

- remotely piloted aircraft
- model aircraft
- rockets
- unmanned free balloons.

2.1.3 State aircraft and Australian Defence Force RPAs

2.1.3.1 Unmanned aircraft operated by the Australian Defence Force (ADF) are defined by the *Civil Aviation Act 1988 (the Act)* as 'State aircraft' and operate under Defence regulations. A 'Regulator-to-Regulator' agreement exists between CASA and the Defence Aviation Safety Authority (DASA) to ensure that both civil and Defence regulations move towards harmonisation.

2.1.3.2 The ADF will determine the issues relating to civil contractors and the Defence service and will exercise its own requirements, however, CASA's standards are expected in the first instance.

2.1.3.3 A civilian operator is required to hold a CASA approval for operations that are conducted for the ADF in Australian civil airspace. The development of a mission plan is a joint effort between the contractor, ADF and CASA, with CASA providing final approval.

2.1.3.4 Unless the unmanned aircraft is designated in writing to be a 'State aircraft' by the ADF, CASA will proceed on the basis that operation of the unmanned aircraft constitutes a civilian operation and requires the necessary CASA approvals to first be obtained before any operations are undertaken.

2.1.4 Civilian aircraft

2.1.4.1 Within civilian aircraft, UAS are further classified as either:

- remotely piloted aircraft systems (RPAS)
- autonomous aircraft systems.

Remotely piloted aircraft systems

2.1.4.2 RPAS are a subset of UAS that are piloted by a remote pilot. RPAS include, but are not limited to:

- the RPA

- a remote pilot station (RPS)
- the command and control (C2) data-link.

2.1.4.3 Model aircraft are defined by purpose as an unmanned aircraft used for sport or recreation.

Autonomous aircraft systems

2.1.4.4 While there are various degrees of automation in UAS, an autonomous operation is one in which there is no ability for the pilot to intervene in the conduct of the flight. Systems such as a pre-programmed flight or an automated 'return to home' are features of automation and typically not considered 'autonomous' operations.

2.1.4.5 Autonomous operations may be approved but will be considered on a case-by-case basis and require the submission of an acceptable safety case to CASA. If operators are considering autonomous operations, they should contact CASA as early as possible in the planning stages.

2.2 International regulation of unmanned aircraft

2.2.1 Article 8, Pilotless Aircraft, of the Convention on International Civil Aviation (the Chicago Convention) stipulates that:

> No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization.

2.2.2 All UAS are subject to the provisions of Article 8 of the Chicago Convention. Australia, as a signatory to the Chicago Convention, has created specific regulations to authorise unmanned aircraft operations in Australian territory. However, only RPA will be able to integrate into the civil aviation system in the foreseeable future as the remote pilot's functions and responsibilities are considered essential to the safe and predictable operation of the aircraft as it interacts with other aircraft and the air traffic management system.

3 Types of RPA operations

This Chapter will help you to:

- understand how CASA categorises RPA operations
- identify the type of operation you plan to conduct
- find the right guidance for different types of RPA operations.

3.1 Overview

3.1.1 Operators and pilots of all RPA are operating within the national aviation system and must operate their RPA safely and in accordance with the relevant legislation that governs aircraft operations.

3.1.2 RPAS operations may pose safety risks to other airspace users and to the people and property over which they fly. These risks must be kept at an acceptable level.

3.1.3 A suitable baseline level of aviation risk is demonstrated by the conventionally-piloted aircraft industry. It is CASA policy that the RPAS sector demonstrate a level of safety that is similar to that currently achieved in the conventionally-piloted aircraft sector.

3.1.4 CASA acknowledges a 'one-size-fits-all' approach to RPAS policy and regulation is not always appropriate and has determined that RPA operations, when conducted under strict conditions only, present a low level of risk to other airspace users, other people, and property. As such, CASA has determined that certain RPA, in particular circumstances, can be operated safely in Australian airspace without requiring CASA authorisations in the form of a remote pilot licence (RePL) and an RPA operator's certificate (ReOC). These low-risk operations termed 'excluded RPA' operations, are defined in regulation 101.237 of CASR.

3.1.5 With the exception of model aircraft, and micro RPA, all other operations are considered to be 'included RPA'. CASA manages the risks of these operations by requiring the operator and remote pilot to be authorised:

- The operator must hold an RPA operator's certificate (ReOC) - see Chapter 6
- The remote pilot must hold a remote pilot licence (RePL) - see Chapter 7.

3.1.6 Section 3.2 explains the criteria used to determine whether an operation is an included RPA or excluded RPA operation.

3.2 Assessment of operational risk

3.2.1 When considering requests for RPAS-related authorisations and approvals CASA will consider the whole remote system, not just the aircraft.

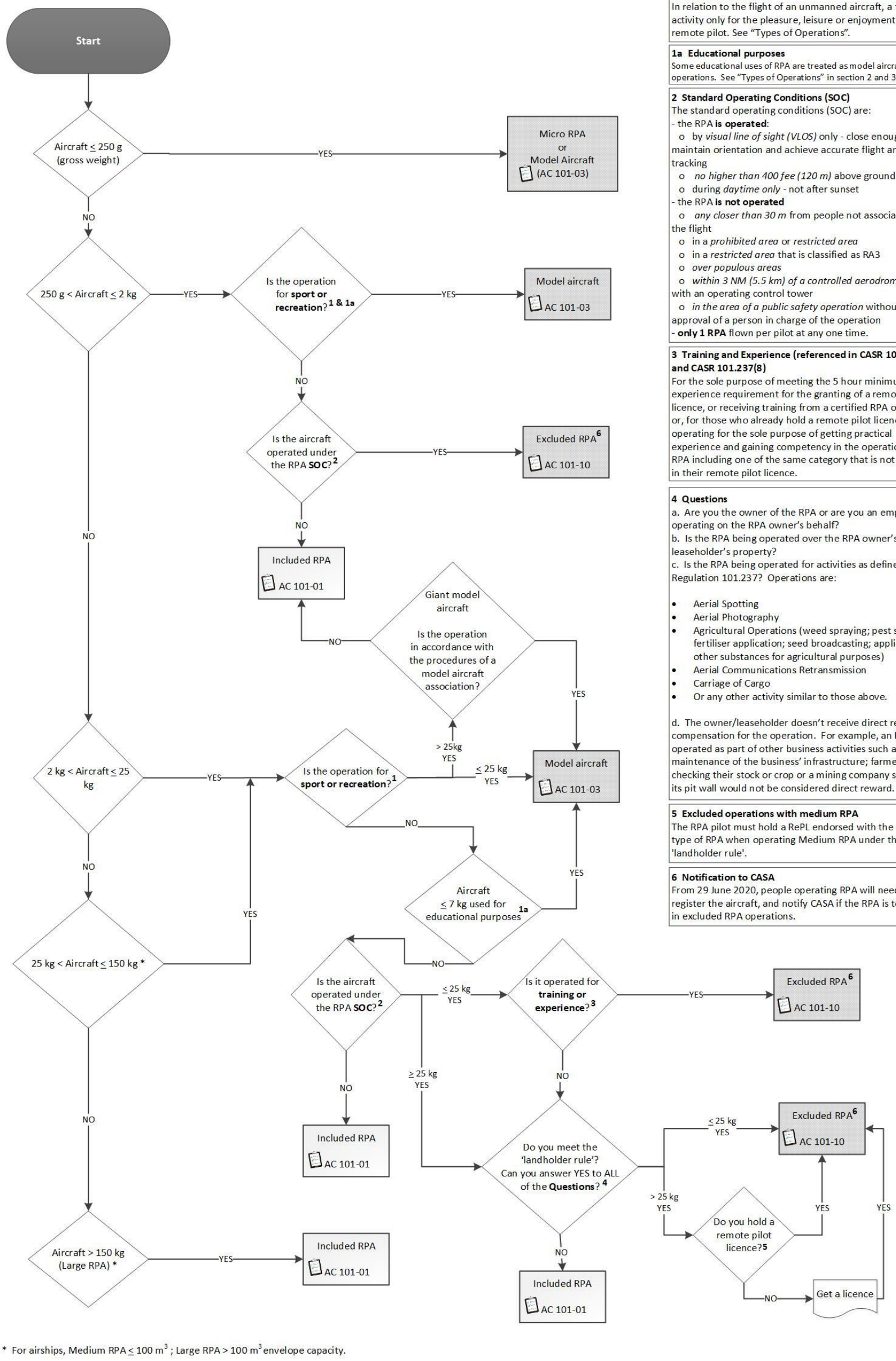
3.2.2 The assessment of an operation as either an excluded or included RPA operation depends on several criteria:

- gross weight of the RPA (at take-off including any batteries/fuel)
- whether the flight is for sport or recreational purposes
- whether the flight complies with the standard RPA operating conditions (SOC).

3.2.3 For some RPA weight categories, a flight that is compliant with the SOC is further assessed for:

- meeting training or experience rules
- compliance with the ‘landholder’ rules.

3.2.4 Figure 1 shows how these criteria are used to decide whether an operation would be an included or excluded RPA operation. The criteria are then explained in more detail in the following paragraphs.



1 Sport or Recreation
In relation to the flight of an unmanned aircraft, a flight activity only for the pleasure, leisure or enjoyment of the remote pilot. See "Types of Operations".

1a Educational purposes
Some educational uses of RPA are treated as model aircraft operations. See "Types of Operations" in section 2 and 3.

2 Standard Operating Conditions (SOC)
The standard operating conditions (SOC) are:
- the RPA **is operated**:
  - o by *visual line of sight (VLOS)* only - close enough to see, maintain orientation and achieve accurate flight and tracking
  - o *no higher than 400 fee (120 m)* above ground level
  - o during *daytime only* - not after sunset
- the RPA **is not operated**
  - o *any closer than 30 m* from people not associated with the flight
  - o in a *prohibited area* or *restricted area*
  - o in a *restricted area* that is classified as RA3
  - o *over populous areas*
  - o *within 3 NM (5.5 km) of a controlled aerodrome* - one with an operating control tower
  - o *in the area of a public safety operation* without the approval of a person in charge of the operation
- **only 1 RPA** flown per pilot at any one time.

3 Training and Experience (referenced in CASR 101.237(6) and CASR 101.237(8)
For the sole purpose of meeting the 5 hour minimum experience requirement for the granting of a remote pilot licence, or receiving training from a certified RPA operator; or, for those who already hold a remote pilot licence, operating for the sole purpose of getting practical experience and gaining competency in the operation of an RPA including one of the same category that is not specified in their remote pilot licence.

4 Questions
a. Are you the owner of the RPA or are you an employee operating on the RPA owner's behalf?
b. Is the RPA being operated over the RPA owner's/ leaseholder's property?
c. Is the RPA being operated for activities as defined in Regulation 101.237? Operations are:

- Aerial Spotting
- Aerial Photography
- Agricultural Operations (weed spraying; pest spraying; fertiliser application; seed broadcasting; application of other substances for agricultural purposes)
- Aerial Communications Retransmission
- Carriage of Cargo
- Or any other activity similar to those above.

d. The owner/leaseholder doesn't receive direct reward or compensation for the operation. For example, an RPA operated as part of other business activities such as maintenance of the business' infrastructure; farmers checking their stock or crop or a mining company surveying its pit wall would not be considered direct reward.

5 Excluded operations with medium RPA
The RPA pilot must hold a RePL endorsed with the relevant type of RPA when operating Medium RPA under the 'landholder rule'.

6 Notification to CASA
From 29 June 2020, people operating RPA will need to register the aircraft, and notify CASA if the RPA is to be used in excluded RPA operations.

Figure 1: Decision flow chart to determine eligibility as an excluded RPA[2]

[2] Figure adapted courtesy of the copyright holder, the Australian Association for Unmanned Systems (AAUS). Please note, the term 'uncrewed' is now used instead of 'unmanned'.

3.2.5 Types of RPA are separated into the following types:

- **micro:** gross weight of not more than 250 g
- **very small:** gross weight of more than 250 g and not more than 2 kg
- **small:** gross weight of more than 2 kg and not more than 25 kg
- **medium:** gross weight of more than 25 kg and not more than 150 kg (or, for airships, an envelope of 100 m^3 or less)
- **large:** gross weight of more than 150 kg (or, for airships, more than a 100 m^3 envelope).

Sport or recreational purposes

3.2.6 'Sport or recreational purposes' means operating an unmanned aircraft as a hobby or for pleasure and where the operation does not generate a direct commercial outcome of any sort (for the pilot or any third party).

3.2.7 The use of an unmanned aircraft for any sport or recreational operation defines the aircraft as a 'model aircraft'.

Educational purposes

3.2.8 Operations for certain educational purposes are model aircraft operations (see regulation 101.023 of CASR).

3.2.9 The operation of model aircraft with a gross weight of not more than 7 kg is permitted when operated in connection with the educational, training or research purposes of:

- a school in relation to which there is an approved authority under the *Australian Education Act 2013* or
- a higher education provider within the meaning of the *Higher Education Support Act 2003*.

3.2.10 Operations conducted by educational institutions on a contracted basis for industry or government are not considered model aircraft operations and must meet the requirements of excluded RPA operations or a ReOC.

