FIRE RESCUE VICTORIA

VICTORIA State Government

Australian Government

Beyond Horizons

Remotely piloted aircraft systems beyond visual line of sight

Trial and evaluation for emergency management use

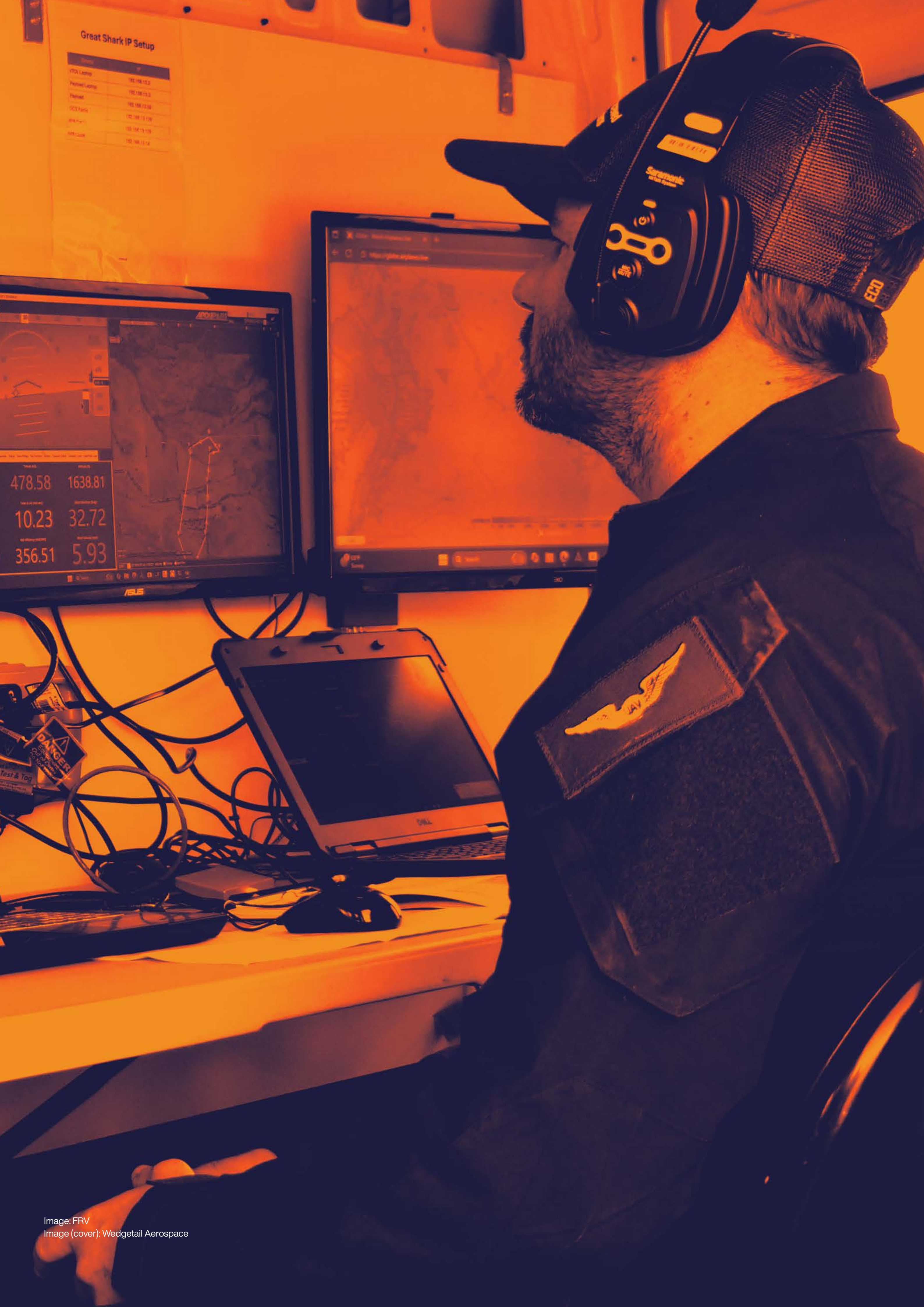

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Image (cover): Wedgetail Aerospace

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Foreword

The project aimed to examine how BVLOS RPAS could support fire and emergency management and to progress the development of procedures and practices that would underpin safe and effective operations.