Standard RPA operating conditions

3.2.11 The standard RPA operating conditions (SOC) applicable to excluded RPA (see regulation 101.238 of CASR) are:

- the RPA **is operated**:
  - only in Australian territory (including within 12 NM or 22 km of coastline)
  - within the visual line of sight (VLOS) of the person operating the RPA – the pilot must be able to see[3] the RPA at all times and be close enough to control it correctly in normal and emergency situations
  - no higher than 400 ft (120 m) above ground level (see SOC note 1)
- the RPA **is not operated**:

[3] Visual line of sight must not depend upon binoculars or telescopes, however, vision correction by glasses or contact lenses is permitted.

- closer than 30 m from people not associated with the flight[4]
- in a prohibited area or restricted area (see SOC note 2)
- in a restricted area that is classified as RA3 (see SOC note 3)
- over populous areas (see SOC note 4)
- within 3 NM (5.5 km) of the movement area of a controlled aerodrome – one with an operating control tower (see SOC note 5)
- in the area of a public safety operation without the approval of a person in charge of the operation (see SOC note 6)

– **only 1 RPA** flown per pilot at any one time.

SOC Notes:

1. Height limit of 400 ft (120 m) referenced to a point on the ground immediately below the RPA at all times during the flight**,** except in the vicinity of aerodromes as described at paragraph 5.

2. Prohibited area—an area of airspace where the operation of all civil aircraft is prohibited. There are no permanently prohibited areas in Australia, but temporary ones are notified in notices to airmen (NOTAMs)—see section 4.3. As there is no possibility of permitting operation in these areas when they are active, no controlling authority contact details are published.

3. Restricted areas are temporary and permanent prescribed areas of airspace in which flight may be permitted, but only with the express permission of the controlling authority for that area. Permission to operate in a restricted area is as follows:

- Excluded RPA subject to the SOC may apply to the controlling authority for permission to operate within these areas. Controlling authorities are not obliged to grant permission or to give specific reasons for declining the request for access.
- Approved operations will be subject to any conditions imposed by the controlling authority. Failure to comply with the conditions is a failure to comply with the regulations and would be treated as such.
- The locations of permanent and temporary restricted areas are marked on aeronautical charts and contact details for controlling authorities are published in the En Route Supplement Australia (ERSA) of the Aeronautical Information Publication (AIP) at section PRD-1.
- Temporary restricted areas are notified by NOTAM (see section 4.3).

4. Populous areas - for RPA operations, populous area is defined in the regulations as:

> …an area [that] has a sufficient density of population for some aspect of the operation, or some event that might happen during the operation (in particular, a fault in, or failure of, the aircraft…) to pose an unreasonable risk to the life, safety or property of somebody who is in the area but is not connected with the operation.

For example, if a rotorcraft-type RPA is flying at a relatively low height (i.e., 100 ft) directly above a single person not associated with the flight, it may be considered to be operating in

[4] Any person who is not charged with duties essential to the safe operation of an RPA.

a populous area due to the fact that a complete loss of power may cause injury to the person below. This interpretation would apply equally to higher flight over small or large public gatherings, or over built-up areas where there is a greater risk to property.
It is the responsibility of remote pilots operating RPA to ensure the flight does not take place unless it is compliant with the 'populous area' rule and to take sufficient precautions when operating in the vicinity of people and property.

5. Operation in controlled airspace
Micro RPA may be operated in controlled airspace, including within 3 NM (5.5 km) of a controlled aerodrome (not inside the boundary/ fence of the aerodrome), but must remain below 400 ft/120 m, and outside the approach and departure paths.

RPA may be operated in controlled airspace, provided the operation takes place outside 3 NM from the aerodrome. If the RPA is over 2 kg, the person flying the drone must hold an aviation radio qualification[5].

6. Public safety operations
Includes fire and rescue services, rural fire service, ambulance, police or other public safety or emergency operation (e.g., bush fires, traffic accidents).

Training or experience

3.2.12 The regulations permit certain training and experience to qualify as excluded RPA operations. These are described in subregulations 101.237 (6) and (8) of CASR and allow remote pilots to do any of the following under the SOC:

- gain the experience needed to meet the 5-hour minimum experience requirement for the grant of a RePL, or for those who already hold a RePL, to gain practical experience and competency in the operation of an RPA not specified in their RePL[6]
- receive training from a certified RPA operator.

Landholder rule

3.2.13 The 'landholder rule' requires that the operation be compliant with all the following:

- the remote pilot is the owner of the RPA or is an employee operating the aircraft on the RPA owner's behalf
- the RPA is being operated over the owner's property or property leased by the owner
- the RPA is being used for activities defined in regulation 101.237 of CASR:
  - aerial spotting
  - aerial photography

[5] See subregulation 101.285 (2) of CASR.
[6] See CASA EX38/21 - Obtaining Experience for Grant of RePL for Medium RPA, and for RePL Upgrade to Different Category of Small or Medium RPA - Exemption Instrument 2021.

- agricultural operations (e.g., weed spraying, pest spraying, fertiliser application, seed broadcasting or application of other substances for agricultural purposes)[7]
- aerial communications re-transmission
- carriage of cargo
- any other activity similar to those listed above

– the remote pilot or the owner/leaseholder do not receive direct reward or compensation for the operation.

3.2.14 You may fly a medium RPA that weighs more than 25 kg but not more than 150 kg over your own land for business or as part of your job, provided you do not accept any type of payment for the services. This is called the landowner or private landholder excluded category. You must get a remote pilot licence (RePL) for the type and model of RPA you want to fly.

3.3 Getting the right advice for your RPA operation

3.3.1 The decision flow chart in Figure 1: Decision flow chart to determine eligibility as an excluded RPA, can be used to determine whether an RPA operation is considered to be an 'included' or excluded RPA operation. Advice on 'included' operations is provided in Chapter 4. Directions to advice on other RPA operations are noted in the following sections.

3.3.2 Micro RPA (up to 250 grams)

3.3.2.1 Micro RPA operations are categorised as a standalone class, requiring neither ReOC nor RePL authorisations[8]. They are, nonetheless, subject to the general rules regarding RPA operations (Subparts 101.A to C).

3.3.3 Very small RPA (more than 250 grams up to 2 kg)

3.3.3.1 A ReOC and RePL are generally not required when using very small RPA under the SOC. The risks associated with aircraft of this type have been determined to be low when they are operated in accordance with the SOC and are therefore treated as excluded RPA operations[9].

3.3.3.2 Any operation of a very small RPA that doesn't comply with the SOC or Subpart 101.G will require the operator to hold a ReOC (see Chapter 6) and the remote pilot to hold a RePL (see Chapter 7). The general operating conditions that apply to these 'included' RPA operations are described in section 4.1.

[7] State/Territory environmental protection legislation applies.
[8] See the CASR Part 101 Micro and Excluded RPA Plain English Guide.
[9] See AC 101-10 and the CASR Part 101 Plain English Guide.

3.3.4 Small RPA (more than 2 kg up to 25 kg)

3.3.4.1 The rules are slightly more complex for small RPA. An authorisation is required unless the operation meets certain criteria such as the 'training or experience rule' or the 'landholder rule'[10].

3.3.4.2 Operation of small RPA in a way that doesn't comply with both the SOC and one of the additional criteria for an excluded RPA operation will require the operator to hold a ReOC (see Chapter 6) and the remote pilot to hold a RePL (see Chapter 7). The general operating conditions that apply to these operations are described in section 4.1.

3.3.5 Medium RPA (more than 25 kg up to 150 kg)

3.3.5.1 Authorisations are required for medium RPA flown for commercial purposes, unless they meet the requirements of the 'training or experience' or 'landholder' rules and are flown under the SOC. For medium RPA flown under the landholder rule, the remote pilot must also hold the rating on their RePL for the type of RPA to be operated.

3.3.6 Large RPA (more than 150 kg)

3.3.6.1 All operations involving a large RPA are 'included' operations. CASA should be contacted for guidance if you are considering operating this type of RPA. The general operating conditions that apply to these aircraft are described in section 4.1.

3.3.6.2 All large (> 150 kg) civil RPA are 'included' RPA, whether or not they are operated for sport or recreation and are regulated by additional provisions for remotely piloted aircraft (Subpart 101.F of CASR). This requires the operator to conduct operations as described in this AC, and includes the requirement for the operator to hold a ReOC (see Chapter 6) and the remote pilot to hold a RePL (see Chapter 7). The general operating conditions that apply to included RPA operations are described in section 4.1.

WARNING

Unauthorised persons operating RPA outside of the conditions applicable to excluded RPA are in breach of the law and may be subject to enforcement action by CASA.

[10] See the CASR Part 101 Plain English Guide.

4 Included RPA operations

4.1 General operating conditions

4.1.1 Included RPA operations, need to comply with the general operating conditions that apply to the holder of a ReOC (see Chapter 6) or RePL (see Chapter 7).

4.1.2 Only RPA listed on the ReOC certificate may be operated under the authority of the ReOC. Any remote pilot operating under the ReOC may be further restricted by their RePL ratings. Generally, whichever rating is more restrictive on the ReOC or RePL, that type of RPA may only be operated.

For example, a ReOC is authorised to operate multirotor small (up to 25 kg), and a remote pilot operating under the ReOC only holds a multirotor small (up to 7 kg) licence. In this scenario, the remote pilot can only operate multirotor RPA of 7 kg or less. This also applies when the RePL holder has a rating greater than the ReOC; the ReOC rating limits the RPA that can be operated.

4.1.3 Unless otherwise approved, the holder of a ReOC or RePL must also adhere to the following conditions:

- the RPA **is operated**:
  - only in Australian territory – including within 12 NM or 22 km of coastline
  - by *visual line of sight (VLOS)* only - close enough to see, orient and navigate the RPA
  - no higher than 400 ft/120 m above ground level
- the RPA **is not operated**:
  - any closer than 30 m from people not associated with the flight
  - any closer than 15 m from people who have consented to the RPA operating close to them and in accordance with practices and procedures.
  - autonomously
  - within 3 NM/5.5 km of a controlled aerodrome
  - in a prohibited area (see section 3.2.11)
  - at night, unless in accordance with CASA 01/17
  - in or out of cloud
  - over populous areas (see section 3.2.11)
  - over the movement area or within the approach and departure paths of an aerodrome without approval from CASA.
- only 1 RPA may be flown per pilot at any one time.

4.2 General operational matters

4.2.1 When conducting RPA operations, the most important considerations are the safety of:

- other aircraft in the airspace
- people and property on the ground
- the crew.

4.2.2 Care should be taken in areas where low-level conventionally piloted aircraft operations take place, especially in the vicinity of beaches and scenic areas (e.g., helicopters on

shark patrol). All unmanned aircraft operators, remote pilots and observers should be acutely aware that low-flying aircraft may suddenly appear with little warning. Even relatively noisy aircraft may not be heard by the remote crew due to wind, the RPA's motors, and other noises.

4.2.3 Operators should also make crew aware of 'cognitive tunnelling', where the remote pilot is so focused on the task at hand that other events and noises are not perceived or identified until it's too late to take corrective action.

4.2.4 Restricted areas

4.2.4.1 These are temporary and permanent prescribed areas of airspace in which flight may be permitted, but only with the express permission of the controlling authority for that area. Permission to operate in a restricted area is as follows:

- Approved operations will be subject to any conditions imposed by the controlling authority. Failure to comply with the conditions is a failure to comply with the regulations and would be treated as such.
- The locations of permanent and temporary restricted areas are marked on aeronautical charts and contact details for controlling authorities are published in ERSA.
- For operations in Sydney Harbour Restricted airspace (R405A/B), the chief remote pilot of a ReOC must apply to CASA and provide all operational documentation to support the application. Applications will not be accepted less than 72 hours from the requested start date.

4.2.5 Communications

4.2.5.1 Operations with very small RPA below 400 ft/120 m and further than 3 NM/5.5 km from a controlled aerodrome are not required to use aeronautical radio, although CASA recommends that remote pilots with radio qualifications monitor the relevant frequency if there is a chance that the operation may infringe these restrictions.

4.2.5.2 The ReOC's operations manual should address how communications between any crew and the remote pilot will be managed. It should also detail how communications with any third parties (e.g., air traffic control [ATC] and other aircraft) would be handled in the event of the loss of the primary communication channels.

4.2.6 Transponders and aircraft surveillance

4.2.6.1 CASA will only approve the use of a secondary surveillance radar (SSR) or an automatic dependent surveillance broadcast (ADS-B) transponder if it is required for the duration of an RPA operation, subject to CASA assessment, in the interest of air navigation safety.

4.2.7 Meteorological conditions

4.2.7.1 For VLOS operations, meteorological conditions must permit unaided visibility of the RPA, the surrounding airspace, and the ground beneath so that the remote pilot can avoid collisions and infringements of the regulations. The weather minima for any RPA flight are as follows:

- 3000 m visibility
- clear of cloud
- only by day.

4.2.7.2 For BVLOS and EVLOS RPA operations, weather minima remain the same and the RPA must not be operated in conditions other than prescribed above. CASA may prescribe additional weather minima requirements for these operations, especially if operating above 400ft AGL or in controlled airspace.

4.2.7.3 A ReOC holder may operate at night in accordance with the prescribed night requirements and procedures in the sample RPA Operations Manual. The instrument for night operations, CASA 01/17 Approval - operation of RPA at night, must be placed into the operations manual.

4.2.8 Recommendation for RPA conspicuity

4.2.8.1 RPA should be painted or patterned for maximum visibility. This may involve the use of high gloss, high visibility paint and contrasting colours and, where practicable, suitable collision avoidance lighting, such as strobe lights.

4.2.9 Precautions for automated flight

4.2.9.1 Care should be taken when inserting flight plans into the ground control station (GCS) for automated operations. Instances have occurred where incorrect or corrupt information has resulted in a crash or loss of the RPA. Transferring way points from one program or application to another can cause errors, as can corrupt or outdated software. Automated flights should be continuously monitored to identify any deviations from the intended flight path, and rapid remedial action taken to fix the problem or terminate the flight to avoid creating an unnecessary hazard.

4.2.10 RPA operational requirements outside controlled airspace

4.2.10.1 The job safety assessment for any planned operation should include (but not limited to) the following areas:

- aerodromes
- helicopter landing sites (HLS).

4.2.10.2 Operations may be conducted below 400 ft/120 m above ground level (AGL) near (< 3 NM/5.5 km) non-controlled aerodromes, but not over the movement area or in the approach and departure paths, unless specifically approved by CASA. Those operating near aerodromes without a specific approval must land or not launch in the event of manned aircraft operations being conducted at the aerodrome.

4.2.10.3 Operators can apply to CASA to be approved for conducting operations near non-controlled aerodromes while conventionally piloted aircraft are operating, and/or in the approach and departure paths. The application must include the operator's proposed procedures. Any approval will be subject to conditions.

4.2.10.4 A thorough specific operation risk assessment is required with the application. This includes liaising with aerodrome operators and local operators of conventionally piloted aircraft and addressing any residual risk or issues such as 'return-to-home' functions and uncommanded climbs.

4.2.10.5 Depending on the level of conventionally piloted aircraft activity at the aerodrome a NOTAM may need to be issued detailing the RPAS operation. Note, however, that an RPAS operation during periods of moderate or frequent aircraft operations is very unlikely to meet the requirement to NOT create a hazard to other aircraft (see regulation 101.055 of CASR) or an obstruction under subregulation 101.075 (4) of CASR.

4.2.10.6 Communication requirements for Class G operations are described in AIP–ENR, including the procedures for common traffic advisory frequency (CTAF) and broadcast areas. When within 10 NM of a certified or registered aerodrome or within 3 NM/5.5 km of other non-controlled aerodromes, remote pilots with relevant radio qualifications should monitor the relevant aeronautical radio frequency and make broadcasts as required.

Note: In the vicinity of an aerodrome with a CTAF, or inside a broadcast area, broadcasts are only required if the RPA operation is likely to conflict with another aircraft.

4.2.10.7 Radio use is not required for operations below 400 ft/120 m outside controlled airspace, but suitably qualified remote pilots should use their best judgement as to whether broadcasts or responses to transmissions by other stations would enhance the safety of their operations.

4.2.10.8 Many non-controlled aerodromes appear in ERSA. However, some aerodromes are listed only in ERSA with their name and location code. Not all aerodromes are marked on aeronautical charts, and some aerodromes do not appear in ERSA, so operators should check using satellite pictures or seek local knowledge to identify any nearby non-controlled aerodromes or HLS.

Broadcast areas

4.2.10.9 The lateral and vertical boundaries of broadcast areas are depicted on aeronautical charts.

4.2.10.10 Remote pilots operating within a broadcast area are to maintain a listening watch on the relevant CTAF. They may also need to make broadcasts in accordance with standard aviation communication procedures when operating near aerodromes.

Position reporting

4.2.10.11 If required, position reporting to other traffic should be referenced to the RPA position (not the remote pilot position) relative to an aerodrome, navigation aid, prominent ground feature, etc.

4.2.10.12 When an RPA is operated at a non-controlled aerodrome, launch and recovery will need to comply (as appropriate) with the normal procedures that apply to that aerodrome or a NOTAM issued with the relevant details of the non-standard activities (refer to Section 4.3).

4.2.11 Populated and populous areas

4.2.11.1 A populous area is defined as:

> an area in relation to the operation of an unmanned aircraft that has a sufficient density of population for some aspect of the operation, or some event that might happen during the operation (in particular, a fault in, or failure of, the unmanned aircraft) to

pose an unreasonable risk to the life, safety, or property of somebody who is in the area but is not connected[11] with the operation. [12]

4.2.11.2 An area within an urban environment may be deemed as 'non-populous' for the duration of an RPA operation if certain conditions are met. For example, an oval devoid of people could be used to photograph real estate from across the road using oblique photography; or the area around a power pole within an urban area, set up as a demarcation zone with appropriate 'temporary workplace' signage may be used. It is the operator's responsibility to ensure that any demarcation zone is suitably placarded, and an observer is in place to ensure that there are no encroachments on that area.

4.2.11.3 When considering RPA operations conducted over populated areas, the safety of people and property on the ground (or water) is paramount. The risk of injury or damage resulting from RPA operations should be addressed in the operator's risk assessment and the job safety assessment.

4.2.11.4 For certificated RPA, approval to operate over densely populated areas will be dependent on the safety case provided to CASA by the operator. The assessment will need to demonstrate that the risk mitigations put in place by the operator make the area effectively 'non-populous'.

4.2.11.5 As a guide, to what may be considered an 'unreasonable risk', operators may look at the level of other risks the community accepts (e.g., from motor vehicles or as casual observers of sports like cricket and golf), provided that a person who may be at risk could reasonably be expected to understand and perceive the risks involved when in the vicinity of RPA operations.

4.2.11.6 Operations over a populated area should only take place if conducted at an altitude that would prevent the RPA injuring people or damaging property in the event of an aircraft or system failure.[13] This is particularly important when planning to operate at large public or private events (e.g., sports events, demonstrations, shows and exhibitions). The requirement for the RPA to clear the area would generally preclude rotorcraft from flying over crowds/groups of people.

4.2.11.7 The alleviation in subregulation 101.245 (3) of CASR that permits RPA operations less than 30 m from a person, should only be exercised with explicit consent from the individuals involved and only after they have been personally briefed on the risks associated with proximity to the RPA flight. Even then, the RPA must remain at least 15 m from the person.[14] Operations closer than 15 m to a person require CASA approval.

4.3 Use of NOTAMs

4.3.1 A NOTAM is used to alert pilots and crews about activities that may be hazardous to aviation operations.

[11] 'Connected with the operation of the RPA' only refers to members of the remote flight crew who have direct responsibility for the safe conduct of the flight.
[12] Refer to regulation 101.025 of CASR.
[13] In accordance with regulation 101.280 of CASR.
[14] In accordance with regulation 101.245 of CASR.

4.3.2 NOTAMs are required if you have been issued an Instrument of approval that contains a condition requiring a NOTAM:

a. operating within 5.5 km (3 NM) of a controlled aerodrome
b. operating within the movement area of any aerodrome
c. operating above 400 ft (120 m) above ground level
d. operating beyond visual line-of-sight (BVLOS)

4.3.3 RPAS operators seeking to have a NOTAM issued should complete the latest version of the NOTAM Request Form as published by Airservices Australia. It is highly recommended to follow information in the NOTAM Data Quality Requirements for Unmanned Aircraft Operators as well as the NOTAM Originator User Guide (both accessible from the above link), as NOTAM requests that contain errors will not be accepted.

4.3.4 The method of submission of the NOTAM Request Form will depend on whether you are a 'NOTAM authorised person'. If registered as a NOTAM authorised person, submit completed NOTAM Request Form directly to the NOTAM office (NOF). If not, submit to the CASA RPAS office (send to rpas.pac@casa.gov.au only) for quality checking and submission to the NOF on your behalf.

4.3.5 Individuals that are registered as NOTAM authorised persons with Airservices can request a NOTAM to be issued via the NOTAM Request Form or electronically via the NOTAM Web Service in NAIPS.

4.3.6 To register as a NOTAM authorised person, your organisation must have a data product specification (DPS) in place with Airservices. For more information and application, please see the Airservices website.

4.3.7 When submitting NOTAMs via CASA, they must be provided to CASA's RPAS office at least 2 business days prior to the required publishing date. Please note these requests can only be actioned during business hours (0800-1700 AEST, Monday to Friday).

Note: CASA receive a large percentage of NOTAM request forms from the RPAS industry that require correction before they may be submitted. CASA may review the quality of previously received NOTAM request forms and recommend changes to the NOTAM submission process.

4.4 Flight logging

4.4.1 Flight and technical logging requirements are published in Chapter 10 of the Part 101 Manual of Standards (MOS). These reporting requirements have been incorporated into the sample RPA operations manual on the CASA website. A ReOC holder may transition to the revised manual or simply adopt the relevant sections into their current manual to ensure they remain compliant.

4.5 Changes to supplied information

4.5.1 Changes to a ReOC holder's organisation, or documented practices and procedures need to be notified to CASA. These requirements are published in the Part 101 MOS, specifically section 10.17.

4.6 Emergency procedures

4.6.1 A ReOC's documented practices and procedures must identify relevant emergency procedures to be followed under normal operations. If type specific emergency procedures are required, these should be identified in the specific RPA section.

4.6.2 If the standard emergency procedure cannot be achieved or requires slight variation due to the specific task at hand, the RPA mission plan should detail the emergency procedures to be followed in the event of an emergency, such as:

- engine/propeller failure
- loss of data link
- loss of control
- failure of navigation equipment e.g., loss of GPS
- airframe damage.

4.6.3 A mission plan should be prepared for each flight of an RPA. The plan should include information about the local area and any hazards. It should also contain procedures about planned emergency flight profiles in the event of a lost data link. Depending on system capabilities, these profiles should include either an:

- RPA automated transit to a pre-designated recovery area, followed by an automated recovery

  or
- RPA automated transit to a pre-designated recovery area, followed by activation of a flight termination system.

Note: Prior to the implementation of these procedures the lost link SSR/ADS-B code should be either automatically or manually selected and transmitted in line with pre-defined procedures.

4.6.4 The RPAS data link should be continuously and automatically monitored while the RPA is in flight, and a real-time warning should be displayed to the remote pilot in the case of failure.

4.6.5 In the case of a lost control data link, other than intermittent loss of signal or during programmed periods of outage, the pilot should:

- advise ATS (if applicable) and any aircraft in the vicinity if the RPA is likely to pose a hazard
- execute recovery procedures.

Note: The parameters that determine acceptable intermittent loss of signal and total loss will be pre-determined by the manufacturer and documented in the operations manual.

4.6.6 In controlled airspace, the operator and ATS should agree how much time can elapse before the pilot must notify ATC of the loss of link.

4.7 Reporting

4.7.1 To help CASA and the Australian Transport Safety Bureau (ATSB) to monitor the safety of RPA operations, the RPA operator should report incidents and accidents for analysis and evaluation.

4.7.2 The ATSB defines two types of RPAs subject to specific reporting requirements:

4.7.3 Type 1 RPA are type certified; large (more than 150 kg) or medium (more than 25 kg but not more than150 kg) RPA.

4.7.4 Type 2 RPA are not Type 1 and are not an excluded or micro (250 g or less) RPA.

4.7.5 Type 1 operators are required to immediately report to the ATSB, RPA occurrences involving:

- death or serious injury
- accidents
- loss of a separation standard with aircraft
- serious damage to property.

4.7.6 Less serious incidents and occurrences are required to be reported to the ATSB within 72 hours.

4.7.7 Occurrences involving Type 2 RPA need to be immediately reported to the ATSB if they involve death or serious injury, while less serious incidents and damage to the RPA will need to be reported within 72 hours.

4.7.8 Such instances should be reported in accordance with ATSB requirements (see the ATSB website).

4.8 Other considerations

4.8.1 'Included' RPA operations are also subject to the following general considerations.

4.8.2 Legal restrictions

4.8.2.1 CASA regulations do not grant an RPA operator any rights against the owner or occupier of any land on or over which operations are conducted. They do not prejudice the property rights of a person in respect of any injury or damage to property caused directly or indirectly by an RPAS operation.

4.8.2.2 Compliance with CASA regulations do not absolve the operator from compliance with any other regulatory requirements that may exist under Commonwealth, State, or local law.

4.8.3 Surveillance and enforcement

4.8.3.1 As with other sectors of the aviation industry, RPA operators are subject to oversight, surveillance, and enforcement by CASA. Oversight and surveillance can be in the form of safety audits of the ReOC's facilities, RPA and procedures, and on-site checks of flying operations.

4.8.3.2 Operators and pilots should be aware that Part 117 of CASR contains severe penalties for a person misrepresenting that they hold civil aviation authorisations.

4.8.3.3 Non-compliance with regulations will be investigated and operators found to be in breach may be subject to safety and/or enforcement action. See the CASA website for more information.