To provide the best possible service to our communities, it is important that fire and emergency services stay "ahead of the game". This is especially so in the context of rapidly advancing technology. Adopting appropriate technology to enhance community safety and resilience and to make the most effective use of resources must be a key objective for any emergency management organisation.

Australian fire and emergency agencies have long recognised the utility of Remotely Piloted Aircraft Systems (RPAS), or drones, to support emergency operations. Many now operate advanced RPAS with sophisticated payloads. The option to extend RPAS operations beyond the line-of-sight (BVLOS) of the pilot promises a range of possibilities for improving community safety and support. Almost by definition, "beyond-visual-line of sight" speaks to these possibilities. They cannot be ignored.

On behalf of Australian fire and emergency agencies and in collaboration with the Australian RPA industry, Fire Rescue Victoria (FRV) was both privileged and excited to conduct an operational trial of RPAS BVLOS during 2025. The project aimed to examine how BVLOS RPAS could support fire and emergency management and to progress the development of procedures and practices that would underpin safe and effective operations. The trial was supported by funding from FRV and the Australian Government.

To say that the project was groundbreaking would not be an understatement. The trial explored use of RPAS in situations that have not been previously examined in Australia. I am confident that the outcomes described in this report will be pivotal in furthering the use of what will undoubtedly become a most valuable capability.

The project faced its fair share of challenges, and I would particularly like to acknowledge the work of the FRV project team and project control group. Valuable support for the project provided by the Australian Association for Uncrewed Systems (AAUS) is also gratefully acknowledged.

Thanks are due to the Australian Government who provided funding through the National Partnership Agreement for Disaster Risk Reduction, facilitated by the Victorian Government.

Special mention must be made of the RPAS service providers who participated in the trial and wholeheartedly committed their expertise, experience and resources.

Finally, I would like to acknowledge the support of the Australian Civil Aviation Safety Authority (CASA). The regulatory environment for operation of BVLOS RPA is complex and demanding. The cooperation of CASA was much appreciated and indeed crucial to success.

The prospect of using RPAS BVLOS to help us support our communities is exciting, and we are optimistic that harnessing this technology will provide tangible benefits across the emergency management sector in the future.

Edward (Eddie) Lacko
Deputy Commissioner Strategy

2.

Preamble

2.1 Observations, findings and recommendations

This report includes observations, findings and recommendations:

OBSERVATIONS
are points worth highlighting to stakeholders and readers.
In some cases, observations lead to findings and recommendations.

FINDINGS
are important conclusions synthesised from evidence gathered or evaluated by the project. Findings will normally lead to a recommendation or series of recommendations.

RECOMMENDATIONS
provide consolidated advice, proposals or suggestions for addressing important issues, for consideration by stakeholders.

2.2 Nature of recommendations

Any observations, findings or recommendations are for consideration by the relevant agency or organisation and are not intended to confer any obligation. Recommendations are advisory only. Respective agencies and organisations will need to consider recommendations in the context of their overall responsibilities and priorities.

2.3 Inclusive language

Fire Rescue Victoria (FRV) has a strong commitment to diversity, equity, and inclusion (DEI) and strives to foster and promote inclusion through a culture of respect, fairness, and belonging. This includes addressing gender equality through use of appropriate language, such as the term "uncrewed" in place of stereotypical words such as "unmanned". Unfortunately, current legislation (and related publications) in Australia and throughout the world commonly uses gender-biased terminology. This extends to the Civil Aviation Safety Regulations (CASR) which are the key legislative instruments governing the use of Remotely Piloted Aircraft in Australia. This means that, on occasions, this report has necessarily used non-preferred terms. Otherwise, where relevant, use of the word "uncrewed" may be taken to have the same meaning as "unmanned" where that term appears in legislation and related publications.

2.4 Confidential information

The project adopted the principle that, as far as practicable, relevant information should be in the public domain, and that the need to treat information as confidential should be minimised. However, for commercial reasons, some proprietary information provided to the project has been treated as confidential.

2.5 Nature of report

As far as practicable all research undertaken as part of or in conjunction with the project has been conducted empirically, however this report is narrative in nature and aimed at non-specialist readers. It is not intended to be a scientific paper. It includes reference to material that has not been formally published or peer reviewed.