4.8.4 Privacy

4.8.4.1 CASA does not consider privacy concerns when issuing approvals.

4.8.4.2 CASA strongly recommends operators include relevant privacy provisions in their operations manuals (refer to the *Privacy Act 1988).*

4.8.4.3 Further information can be found on the Office of the Australian Information Commissioner's website.

4.8.5 Aviation security

4.8.5.1 Remote crew members operating an RPA from a security-controlled airport, should consider the applicable aviation security requirements for access to airport operational areas. Refer to the Department of Infrastructure, Transport, Regional Development, Communications and the Arts' aviation safety web page for further information.

4.8.6 Drug and alcohol management plan (DAMP) and testing

4.8.6.1 ReOC holders are not currently required to develop a DAMP as set out in Part 99 of the CASR. CASA does encourage RPA operators to develop a policy that identifies reasonable practices and procedures for fitness for duty and the management of drug and alcohol matters for their remote pilots. These policies may be developed alongside the DAMP requirements identified in Part 99 however, CASA will not approve the system as a DAMP under the regulations. CASA will identify whether the procedures are acceptable as part of the documented practices and procedures of the RPA operator.

4.8.7 Frequency spectrum management

4.8.7.1 To operate a radio transmitter, a radio communications apparatus licence issued by the Australian Communications and Media Authority (ACMA) must be obtained. A radio transmitter not only includes radios used for voice communications, but also includes the radio control devices used on RPAS.

4.8.7.2 The majority of commercial-off-the-shelf RPAS will fall under the Radiocommunications (Low Interference Potential Devices) Class Licence 2015, as it exists from time to time, however, the operator of a radio transmitter must ensure they adhere to any requirements from ACMA.

4.8.7.3 Airservices Australia is responsible for the Aeronautical Radiofrequency Spectrum within Australia and its Territories. Airservices Australia can provide a frequency assignment service as a first step to obtaining a radio communication apparatus license to operate a radio transmitter within the aeronautical bands. Assignment can be made for radio communications, links, navigation aids, surveillance, and landing systems.

4.8.7.4 The frequency band allocated for aeronautical very-high frequency (VHF) communications is 118-137 MHz.

4.8.7.5 Airservices Australia is also responsible for the radiofrequency spectrum used for aeronautical high frequency (HF) and ultra-high frequency (UHF) communication, navigational aids and landing system.

4.8.8 Environment

4.8.8.1 CASA strongly recommends that operators address obligations under the *Environment Protection and Biodiversity Conservation Act 1999* in their operations manuals.

4.8.8.2 For RPA operations which involve discharging chemicals, pesticides or other environmentally hazardous materials, CASA strongly recommends the operator contact the relevant environmental protection agency in each state or territory, to identify any requirements for aerial application.

4.8.9 Noise Regulations

4.8.9.1 On 14 December 2021, the Government introduced a new regulatory framework to better manage noise from drones. The new regulations are set out in the Air Navigation (Aircraft Noise) Regulations 2018 (Noise Regulations). Most RPA operators will likely be exempt from requiring an approval. RPA operators undertaking complex or large operations may be required to obtain an approval from the Department of Infrastructure, Transport, Regional Development, Communications and the Arts.

4.8.10 You do not need to seek an approval under the Noise Regulations if:

- you are flying for fun or recreation or
- you are flying for a commercial purpose in the 'Excluded RPA' category or
- you only fly drones for one or more of the following purposes:
  - agricultural operations or
  - environmental operations or
  - firefighting, medical, emergency, or policing operations.

4.8.11 You may need to seek approval under the Noise Regulations if you are flying for a commercial purpose and/or you have been issued a ReOC. Only the ReOC holder should apply for an approval under the Noise Regulations. RePL holders who operate RPA under a ReOC need not apply.

4.8.12 If you are operating under a ReOC and are not sure if you require an approval, it is recommended that you use the self-assessment application form.

4.8.13 Insurance

4.8.13.1 CASA strongly recommends operators discuss with an insurer the potential liability for any damage to third parties resulting from RPAS operations and consider suitable insurance.

4.8.13.2 CASA will not consider an insurance policy as a risk control measure or risk mitigation strategy when assessing any application from a certified RPA operator.

5 Specialised RPA operations

5.1 Authorisations for specialised operations

5.1.1 Before using an RPA for a particular task, ReOC holders should first assess whether the flight/mission is within the scope of their approved operations. This is commonly referred to as the feasibility process and a sample procedure is included within the sample RPAS operators manual. This process will identify whether an additional CASA authorisation is required. Where the proposed operation is outside the ReOC holder's current authorisations, operators should apply to the CASA RPAS office. A flowchart in Appendix C has been developed to identify the type of authorisation required.

5.1.2 Requests for approval should be submitted via email to CASA and should be accompanied by a robust safety case.[15] To assist with the application process and fee estimation, details of the purpose, scope of the operations and all operational documentation must be included in the application.

5.1.3 There may be delays if all the required information is not included when the application is submitted. CASA is unable to make any assessment or provide significant advice without first providing an estimate of costs and receiving payment.

5.1.4 Area approvals may be considered by CASA's Office of Airspace Regulation (OAR) to determine whether an airspace solution is required for the operational area. This is necessary to address any residual risk after the application of other risk mitigations.

5.1.5 If residual risk exists with all mitigations in place, an applicant may be required to submit an airspace change proposal; this process is defined in the OAR operations manual, which can be accessed through the CASA website. Staff in the CASA RPAS office will coordinate with the OAR, as required.

5.1.6 When issuing approvals, CASA may impose limitations on the operation of an RPA to ensure that the RPA will pose no greater threat to the safety of air navigation than posed by a similar operation involving a conventionally piloted aircraft. Such limitations may include but not limited to:

- altitudes
- geographical restrictions
- radio broadcast requirements
- the provision of observers
- the timing of operations
- pilot qualifications, experience, and competency in relation to the operator's procedures.

[15] CASA Form 101-09 can be submitted in relation to a number of RPA approvals and permissions, such as operations within 3 NM of a controlled aerodrome, operations above 400 ft AGL in controlled airspace, etc.

5.2 Specialised operational matters

5.2.1 Extended visual line of sight operations

5.2.1.1 Extended visual line of sight (EVLOS) is an operational category in which the remote pilot does not have direct visual sight of the RPA. However, with assistance from trained RPA observers (persons who demonstrate competency via the operator's approved training requirements), the remote pilot is still able to ensure safe operation of the RPA.

5.2.1.2 EVLOS operations are not routinely permitted. CASA requires operators to conduct a case-by-case safety risk assessment and mitigation strategy prior to any application for approval to operate EVLOS.

5.2.1.3 In EVLOS operations, operators should be satisfied that all areas of the intended operational airspace will be always visible, by at least one of the remote crew during the operation. This assessment should consider physical obstacles and meteorological conditions. RPA observers are to alert the remote pilot to any incoming traffic, and the remote pilot is to take the necessary actions to manage the flight and avoid collisions.

5.2.1.4 At least one of the RPA observers, or the remote pilot, must have direct visual sight of the airspace around the RPA and be able to communicate with the remote pilot continually to assist with collision avoidance responsibilities[16]. When the RPA is out of sight the observers must be acutely aware of the aircraft's location and have the surrounding airspace and ground below it in direct visual sight.

5.2.1.5 Both operators and remote pilots require CASA approval to conduct EVLOS operations.[17] Any approval will contain conditions to ensure the safety of other airspace users and people and property on the ground, including the situations and length of time that the aircraft may not be directly visible.

5.2.1.6 EVLOS operations Class 1 do not require remote pilots to hold a pass in an instrument rating examination (IREX). This has been permitted through exemption, CASA EX46/21 Remotely Piloted Aircraft Operations Beyond Visual Line of Sight Instrument 2021.

Electronic aids

5.2.1.7 Electronic aids, such as on-screen or moving map displays, can be beneficial to improving situational awareness of the local airspace environment for the remote pilot during EVLOS operations and, where available, may be used as risk mitigation tools. Such displays may be used as an additional aid to safety, but cannot be used instead of, or to replace, direct eye contact in VLOS operations.

First person view

5.2.1.8 First person view (FPV) may be used in EVLOS operations as an aid to obstacle avoidance. The RPA observers or the remote pilot must be able to see the aircraft

[16] In accordance with regulation 101.073 of CASR.
[17] In accordance with regulation 101.029 of CASR (it should be noted that, CASA is working towards giving general approvals for EVLOS to operators who meet all the conditions for EVLOS in the Part 101 MOS when it comes into effect).

without electronic aids, the airspace around it and the ground beneath to ensure that the operation remains compliant with the regulations.

Note: FPV is not an acceptable solution for visually separating RPAS from other airspace users in a safety case for approval of beyond visual line of sight (BVLOS) operations.

5.2.2 Beyond visual line of sight operations

5.2.2.1 BVLOS operations are not routinely permitted. CASA requires operators to conduct a case-by-case safety risk assessment and mitigation strategy prior to any application for approval to operate BVLOS.

5.2.2.2 Applicants will need to demonstrate how the proposed operation can be mitigated to an acceptable level of safety; among other elements of the operation, particular consideration should be given to:

- aircraft control link and redundancy
- fail-safe systems
- collision risk mitigation
- navigation accuracy
- altitude accuracy
- stakeholder engagement for other relevant air users
- whether any technical solutions or procedures have been certified/assessed by the manufacturer of the RPA to meet design assurance requirements.

5.2.2.3 CASA may apply conditions to an approval for BVLOS operations, and all flights must be conducted in accordance with the conditions specified in the approval.

5.2.2.4 The OAR may be required to review the application if there is residual risk present. An airspace solution may be required and the process for this is outlined at paragraph 5.1.5.

Equipment requirements

5.2.2.5 CASA may require the following equipment to be fitted to the RPA and operable for a BVLOS flight[18]:

- **position lights** (navigation lights)[19] - should be always turned on, while the RPA is in motion (including taxi, launch, flight, and recovery).
- **anti-collision or strobe lights** - should be always turned on the RPA is in flight (unless otherwise directed by CASA or ATS).
- **landing lights** - should be turned on during recovery (if fitted).
- **transponders** - an approved SSR transponder or ADS-B out unit may be required (Some flights below 400 ft/120 m may be exempt). Subsection 9C of CAO 20.18 specifies the standards for Mode S transponder equipment. The transponder should be always switched to ON/ALT while the RPA is airborne.
- **aeronautical radio** - RPA communication architecture should allow the remote pilot to have direct communications with ATS, regardless of the aircraft's location.

[18] In accordance with regulations 101.073 and 101.300 of CASR.
[19] Position, anti-collision, strobe and landings lights, where required, should be demonstrably effective, but do not have to meet the standards of manned aircraft.

The normal published aeronautical very high frequencies should be used for communications with ATS.

- **navigation equipment -** the RPA should have the navigation capability to comply with the tracking requirements of the airspace classification in which the RPA is being operated, and an acceptable level of design assurance.
- **any additional equipment** that the operator has included in its safety case for the approval of the operation.

5.2.3 RPA operations in controlled airspace

5.2.4 Pilots of RPA intending to operate above 400 ft/120 m in controlled airspace or within 3 NM/5.5 km of the associated aerodrome must apply to CASA for an approval. CASA will liaise with the relevant air navigation service provider (ANSP) to identify if the operation may proceed as applied for. The initial application should be made using Form 101-09, ensuring all documentation as requested within the form is supplied.

5.2.5 Form 101-09 does not apply to flights under the automated airspace authorisations trial. More information about how to participate in the trial can be found on the 'automated airspace authorisations trial' CASA webpage.

Preparation for controlled airspace operations

5.2.5.1 Operators will need to have suitable procedures in their operations manual, and pilots will need to have the relevant training certification from the ReOC holder.[20]

5.2.5.2 Advice on any performance requirements or limitations unique to the RPA should be provided as part of the application.

5.2.5.3 Designated ‘safe areas’ are to be established by the operator, on advice from the ANSP, for RPA emergency holding and flight termination. A meeting between the operator, ANSP and CASA may be required to establish the specifics relating to different phases of flight.

Flight termination procedures

5.2.5.4 Specific flight termination procedures developed by the ReOC holder and executed by the remote pilot should be agreed with ATS before undertaking the operation. At a minimum, the following information should be briefed:

- pre-programmed loss-of-C2 link flight profile-including actions to take should the control link not be re-established within an agreed timeframe
- flight termination capabilities
- RPA performance under termination conditions.

5.2.5.5 RPA should not be operated within controlled airspace without an operable flight termination system or one that provides automated recovery to a predetermined recovery area.

[20] In accordance with regulations 101.070 and 101.072 of CASR. (Remote pilots receive certification from the ReOC holder when they complete the operator’s approved training course for this purpose.)

5.2.5.6 In the event of communications failure between the remote pilot and the ANSP, the remote pilot must follow the conditions of the approval in relation to this failure, or the documented procedures of the certified operator, until such time the communication link is re-established.

Coordinating with ANSP

5.2.5.7 If a person is using an aeronautical radio to communicate with the ANSP, the certified operator must ensure that person holds a relevant qualification in accordance with regulation 101.285 of CASR. Where agreed with the ANSP, mobile telephone or other means may be used, but as a contingency only in the event of the loss of VHF radio communications.

5.2.5.8 Communication requirements may be prescribed within the documented practices and procedures or conditions on the approval. The remote pilot should ensure they understand the communication requirements when operating under the approval.

Position reporting

5.2.5.9 RPAs operating in controlled airspace should be continuously monitored by the remote pilot for adherence to the approved area of operation. Position reporting to the ANSP must be conducted on request from the ANSP or other air users and IAW ENR 1.1-101.

Flight deviations

5.2.5.10 Requests for deviations from the approved area of operation will require further assessment and reissue of the approval from CASA. Deviations outside the approved area cannot occur dynamically during the operation.

RPA operations at or near controlled aerodromes

5.2.5.11 CASA and the ANSP permission are required to operate at or within 3 NM/5.5 km of a controlled aerodrome[21], being an aerodrome at which the control tower is *operating*. Outside tower hours, controlled aerodromes are treated as non-controlled aerodromes and the prescribed requirements in Chapter 9 of the Part 101 MOS must be adhered to. Such aerodromes, tower hours and procedures are listed in AIP ERSA.

5.2.5.12 It is the responsibility of the remote pilot and ReOC holder to determine whether there are any other aerodromes within 3 NM/5.5 km of their proposed area of operation. This can be done through:

- a review of ERSA and aeronautical maps and charts, noting that not all aerodromes appear in or on these publications
- satellite imagery
- consultation with local government bodies
- consultation with landholders, other operators, and pilots in the area.

5.2.5.13 Where there are other aerodromes or HLS within 3 NM/5.5 km, the operator and remote pilot will need to also comply with Chapter 9 of the Part 101 MOS with respect to operating near non-controlled aerodromes.

[21] In accordance with regulation 101.080 of CASR.

5.2.5.14 The height reference for controlled aerodromes is the aerodrome's elevation as listed in ERSA.

5.2.5.15 If operations are planned from a security-controlled aerodrome, operators should also consider the requirements for access to operational areas and the aviation security requirements that apply to security-controlled aerodromes.[22]

Military controlled airspace and military controlled aerodromes

5.2.5.16 If operations are planned within the no-fly zone of an aerodrome where the ANSP is the Australia Defence Force (ADF), the applicant will need to contact the ADF ATC unit listed in ERSA and seek a letter of agreement for operations within their proposed area of operation. This letter of agreement is required prior to issuing the approval from CASA.

5.2.6 Dropping, discharging, and dispensing operations

5.2.6.1 Australian state and local government regulatory requirements should be met for the dropping or dispensing of chemicals or other materials. Local jurisdictions issue their own chemical licences to cover these activities. It is the responsibility of the operator to ensure that the appropriate approvals are obtained from local authorities before conducting such operations.

5.2.6.2 To be satisfied that the operator can carry out the proposed operations safely, suitable procedures will need to be included in the company operations manual for CASA to approve.[23]

5.2.6.3 Dropping and discharging operations may present a heightened risk to other people, property or other aircraft. Remote pilots conducting dropping, discharging, or dispensing operations should have sufficient flight experience under supervision in such operations prior to any solo operations.

5.3 International RPA operations

5.3.1 ICAO requirements

5.3.1.1 Paragraph 3.1.2 and Appendix 4 of Annex 2 to the Chicago Convention contains requirements with respect to international operations as follows:

a. RPA shall not be operated without the appropriate authorisation from the State from which the departure is made.
b. RPA shall not be operated across the territory of another State, without special authorisation issued by each State, in which the flight is to operate. This authorisation may be in the form of agreements between the States involved.
c. RPA shall not be operated over the high seas, without prior coordination with the appropriate ATS authority.

[22] For further information, refer to the Department of Home Affairs.
[23] In accordance with regulation 101.090 of CASR.

d. The authorisation and coordination referred to above (b and c), shall be obtained prior to departure if there is a reasonable expectation, that the aircraft may enter the airspace concerned.
e. RPA shall be operated in accordance with conditions specified by the State of registry and the State(s) in which the flight is to operate. Any conflicting operational rules will need to meet the more exacting standard.

5.3.2 Flight outside CASA's territorial jurisdiction

5.3.2.1 Operators will need an 'in-and-out of Australia' approval in their ReOC to fly to and from Australia and its territories outside the twelve-mile territorial limit.[24] This will allow the operator to fly throughout the Australian flight information region and not be restricted to Australian territory.

5.3.2.2 Any approval given by CASA would need to consider ICAO guidance until formal international standards are published.[25] Operators should contact CASA's RPAS office if they think they will need this approval.

5.3.3 International operators

5.3.3.1 International operators who want to fly RPA into or out of Australian territory should contact CASA's RPAS office in the first instance. CASA will ask you for the following information:

- a comprehensive description of the planned operations
- details of the aircraft to be flown (i.e., the performance characteristics)
- a copy of the company operations manual and the flight and maintenance manual for the aircraft
- a copy of the risk assessment for the event, based on ISO 31000 principles
- a copy of the remote pilots' and operator's RPAS credentials
- any national aviation authority (NAA) approvals that permitted the mission in that authority's jurisdiction.

Note: This information will be verified with the appropriate NAA.

5.3.4 Verification and scrutineering

5.3.4.1 CASA will conduct verification and scrutineering of international operators before any operations are conducted in Australian territory. To cover these requirements, international operators are requested to position their mission team in Australia, or arrange for CASA inspectors to visit their facilities, with sufficient time to allow testing and demonstration flying, including emergency procedures.

[24] In accordance with Section 3 of the Act.
[25] Refer to the Manual on Remotely Piloted Aircraft Systems (Document 10019) available from ICAO.org for further information.

6 RPA operator's certificate

6.1 Overview

6.1.1 A ReOC is like the air operator's certificate (AOC) for traditional aviation operations. Like the AOC, it authorises the holder to conduct included (most commercial) operations using the type(s) of RPA and under the conditions endorsed on the certificate.

6.1.2 A ReOC is required for any operation that is not an excluded RPA operation, including for:

- all RPA operating outside of the SOC, other than micro RPA and model aircraft operations
- RPA weighing more than 2 kg whether flying under the SOC, unless meeting the 'landholder' criteria.
- all operations with a large RPA.

Note: Model aircraft are, by definition, used for sport and recreation and do not require a ReOC.

6.1.3 The benefit of holding a ReOC is that it permits a range of RPA operations—subject to an approval or a permission—that are unavailable to other operators (see 'Specialised operations' in Chapter 5).

> If you are still unsure whether a proposed operation requires a ReOC, contact CASA.

6.2 RPA operator's personnel

6.2.1 Figure 2 shows the relationships between the chief remote pilot (CRP), remote pilot and other members of the remote crew. CASA requires the RPA observer and other remote crew to be trained and certified as competent in their roles by the ReOC holder, in accordance with the organisation's approved documented procedures. These personnel will not be directly authorised by CASA.

Note: In all cases, ReOC holders must be approved to conduct the type of operations flown by their remote pilots.[26]

[26] In accordance with regulations 101.029 and 101.335 of CASR.

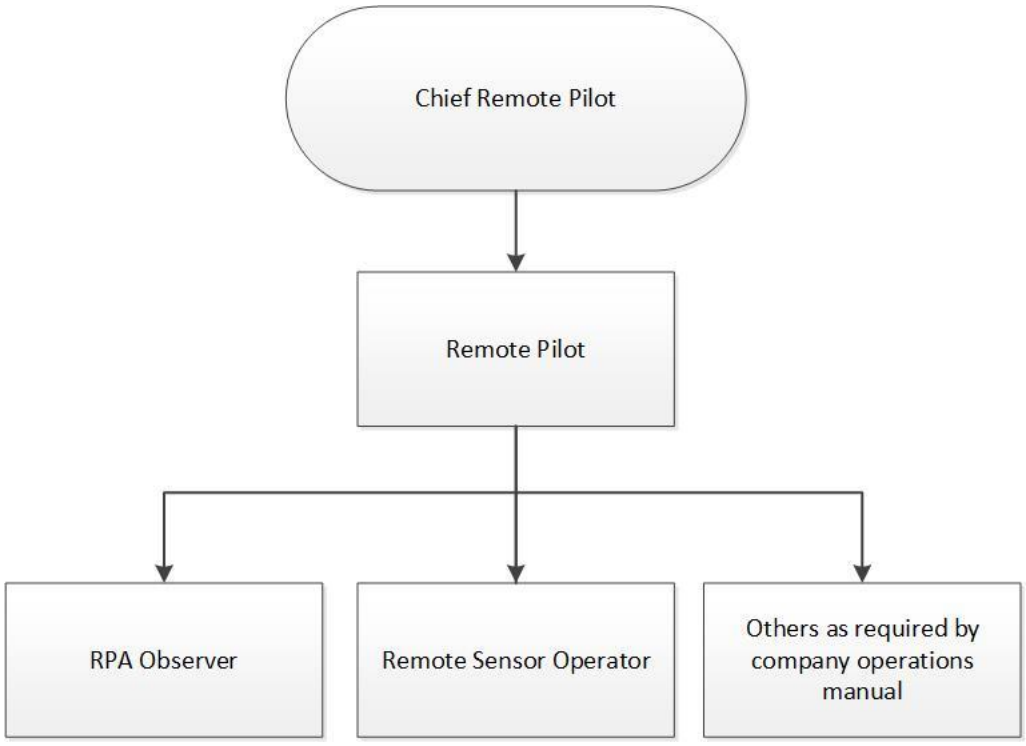


Figure 2: Remote crew organisational structure

6.2.2 Chief remote pilot

6.2.2.1 All ReOC holders must either qualify to be, or employ, a CRP.[27] Currently CASA does not require additional training qualifications or experience requirements for the position of company CRP. However, to be considered suitable, the person would need to hold a RePL and advanced knowledge and experience commensurate with the operator's planned operations. The company must ensure that the person intending or proposed to occupy the position can effectively carry out the functions and duties of the CRP required by regulation 101.342 of CASR, specifically:

- ensuring the operator's RPA operations are conducted in accordance with the civil aviation legislation
- maintaining a record of the qualifications held by each person operating an RPA for the operator
- monitoring the operational standards and proficiency of each person operating an RPA for the operator
- maintaining a complete and up-to-date reference library of the operational documents required by CASA, under paragraph 101.335 (1) (d) for the types of operations conducted by the operator.

6.2.2.2 The person nominated to fulfill the role of CRP will be required to undergo an assessment by CASA. The assessment involves a scenario-based activity and a set of questions relating to the operation of RPA under the authority of a ReOC. To be successful, the nominated CRP should have a thorough knowledge of:

[27] In accordance with paragraph 101.335 (1) (f).

- the company's documented practices and procedures
- Part 101 of CASR
- The Part 101 Manual of Standards
- Aviation safety management systems (SMS)
- The aeronautical information package (AIP)

6.2.2.3 A company must not perform ReOC operations unless a person has been approved by CASA to fulfill the role of the CRP within that company and they are fulfilling the roles and responsibilities of that role.

6.2.2.4 If the nominated CRP is no longer fulfilling the role of CRP, or the company intends to change the nominated CRP, an application must be made to CASA using Form 101-02.

6.2.3 Remote pilot

6.2.3.1 Any other remote pilots working for the operator must hold a RePL and be inducted into the company. This induction must include training on all operational practices and procedures, and practical competency checks on the RPAS to be operated within the company.

6.2.4 RPA observers and other remote crew

6.2.4.1 CASA does not specifically approve other remote crew members. RPA observers and other remote crew should complete an operator's course of training appropriate to their function, in accordance with the syllabus and program in the operator's approved operations manual.

6.2.4.2 Competency standards and training for intercommunication among RPAS crew (e.g., between an RPA observer and remote pilot) is the responsibility of the operator. Training procedures and standards must be included in the operations manual.[28]

6.2.4.3 RPAS operators must maintain records that show the training delivered to, and the level of competency of, personnel in non-regulated roles.[29] This should be consistent with the requirements in Chapter 10 of the Part 101 MOS.

6.3 Training obligations of a ReOC holder

6.3.1 To ensure the unmanned aircraft community conducts safe RPA operations, operators and remote pilots should keep up to date with the development of technology and procedures. Operators should also ensure they and their remote crew are appropriately trained and competent in conducting RPA operations.

6.3.2 Operators should determine the training required for their RPA crew and detail this in their operations manual. If a remote pilot does not fly within any currency timeframe identified in the operations manual for the RPA, a refresher program of theory and practical flying should be conducted. Some of the practical training may be done in a simulator.

[28] In accordance with subregulation 101.335 (1) of CASR.
[29] In accordance with regulation 101.272 of CASR.

6.4 RePL training organisations

6.4.1 Organisations wishing to conduct RePL training courses for the issue of an RePL, must be assessed and approved by CASA. The assessment includes a review of all relevant training documentation and a face-to-face assessment where the chief instructor of the organisation demonstrates teaching in a classroom environment and practical flying. Further information can be found on the 'Become a training provider' page on the CASA website.

6.5 Preparing a ReOC application

6.5.1 Figure 3 depicts the steps involved in preparing a ReOC application. Before applying for a ReOC, applicants should consider the type(s) of operations planned and the category and size of RPA to be used.