2.6 Aviation procedures

This report includes some highly summarised or abbreviated descriptions of procedures and processes associated with aviation. These are not necessarily comprehensive and are intended only to give a non-specialist reader a broad understanding of procedural steps and key requirements. These descriptions must not be relied on for operational use. Material published by the Civil Aviation Safety Authority or Airservices Australia is the only source of authoritative information regarding aviation processes and procedures.

2.7 Non-endorsement

The project engaged several commercial entities to provide Remotely Piloted Aircraft Systems or other services. Engagement of any provider by Fire Rescue Victoria or the mention of any provider in this report does not constitute an endorsement of that organisation or their products and services.

2.8 Conflict-of-interest

Fire Rescue Victoria and the project team declare that to the best of their knowledge there is no conflict-of-interest in relation to conduct of the project.

The project utilised the services of the consultancy Avtract (ABN 38 707274543) to assist with planning of operational trials, information gathering, analysis and preparation of this report.

Avtract declares that to the best of its knowledge there is no conflict-of-interest in relation to the project or the preparation of this report. Avtract has no beneficial interest in any products or solutions canvassed or recommended.

2.9 Artificial Intelligence

Artificial Intelligence (AI) has not been used in the analysis of documents for this project and generational AI has not been used in the production of this report.

2.10 Acknowledgements

The project team would like to gratefully acknowledge the cooperation and assistance of:

- Australian Association for Uncrewed Systems
- Australian Government
- Ararat Rural City
- Civil Aviation Safety Authority
- Country Fire Authority
- Department of Energy, Environment and Climate Action, Victoria
- Emergency Management Victoria
- Fire Rescue Victoria RPAS Unit
- Parks Victoria
- Landholders and residents of the Raglan and Bayindeen areas
- Silvertone UAV
- Toll Uncrewed Systems
- Wedgetail Aerospace
- Yamaha Sky Division
- Carbonix
- Ninox Robotics
- UASci Ltd
- Burnbot Australia
- Quantum Systems Pty Ltd

Image: FRV

3.

Terminology and definitions

3.1 Key terms

Terms and definitions used in aviation can be open to interpretation, or their meaning depends on the context in which they are used. Different sectors use some terms in different ways.

The following list explains how certain key terms are used **in this report:**

Remotely Piloted Aircraft (RPA)	Means an air vehicle which is piloted by a person outside of the vehicle or is piloted, at times, by an autonomous technological system that may or may not be onboard the vehicle. Normally 'RPA' is intended to refer to the actual air vehicle only. (In some Australian State legislation and associated regulations, the definition of RPA may include the ground-based control station.) RPA are commonly referred to as Uncrewed Aerial Vehicles (UAV) or drones.
Remotely Piloted Aircraft System (RPAS)	Broadly means the set of configurable elements consisting of an RPA, its payload, the associated remote pilot station (or stations), the required command and control infrastructure and links, and any other system elements as may be required at any point in time to operate the aircraft for a purpose. RPAS are commonly referred to as Uncrewed Aerial Systems (UAS) or drones. While care has been taken to use 'RPA' and 'RPAS' in the correct sense as far as possible, unless specifically stated otherwise or the context requires otherwise, in this report RPA can usually be taken to mean RPAS and vice versa. RPA or RPAS are further classified into Types and Categories (refer to sections 3.2 and 3.3).
Aircraft	Refers to any air vehicle and includes rotary-wing aircraft and fixed-wing aircraft; and includes remotely piloted or optionally piloted air vehicles unless stated otherwise.
Conventional aircraft	Refers to aircraft with the flight crew on-board the aircraft.
Aeroplane	Refers to conventional, crewed fixed-wing aircraft; and does not include remote or optionally piloted air vehicles unless stated otherwise or the context requires otherwise.
Helicopter	Refers to conventional, crewed rotary-wing aircraft; and does not include remote or optionally piloted air vehicles unless stated otherwise or the context requires otherwise.
Operator	Means the entity that is supplying the services of an RPA or RPAS (in parallel to the common use of the term 'operator' in relation to conventional, crewed aviation). Note that in some legislation and associated regulations, including in the Civil Aviation Safety Regulations, 'Operator' or 'Controller' may refer to the person manipulating the controls of the RPA.
RPA pilot	Means the person remotely manipulating the controls of an RPA, and responsible for its flight and navigation.
General aviation	Refers to non-airline aviation activity.