Manuals

6.5.2 Procedures for the proposed operations need to be documented in the operator's manuals. The following manuals are required in an application for a ReOC and for the operator's library of operational documents:

- operations manual
- RPAS flight manuals
- RPAS maintenance manuals.

6.5.3 A sample operations-manual for RPAS is provided on the CASA website; this sample manual identifies acceptable means of compliance and should be used as a starting point for the company's operations manual.[30] Applicants for a ReOC can develop their own operations manual by amending or adding extra information to suit their proposed RPA type(s) and planned operations.

6.5.4 The level of detail and complexity in these manuals will depend on the systems operated and the type of operations conducted. For example, the RPAS flight manual and maintenance manual may be a single document for simple aircraft.

[30] Sample manual can be located here.

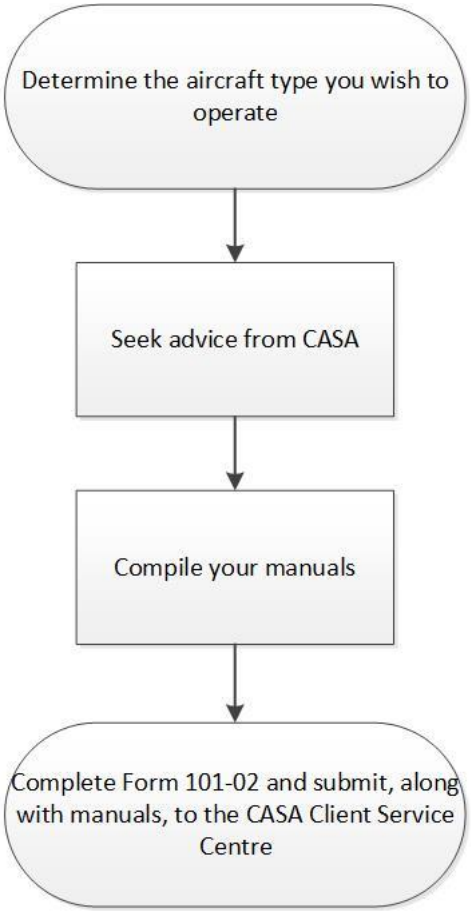


Figure 3: Steps in preparing a ReOC application

Chief Remote Pilot

6.5.5 Each operator must nominate a chief remote pilot.[31] Information about being assessed and approved by CASA as a chief remote pilot can be found in Section 6.2.2. The name, contact details and experience of the person nominated to be chief remote pilot must be included in the operator's application, along with the names of the CEO/Managing Director and the maintenance controller—noting that they can be the same person. These details should be included in Form 101-02.[32]

6.6 Submitting a ReOC application

6.6.1 The required manuals and application Form 101-02 should be submitted electronically to CASA at regservices@casa.gov.au, or to an industry delegate (see CASA website).

6.6.2 CASA will conduct an administrative assessment and estimate the time and cost for processing and assessing the application. CASA will then send the applicant an invoice for payment, based on the estimate, which must be paid before the formal assessment process by CASA can commence.

[31] In accordance with regulation 101.340 of CASR.
[32] Note that the functions and duties of a maintenance controller can be found in AC 101-05.

6.7 Assessment of application

6.7.1 The formal assessment will include:

- assessment of the applicant's manuals
- assessment of the CRP
- assessment of the maintenance controller if the company intends to operate Large RPA (RPA with MTOW >150 kg)
- if applying to become an RePL training organisation, further assessment is required. See the 'Become a training provider' page on the CASA website.

6.8 Issue of a ReOC

6.8.1 CASA will issue successful applicants with a ReOC including the authorisation 'RPAS Aerial Work', which permits the operator to conduct RPA operations under the general operating conditions (see section 3.2.11).[33] A ReOC does not confer on the holder any other privileges, and operators must also ensure that they meet any other Commonwealth, State, Territory, and local laws applicable to their activities.

6.8.2 If you don't need to make any changes to your ReOC, you can renew your ReOC online through the *my*CASA portal. Applications should be submitted at least 5 business days before your ReOC expires. If your ReOC expires before your renewal is processed, you'll no longer be authorised to operate. You will not be allowed to operate and a new application for a ReOC will be required.

6.8.3 If you need to change or update any details in relation to your ReOC, you'll need to complete and submit a form (CASA 101-02).

6.9 Updating your ReOC

6.9.1 ReOC holders may be approved to carry out 'included' operations in general, but their approved manuals must include specific procedures for the types of operations they plan to conduct. Appendix C depicts the process for determining whether an additional approval is needed and whether a particular task can be carried out by the operator.

6.9.2 Intended or proposed changes that will require the ReOC to be reissued are outlined below:

- Increase or decrease in operational weight e.g., multi-rotor 7 kg to multi-rotor 25 kg
- Addition or removal of category of RPAS e.g., adding fixed-wing 25 kg, removing helicopter 7 kg
- Addition or removal of an RPAS above 25 kg (medium and large RPA are type rated for RePL and ReOC)
- Change to legal entity.

6.9.3 Different flight activities and RPA types may be added to the ReOC later, and this will require suitable procedures to be added to the approved operations manual. Any changes to the manuals must be approved by CASA.

[33] RPAS aerial work does not include passenger-carrying operations.

6.9.4 Addition of RPAS that are within the current authorisations on the ReOC does not require CASA to reissue the ReOC e.g., an organisation is issued an ReOC for multi-rotor 7 kg and then brings online a multi-rotor RPAS that weighs 5 kg.

7 Remote pilot licensing and qualifications

This Chapter provides the information necessary for an applicant to obtain a RePL and describes the various limitations and permissions that may be attached to a RePL. It also provides details of additional qualifications that a RePL holder may require for specialised operations.

7.1 RPA categories and types for a RePL

7.1.1 For the purposes of licensing, RPA are divided into several categories:

- aeroplane
- helicopter (single-rotor class)
- helicopter (multi-rotor class)
- airship
- powered lift (hybrid aeroplanes with vertical take-off capability).

7.1.2 RPA are also divided into types:

- **Micro:** with a gross weight of not more than 250 g.
- **Very small:** with a gross weight of more than 250 g and not more than 2 kg.
- **Small:** with a gross weight of more than 2 kg and not more than 25 kg.
- **Medium:** with a gross weight of more than 25 kg and not more than 150 kg.
- **Large:** with a gross weight greater than 150 kg (or > 100 m3 envelope for airships).

7.1.3 Initial training can be done with CASA-approved training organisations. Further information can be found under ‘Get your operator credentials’ on the Drones landing page on the CASA website.

7.1.4 CASA will issue a RePL to a person who qualifies as a remote pilot. Based on that person’s experience and further training, the operating organisation (the ReOC holder) can assign its crew to meet operational requirements. The criteria for each remote crew position should be set out in the company operations manual. [34]

7.2 RePL application process

7.2.1 Existing UAV controller’s certificate holders

7.2.1.1 Holders of unmanned aerial vehicle (UAV) controller’s certificates continue to be authorised to exercise the privileges of that qualification under the amended Part 101. UAV controller certificate holders can transfer at any time to a RePL on request. A certificate holder seeking a variation to their flying privileges (e.g., adding an approval or removing a limitation) will be automatically issued a RePL. Both controller’s certificate holders and RePL holders are subject to the conditions set out in regulation 101.300 of CASR.

[34] In accordance with regulation 101.335.

7.2.2 Applicant with no aeronautical qualifications

7.2.2.1 An applicant for a RePL with no aeronautical qualifications should complete the following steps:

a. apply for an Aviation Reference Number (ARN) (refer to Appendix B)
b. complete an RePL training course through an approved RePL training organisation. The RePL training organisation will ensure you have obtained the minimum experience and submit the required documentation for you to gain your RePL.

7.2.3 Applicant with previous aeronautical qualifications

7.2.3.1 Applicants who already hold a pass in an aeronautical knowledge examination[35], CASA-issued pilot qualification or an acceptable overseas or military equivalent qualification will need to complete either of the following:

a. Pass the practical component of an RePL training course through an RePL training organisation (the RePL training organisation will submit the application for the RePL to CASA)
b. Pass a practical flight assessment with CASA and submit Form 101-01 with supporting documentation to applications@casa.gov.au.

Note: CASA may conduct a flight test with a person seeking a RePL based on overseas or military qualifications. This will include a knowledge test and a test on flight rules and air law.

7.2.4 Application to fly beyond visual line of sight operations

7.2.4.1 An RePL holder who intends to conduct beyond visual line of sight (BVLOS) operations must hold a pass in at least one of the following exams:[36]

– an aeronautical knowledge examination for an instrument rating under Part 61
– the former instrument theory examination (IREX) under Part 5 of the *Civil Aviation Regulations 1988 (CAR)*
– an approved examination for this purpose.[37]

Note: Currently, BVLOS operations can only be conducted by CASA-approved operators on a case-by-case basis.

7.3 Logbooks

7.3.1 A logbook is a practical method of recording flight hours as evidence of flying experience. Remote pilots who choose to use a logbook should record the flight time, location, flight rules and a short description of any tasks performed.

[35] The minimum requirement is for a Part 61 RPL theory examination. Converted RA-Aus RPL holders will need to meet the Part 61 standard.
[36] In accordance with regulation 101.295 of CASR.
[37] At the time of publication of this AC, there are no other approved examinations. An examination tailored specifically for RPAS BVLOS operations will be created once a syllabus of training has been written and included in the Part 101 MOS.

7.3.2 A sample RPA flying hours logbook can be found on the RPA webpage of the CASA website. This format can be printed and formed into a hard-copy document and maintained as evidence of hours accrued.

7.3.3 An electronic logbook may be used, but it should include an auditing functionality that ensures the veracity and accuracy of the data entered.

7.3.4 A traditional pilot's logbook may be used and can be purchased from an aviation store and used as a permanent record of RPA flying hours. Remote pilot hours can be logged in a separate column in the traditional pilot's logbook, but traditional and RPA hours cannot be aggregated.

7.4 RePL permissions

7.4.1 A RePL is issued with certain authorisations endorsed on it, depending on:

- the RPA type and category the person has qualified to fly
- the operations that the remote pilot plans to conduct.

7.4.2 To ensure that the remote pilot is competent to operate different types of RPA, CASA requires pilots to undergo training and demonstrate competency in the RPA category and type that they will fly.[38] For RPA weighing less than 25 kg, a generic grouping is endorsed on the RePL (e.g., multi-rotor, < 7 kg; aeroplane, < 25 kg).

7.4.3 As indicated previously, in the interests of aviation safety, CASA may limit some RePL holders to operations with RPA weighing less than 7 kg.

7.4.4 RPAS that weigh more than 25 kg are treated as individual qualifications and must be listed on the RePL by the name and maximum take-off weight.

RePL upgrade training

7.4.5 RePL upgrade training is required to fly RPA in a different category or type. This training can be conducted by:

- a CASA approved RePL training organisation
- a flight assessment through CASA.

7.4.6 If a RePL holder wishes to conduct a flight assessment through CASA, they must apply to CASA and include the type and category for the upgrade and the location where they wish to conduct the flight assessment. A CASA officer will then be in contact to arrange a suitable date and time.

7.4.7 Operational approvals

7.4.7.1 RePL holders may be eligible to conduct a range of operations, depending on the conditions on their licence. Other operations outside of the general operating conditions (see paragraph 4.1.3) may be conducted provided; ReOC holders have obtained the correct authorisation, there are suitable procedures in their approved Operations

[38] In accordance with subregulation 101.295 (2) of CASR.

Manual and, remote pilots have achieved competency under the operator's training program relevant to the operation to be flown.

7.4.7.2 Normally, approvals will be issued to ReOC holders who will ensure that their remote pilots are suitably trained to operate under the conditions of the approval. Additional approvals are required for the following operations outside the standard ReOC privilege:

- operations in any airspace above 400 ft/120 m AGL
- operations within the no-fly zone of a controlled aerodromes
- operations on or over the movement area of an aerodrome
- operations where the remote pilot is operating more than one RPA at any one time
- EVLOS operations
- BVLOS operations (including flight in other than visual meteorological conditions).
- operations outside of 12 NM of Australian territory.

7.4.7.3 Some approvals relate to a design feature of the RPAS. These are:

- automated flight (usually issued with the initial RePL, as required)
- manual flight (usually issued with the initial RePL, as required)
- liquid-fuel propulsion for aircraft over 25 kg take-off weight.

7.4.7.4 Applicants for these types of approvals may need to demonstrate their knowledge and practical skills in a flight test, noting that CASA may ask an applicant to meet other requirements as a condition of the approval (e.g., knowledge of an operator's procedures for carrying out the type of flight activity proposed).

7.4.7.5 All approvals can be issued with the initial RePL or added later.

Note: Ongoing approvals for airspace and aerodrome activities will not be issued until standards for aeronautical knowledge examinations on these topics are published in the proposed Part 101 MOS.

7.5 Aeronautical radio

7.5.1 Visual flight in controlled airspace

7.5.1.1 Generally, no radio qualification is required to operate an RPA below 400 ft/120 m AGL when more than 3 NM/5.5 km from the boundary of a controlled aerodrome. In other situations, a radio qualification may be required, as described in the following sections.