3.2 RPA types

This report adopts the RPA types (weight categories) prescribed by the Civil Aviation Safety Regulations Part 1998 (C'th) Part 101:

Micro RPA	Gross weight of not more than 250 g
Very small RPA	Gross weight of more than 250 g, but not more than 2 kg
Small RPA	Gross weight of more than 2 kg, but not more than 25 kg
Medium RPA	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 m3)
Large RPA	Gross weight of more than 150 kg or a remotely piloted airship with an envelope capacity of more than 100 m3

3.3 RPA categories

This report adopts the following descriptive categories of RPA:

Multi-rotor	An air vehicle with two or more power-driven rotors operating in the same plane, usually horizontally; achieving lateral movement by modulating rotor speeds and/or tilting the rotor plane or airframe. Sometimes referred to as multi-copter.
RPA helicopter	An RPA in the style of a conventional helicopter, with either one main powered rotor (often combined with a tail rotor or fenestron) or intermeshing main rotors or coaxial main rotors.
RPA aeroplane	An RPA in the style of a conventional aeroplane, with fixed wing(s) that provide lift during forward flight.
Powered-lift	An RPA with fixed wing(s) that provide lift during forward flight but is also capable of take-off and landing more-or-less vertically through use of powered rotors. Powered-lift RPA are sometimes referred to as Vertical Take-Off and Landing (VTOL) RPA, although technically other categories of RPA may also be capable of VTOL.
Hybrid-lift	Hybrid-lift RPA are sometimes considered a subset of powered-lift RPA and usually combine characteristics of an RPA helicopter and an RPA fixed wing to achieve vertical take-off and landing and then shift to or from vertical to horizontal flight. Note: the term **hybrid RPA** may be used to refer to RPA that are powered by multiple sources of energy or use a hybrid powerplant (e.g. an internal combustion engine driving an electrical generator).

3.4 Abbreviations and definitions

The following table sets out some Abbreviations and definitions as they are used in this report. For convenience, the table below also includes some abbreviations and definitions that are not used in the report but may appear in related documents or references.

AAUS	Australian Association for Uncrewed Systems	
AC	Advisory Circular	Issued by CASA
ADF	Australian Defence Force	
ADS-B	Automatic Dependent Surveillance - Broadcast	
AFAMS	Australasian Fire and emergency Aircraft Monitoring System	Provides aircraft position and other data to ARENA and agency operational management systems
AGL	Above Ground level	
AIM	Aerial Incendiary Machine	
Altitude	Height above mean sea level	
AMSL	Above Mean Sea Level	
ARENA	National system for managing fire and emergency aircraft data in Australia	Includes a national registry of aircraft
ASA	Airservices Australia	Body responsible for airspace management and related services
ATC	Air Traffic Control	
ATSB	Australian Transport Safety Bureau	
AVCRM	A commercial, cloud-based electronic system for managing information related to operation of RPAS, including workflows	
BVLOS	Beyond Visual Line of Sight	
CASA	Civil Aviation Safety Authority	
CASR	Civil Aviation Safety Regulations 1998	Made under the Civil Aviation Act 1988 (C'th)
CFA	Country Fire Authority of Victoria	
CONOPS	Concept of Operations	
COP	Common Operating Picture	
CRP	Chief Remote Pilot	
CTA	Controlled airspace	or Control Area
C'th	Commonwealth	Commonwealth of Australia
EC	Electronic Conspicuity	
EFB	Electronic Flight Bag	
EMV	Emergency Management Victoria	
EO/IR	Electro Optical/Infra Red	
ES	Extended Squitter	ADS-B transmission mode
EVLOS	Extended Visual Line of Sight	
Excluded RPA	A class of RPA which may operate commercially under less stringent regulatory requirements, provided certain conditions are met	Amongst other things, requires that RPA are only operated under the Standard Operating Conditions
FLARM	Flight Alarm	A proprietary electronic system used to selectively alert pilots to collision risks
FRV	Fire Rescue Victoria	
GCS	Ground Control Station	
GNSS	Global Navigation Satellite System	Includes GPS
GPS	Global Positioning System	