7.5.1.2 For operations above 400 ft/120 m in controlled airspace or within 3 NM/5.5 km of a controlled aerodrome, remote pilots must hold one of the following (*relevant*) qualifications:[39]

a. an aeronautical radio operator certificate
b. a flight crew licence
c. an air traffic control licence
d. a military qualification equivalent to a licence mentioned in paragraph (b) or (c)
e. a flight service licence.

[39] In accordance with regulation 101.300.

7.5.1.3 CASA may require a specific radio qualification in approvals for operations in circumstances where there may be a heightened risk of collision with other aircraft.

7.5.2 Visual flight in non-controlled airspace

7.5.2.1 A relevant radio qualification is required for flights above 400 ft/120 m AGL outside controlled airspace, unless the operation is more than 3 NM/5.5 km from the movement area of a non-controlled aerodrome.

7.5.2.2 A radio qualification may not be required for flights that take place within an area approved by CASA. This will depend on the type of operation being undertaken and the likelihood of conflict with conventionally piloted aviation.

Lanes of entry, restricted areas and other areas of low-flying conventional traffic

7.5.2.3 CASA may require certain operations in the vicinity of restricted areas or lanes of entry, or other areas where conventionally piloted flights take place at low altitudes to be operated only by remote pilots with suitable radio qualifications. This may be an aeronautical radio operator certificate, or other equivalent relevant qualification, including the flight radio endorsement.[40]

7.5.2.4 Aeronautical radio training leading to an aeronautical radio operator certificate qualification may be obtained from suitably approved RePL training providers or traditional flying schools.

7.6 Flight proficiency and currency

7.6.1 There are no CASA requirements for continuing flight proficiency or currency for RePL holders. However, remote pilots should maintain their proficiency and currency through regular practice, which may consist of RPA flying supplemented by computer-based simulator time.

7.6.2 Lack of proficiency or currency that led to an accident or incident might later be determined to be hazardous operation[41] if it was reasonable to assume that the RPA could have been competently controlled in the circumstance by a remote pilot of higher proficiency or with more currency.

ReOC holders should include proficiency and currency requirements in their documented practices and procedures for all personnel undertaking duties essential to the safe operation of the company's RPAS.

[40] In accordance with subregulation 101.285 (3).
[41] Regulation 101.055 of CASR.

8 Registration of RPA and aircraft requirements

8.1 Registration of RPA

8.1.1 From 28 January 2021, all RPA operated under a ReOC, no matter how much it weighs, must be registered with CASA. Large RPA registration requirements differ and are further detailed in section 9.3.

8.1.2 You can register your RPA online through the *my*CASA portal.

8.1.3 Registration is valid for 12 months unless cancelled sooner.

8.1.4 An electronic or hard copy of the registration certificate must be carried by the person flying the aircraft during operations and produced to an authorised person on demand. It is an offence to operate an RPA that is not registered for commercial purposes.

8.1.5 Even though excluded RPA operations can only be conducted in Australian territory, should you take a registered RPA overseas, and wish to operate it, it would need to be marked with the Australian nationality mark (VH-) followed by the registered serial number and you must comply fully with the rules of that country[42].

8.1.6 You must deregister your RPA if you lose it, damage it beyond repair, or sell or dispose of it. You can do this online through the *my*CASA portal. In the event the RPA is sold, do not remove the serial number. After you have deregistered your RPA, the new owner will be able to register it.

Modifications and registration

8.1.7 To some extent, the regulations permit the original registration to continue even when an RPA is modified. This is to allow development of the RPA without requiring the RPA to be re-registered.

8.1.8 The registration may continue, provided the modifications do not:

- change the category of the RPA (aeroplane, multi-rotor, powered lift etc.)
- increase the weight classification of the RPA into a higher weight classification (i.e., very small RPA to small RPA)
- increase the gross weight on take-off of the RPA by more than 20% (take-off weight includes payload)
- involve removal of parts and components that are critical to the flight of the RPA
- alter any of the following for the RPA:
- the manufacturer’s serial number
- the CASA serial number allocated in substitution for a manufacturer’s serial number
- any electronic identification of the RPA.

[42] Note that it is a requirement of the Convention on International Civil Aviation that an unmanned aircraft operated over the territory of another ICAO State (another country) must be authorised by that State.

8.2 Aircraft identification

8.2.1 Aircraft operated under a ReOC must legibly display the manufacturer's serial number, or if there is no manufacturer's serial number—the mark allocated by CASA when the aircraft was registered

8.2.2 It is acceptable if the manufacturer's serial number is displayed on a surface that is not exposed in flight, such as inside a battery box, or under an easily removeable hatch.

8.2.3 Any identification only need be in place during flight time, but operators should have a system of identification for their aircraft to ensure that they are safely managed, particularly with respect to maintenance.

8.2.4 Operators must also retain the aircraft's electronic identification, as allocated by the manufacturer, in such a way that is not changed, masked or interfered with in any way without the written permissions of CASA.

8.3 Foreign registered RPA and model aircraft

8.3.1 A person operating certain RPA and model aircraft that is registered under a law of a foreign country, but not registered in Australia, must comply with the following operation requirements:[43]

- has applied to CASA for permission to operate the aircraft, in accordance with the approved form for such applications
- paid the fee for such a permission
- have obtained the written permission of CASA and that permission has not expired, been revoked and the unmanned aircraft is not subject to an unacceptable modification
- operates in accordance with any conditions (if any) in the permission
- complies with the limitations and restrictions on the operation of an unmanned aircraft set out in the Australian civil aviation legislation
- when operating the unmanned aircraft, produces the permission, along with photographic identification, on request by an officer of CASA, or of an Australian police service.

8.3.2 CASA will revoke such permissions if it considers the revocation is necessary in the interests of aviation safety.

Modification of foreign registered RPA and model aircraft

8.3.3 Where a permission has been granted in respect of foreign RPA and model aircraft, and the aircraft has undergone an unacceptable modification since the permission was granted, CASA may revoke the permission.

8.3.4 In respect of modifications, a permission granted remains valid, provided any modifications do not:

- change the category of the aircraft (aeroplane, rotorcraft, airship etc.)

[43] See Part 47 of CASR and Chapter 13 of the Part 101 MOS for applicability.

- increase the weight classification of the aircraft into another classification (very small RPA, small RPA etc.)
- increase the gross weight on take-off of the aircraft by more than 20% (take-off weight includes payload)
- involve removal of parts and components that are critical to the flight of the aircraft
- alter any of the following for the aircraft:
  - the manufacturer's serial number
  - the CASA serial number allocated in substitution for a manufacturer's serial number
  - any electronic identification of the aircraft.

9 Design, certification and maintenance

9.1 Design and certification of large RPA

9.1.1 Under subregulation 101.255 (1) of CASR, a person may only operate a large RPA if a restricted certificate of airworthiness (CofA) or an experimental certificate has been issued under Subpart 21.H.

9.1.2 ICAO standards for international air operations (crossing international borders or over the high seas outside Australia's territory) require an aircraft to have a standard certificate of airworthiness, certifying that the aircraft complies with the applicable airworthiness requirements under Annex 8, Airworthiness of Aircraft to the Chicago Convention. RPAS today are in a unique situation, where the technology and capability of unmanned systems have outpaced the ability for the aviation community, NAAs and ICAO to develop a comprehensive suite of dedicated airworthiness standards. An RPAS may, however, be issued a special certificate of airworthiness in the restricted or experimental category.

9.2 Special certificates of airworthiness

9.2.1 Special certificates of airworthiness, which include experimental certificates, are issued to permit the operation of aircraft that do not meet the requirements of the Annex 8, Airworthiness of Aircraft to the Chicago Convention, but are capable of safe operations under defined operating conditions and purposes. These conditions will be specified on the certificate.

9.2.2 Experimental certificates of airworthiness

9.2.2.1 Regulation 21.191 lists the purposes for which an experimental certificate may be issued. For more information on experimental certificates, please read AC 21-10.

Note: An experimental certificate is generally limited in duration and is not intended to be used as a permanent operating category for commercial operations.

9.2.3 Restricted certificate of airworthiness

9.2.3.1 For an RPAS to be issued a restricted CofA, the aircraft must have been type certificated in the restricted category.[44]

9.2.3.2 Regulation 21.025 of CASR lists the purposes for which an applicant can apply for a type certificate for an aircraft in the restricted category. Under paragraph 21.025 (1) (a), an applicant is entitled to a type certificate in the restricted category for one of those purposes if the aircraft:

- can reasonably be expected to be safe for its intended use when it is operated under the conditions limiting its intended use
- the aircraft either:
  - meets the airworthiness requirements of the normal, utility, acrobatic, commuter or transport category, except those requirements that CASA

[44] In accordance with regulation 21.185.

considers are inappropriate for the special purpose for which the aircraft is to be used

or

- is of a type that has been manufactured in accordance with the requirements of, and accepted for use by, the Defence Force, or an armed force of Canada, the United Kingdom, or the United States of America, and has been later modified for the special purpose operation or operations.

Applicable airworthiness standards

9.2.3.3 The process of determining the certification basis involves both CASA and the applicant and is specific to each application for a restricted type certificate. This is further described in AC 21-13. Because RPA are not manned, there are some additional standards that do not have a current manned aircraft equivalent. The applicant should consider implications for the following RPA systems (this list is not exhaustive) when proposing an applicable airworthiness standard:

- command and control link (C2)
- detect and avoid equipment (DAA)
- ground control station (GCS)
- flight termination system (FTS)
- automated recovery system (ARS).

9.2.3.4 RPAS fall into the ‘special classes of aircraft’ under subregulation 21.017 (2) of CASR. The subregulation designates the portions of Parts 22, 23, 25, 27, 29, 31, 32, 33, 35 and the Part 21 MOS that CASA considers to be appropriate for the RPAS.

9.2.3.5 Where possible, CASA will leverage existing conventional aircraft standards and practices to apply a risk-based approach to certification requirements for the RPA type, its intended mission, area of operation, its control method, and intended airspace. This approach is based on the risk to persons on the ground and other airspace users when compared to an equivalent conventional aircraft, and then tailored for the risk of the proposed aircraft operation.

> For example, a 150 kg RPA flying below 400 ft/120 m in non-populous areas will pose less risk to persons on the ground and other airspace users than a 5 000 kg RPA flying in Class C airspace over a populous area. The applicable airworthiness standards would reflect this difference in risk.

9.2.3.6 Subregulation 21.017 (2) of CASR allows for type design approval with a certification basis drawn from any source design, airworthiness and production standards deemed acceptable by CASA. This includes the use of industry standards or new special conditions where applicable.

Restricted certificate of airworthiness

9.2.3.7 An RPAS that has been type certificated in the restricted category is entitled to a special certificate of airworthiness in the restricted category subject to the requirements specified in regulation 21.185 of CASR.

9.3 Registration and marking of large RPA

9.3.1 Registration

9.3.1.1 CASA requires that the operator of a large RPA must register their aircraft under Part 47 of CASR. This applies to both experimental certificate and restricted category aircraft. See the CASA website for information on registering an aircraft.

9.3.2 Marking

9.3.2.1 All Australian aircraft must comply with the aircraft marking requirements of Part 45 of CASR. As RPA may not be able to comply with standard marking requirements, regulation 45.065 of CASR allows that a person can apply to CASA for approval for the RPA to operate with different markings. CASA and the applicant will work together to determine appropriate alternative marking requirements.

9.3.2.2 Paragraph 45.120 (c) of CASR exempts aircraft with a maximum take-off weight of up to 5,700 kg operating inside Australian territory from carrying an aircraft registration identification plate if it has a manufacturer's data plate attached.

9.4 Maintenance of RPA

9.4.1 Flying without satisfying safety requirements

9.4.1.1 All RPA operate under subsection 20AA (4) of the Act and require that an owner, operator, hirer (other than the Crown) or pilot of an Australian aircraft must not commence a flight in the aircraft, or permit a flight in the aircraft to commence, if one or more of the following apply:

- there is outstanding a requirement imposed by or under the regulations in relation to the maintenance of the aircraft
- the aircraft will require maintenance before the flight can end
- there is a defect or damage that may endanger the safety of the aircraft or any person or property.

9.4.2 ReOC requirements

9.4.2.1 All included RPA must be maintained in accordance with the requirements set out in the RPAS maintenance manuals (see section 6.5).[45]

9.4.3 Large RPA – experimental certificate

9.4.3.1 Large RPA must be maintained in accordance with Part 4A of CAR. The registration holder for a class B experimental aircraft must maintain the aircraft in accordance with any conditions noted on the experimental certificate.[46]

9.4.3.2 Personnel performing maintenance on a large RPA issued with an experimental certificate will require a maintenance authorisation or an approval under subregulation

[45] See Division 101.F.4 of CASR.
[46] See regulation 42CB of CAR.

42ZC (6) of CASR to perform maintenance. Given the unique nature of large RPA, CASA strongly recommends organisations that intend to operate large RPA, contact CASA to identify an expected pathway, in the first instance.

9.4.4 Large RPA – restricted category aircraft

9.4.4.1 The design approval holder must give at least one set of instructions for continuing airworthiness to the owner of each aircraft.[47]

9.4.4.2 The maintenance schedule (i.e., the instructions for continuing airworthiness) developed during the certification process is the approved maintenance schedule for the aircraft.[48]

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[47] See subregulation 21.050 (2) of CASR.
[48] Under regulation 42CA of CAR.

Appendix A

Part 101 approach and departure paths for controlled aerodromes (for regulation 101.075 of CASR)

A.1 Controlled aerodrome approach and departure paths

A.1.1.1 Figure 5 shows the approach and departure paths of a controlled aerodrome. A certified operator can fly an RPA in the grey shaded areas only with prior approval from CASA. As a condition of the approval, the RPA must not to be flown in grey shaded areas above 45 m/150 ft (based on the aerodrome elevation).

A.1.1.2 These are strict limits and suitable buffers should be used to ensure the RPA does not enter the restricted airspace zones. The restrictions apply to each runway of the aerodrome, including any, and each, cross runway.

A.1.1.3 Licensed pilots and certified operators may operate in the black area and above 45 m/150 ft in the grey area provided they hold, and comply with, a CASA approval for this purpose (CASA co-ordinates with ATS).

A.1.1.4 Near the extremes of the approach and departure paths the RPA must remain below 300 ft until more than 8.5 km (~4.5 NM) from the runway threshold to ensure separation with aerodrome traffic. Outside these areas, the general 400 ft limit applies.

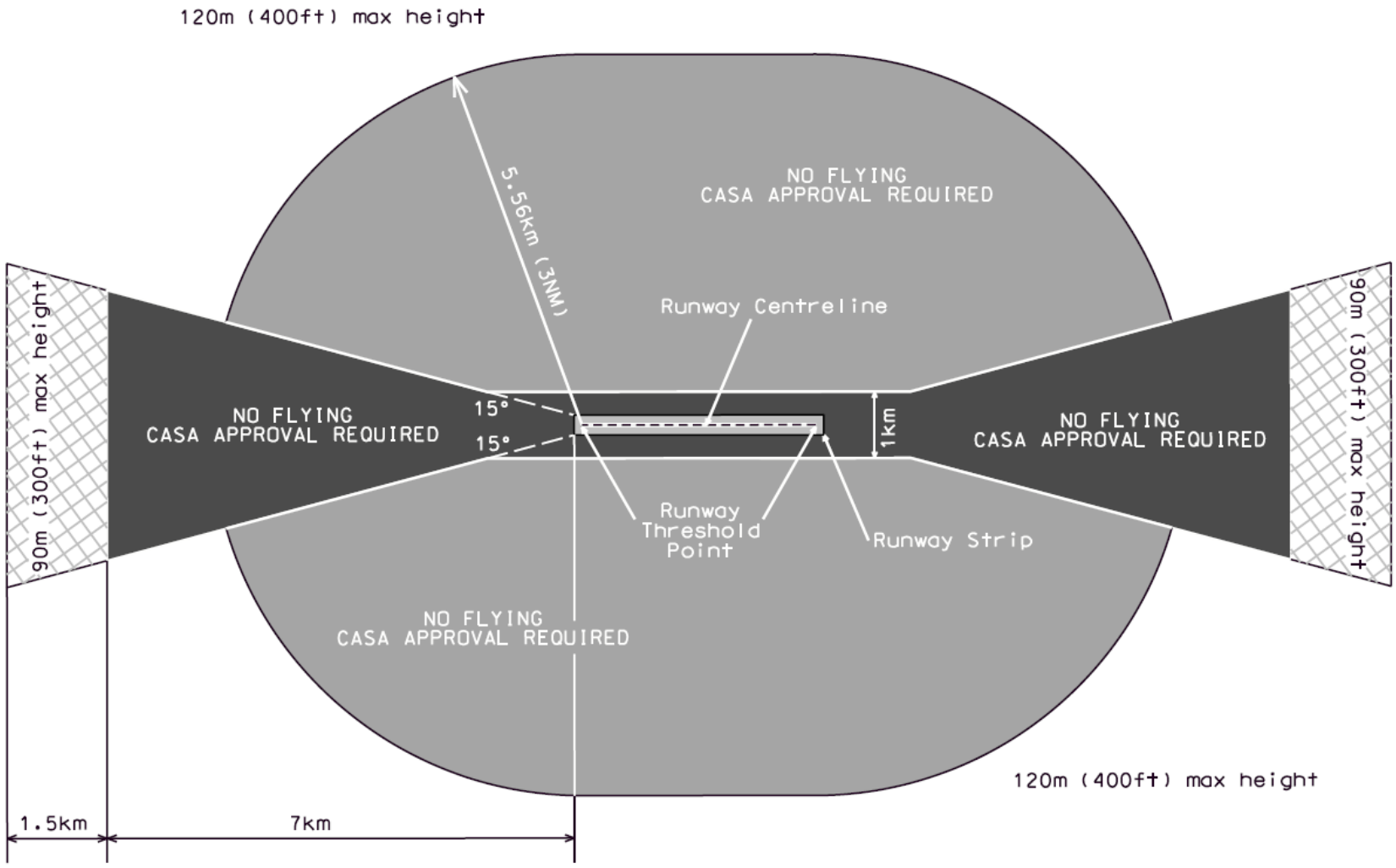

Figure 5: Controlled aerodromes approach and departure paths

A.1.2 Multiple or cross runways

A.1.2.1 Figure 6 depicts the application of the no fly and restricted height zones to multiple or cross runways.

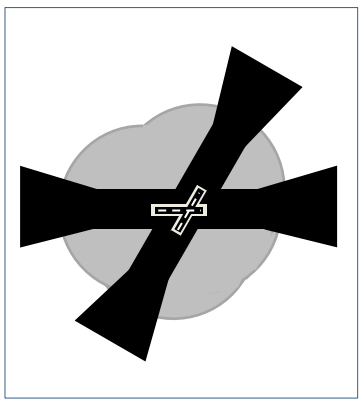

Figure 6: Example for cross runways

Appendix B

Instructions for obtaining an aviation reference number (ARN)

B.1 Applying for an Aviation Reference Number (ARN)

B.1.1 An ARN is a unique identifier, like an account number or customer number and it should be quoted whenever contacting CASA. The number on an authorisation (e.g., licence or certificate) is, in most cases, the ARN belonging to the entity (individual or corporation) that holds that authorisation.

B.1.2 If you hold or once held a CASA issued pilot, air traffic or airworthiness engineer licence you will already have an ARN. If you obtain such a licence in the future, you will retain the same ARN.

B.1.3 You can apply for an ARN online using the *my*CASA portal. Information on applying for an individual aviation reference number is available via the CASA website.

B.1.5 RePLs and RPA authorisations can only be issued to an ARN that is held by an individual. RPA registration can be issued to an ARN that is for an individual or corporation (company etc.). You can apply for an organisational ARN through the myCASA portal. Before applying for an organisation ARN, the authorised representative of the organisation will need to obtain an individual ARN. Information on applying for an organisational ARN is available from the CASA website.

Appendix C

RPA operational approval process

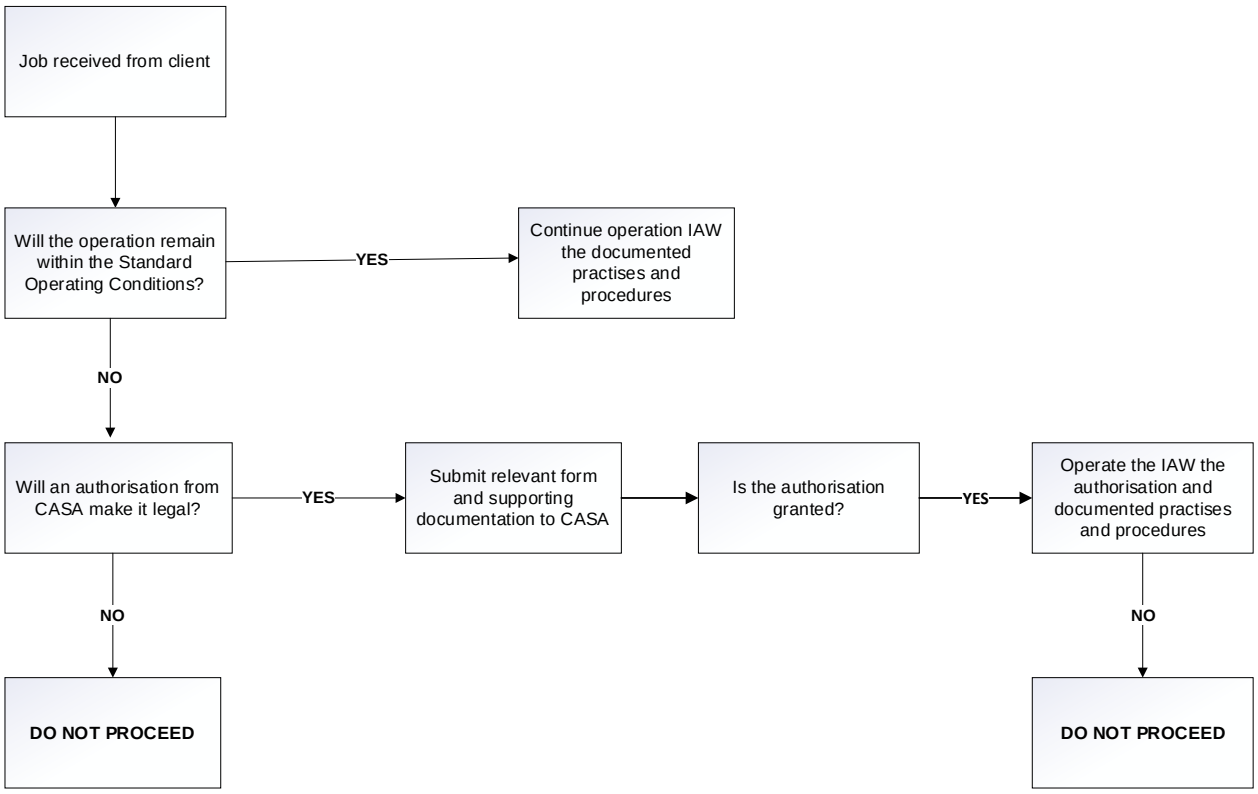

Figure 7: **RPA operational approval process**

Drone mustering – costs & benefits

Using drones for mustering cattle is an emerging practice in the beef industry. Skykelpie promotes the use of drones for mustering by addressing regulatory and other barriers. The project is chaired by Luke Chaplain and supported by MLA and DAF.

An economic evaluation was completed to explore the costs and benefits of mustering cattle with a drone. It assumes a drone is purchased by a grazier to replace helicopter mustering (contracted services) and assumes the same efficacy.

Method

Table 1 outlines the drone assumptions. Labour requirements are assumed to remain the same with the helicopter pilot replaced by the drone operator and no changes to ground crew. No contract drone mustering on other properties is included. Table 2 shows the evaluated scenarios.

Table 1: Drone assumptions.

Drone cost	$24,673
Training & licence	$4,150*
Labour costs	$60/hour (drone operator)
Drone lifespan	5 years, no salvage value
Operating costs	$6/hour** (drone)
Flight time per full battery	30 minutes (advertised to be 41 minutes).
Battery life	250 hours (500 recharges)

* Including forgone wages when attending training ($2,400).
** $600 maintenance at 100 hours of flight time. Recharging of batteries is negligible at 10c per hour of flight.

Table 2: Mustering scenarios.

1) Three 2,000 ha paddocks needing 2 hours mustering each. Two musters a year over 5 years.
2) Same as above but three 5,000 ha paddocks (500 head each*) needing 5-hour musters each.
3) Drone used for total life of 3 batteries (750 hrs).

Results

Table 3 shows the investment results for each scenario. The cost reduction is not quite large enough to recoup the full outlay in five years for the three 2000 ha paddocks scenario (net present value of -$3,677). Although, an initial outlay of less than $25,146 would make the investment worthwhile. Alternatively, if the drone replaced at least 69 hours of the helicopter contractors flight time over 5 years, it would also make the investment acceptable.

In comparison, the 'three 2000 ha paddocks' and 'using the drone for the total life of three batteries' scenarios were both expected to be profitable investments with rates of return between 41% and 251% and payback expected within 3 years and 1 year, respectively.

Table 3: Investment analysis.

	Three 2000 ha paddocks	Three 5000 ha paddocks	Max. battery life
Total flight time	60 hrs	150 hrs	750 hrs
Initial outlay	-$28,823	-$28,823	-$28,823
Cost reduction ($/yr)	$5,808	$14,520	$72,600
Net Present Value	-$3,677	$34,041	$285,497
Annual Benefit	-$849	$7,863	$65,943
Rate of Return	0%	41%	251%
Payback period	>5 yrs	3 yrs	1 yr
Breakeven initial outlay	$25,146	$62,864	$314,320
Breakeven flight time	69 hours		

Other advantages

Other potential advantages include: premapping of musters with navigation to allow predawn starts and reduce livestock heat stress, increased timeliness of operations from less contract helicopter delays, increased flexibility in business operations to muster around events such as weather, and reduced risk of human fatalities or injuries from helicopter accidents.