HEX [CODE]	Hexadecimal [Code]	An assigned code that identifies an individual ADS-B Out device
IFR	Instrument Flight Rules	
IMC	Instrument Meteorological Conditions	
IR	Infra Red	
ISR	Intelligence, Surveillance and Reconnaissance	
JARUS	Joint Authorities for Rulemaking on Unmanned Systems	An international working group
LTE	Long Term Evolution	A commonly applied standard for data exchanged over a mobile telephone system
MOS	Manual of Standards	A supplement to the CASR, published by CASA, which prescribes technical and operational standards. Adherence to the relevant MOS is mandatory
NOTAM	Notice to Airmen (formal)	Notice to Air Mission (preferred non-gendered language)
OCTA	Outside Controlled Airspace	
Ops Manual	Operations Manual	
QNH	Barometric pressure at sea level	Provides a reference point for calibrating altimeters of aircraft operating in a prescribed area
REOC	Remotely piloted aircraft Operator's Certificate	RPA operator certification issued by CASA
REPL	Remote Pilot Licence	RPA pilot certification issued by or with the authority of CASA
RPA	Remotely Piloted Aircraft	UAV/Drone – See also Key terms above
RPAS	Remotely Piloted Aircraft System	UAS/Drone – See also Key terms above
SAIL	Specific Assurance and Integrity Level	A combined residual risk rating assigned through SORA
SMS	Safety Management System	
SOC	Standard Operating Conditions	A set of conditions prescribed by CASA. The SOC essentially constitute a low-risk operating environment for RPA
SOP	Standard Operating Procedure	
SORA	Specific Operations Risk Assessment	Standardised methodology developed by JARUS for assessing risks of operations
Standard Conditions	[see Standard Operating Conditions]	
TABS	Traffic Awareness Beacon System	A simplified, self-powered, low-power ADS-B Out device
TMI	Temporary Management Instruction	A CASA document, usually clarifying or operationalising regulatory requirements
TRA	Temporary Restricted Airspace	or Temporary Restricted Area
UAV	Un-crewed Aerial Vehicle	UAV/Drone - See also RPA in Key terms, above
VHF-AM	Very High Frequency – Amplitude Modulation	[used in this report to refer to] Aeronautical band radio
VFR	Visual Flight Rules	
VLOS	Visual Line of Sight	
VOB	Visual Observer	
VTOL	Vertical Take-off and Landing	
VMC	Visual Meteorological Conditions	

4.

Executive summary

4.1 The headlines

- Fire Rescue Victoria (FRV) undertook a trial during 2024 and 2025 to evaluate the feasibility, safety, and operational value of using Remotely Piloted Aircraft Systems (RPAS) Beyond Visual Line of Sight (BVLOS) in fire and emergency management. The project, jointly funded by FRV and the Australian Government, was conducted in collaboration with industry partners, the Australian Association for Uncrewed Systems (AAUS) and with the cooperation of the Civil Aviation Safety Authority (CASA).
- BVLOS RPAS can be operated safely. RPAS with suitable payloads flying BVLOS offer utility that can support a broad range of fire emergency response operations in Australia and enhance community safety and resilience.
- BVLOS RPAS can be subject to significant operational limitations and considerations. These need to be carefully factored in when planning and executing missions.
- Under most circumstances, BVLOS RPAS are unlikely to substitute for conventional aircraft in fire and emergency management anytime soon. However, BVLOS RPAS can provide important complementary capabilities and address current capability gaps. There is a potentially viable and valuable place for BVLOS RPAS in fire and emergency management.
- The current standard published process for regulatory authorisation of BVLOS RPAS operations in Australia is not well aligned to the needs of fire and emergency response. It is recommended that CASA, with support from the RPAS industry and the fire and emergency sector, develop more suitable, streamlined authorisation procedures.
- Electronic conspicuity technology can significantly enhance the safety and efficiency of all RPAS operations and can help enable the safe integration of RPA with conventional aircraft. Facilitation and promotion of widespread adoption of suitable electronic conspicuity technology should be a priority for regulatory authorities, the RPAS industry and the fire and emergency sector.

4.2 Summary

Remotely Piloted Aircraft Systems (RPAS, or "drones") help fire and emergency management agencies in Australia to deliver services and keep communities protected and safe. Use of RPAS has increased significantly in recent years as platform and payload capabilities have improved and relative costs have decreased.

Regulatory, operational and safety considerations currently limit RPAS flying beyond the visual-line-of-sight (BVLOS) of the operating pilot in many situations. This constrains the ability of emergency agencies to utilise RPAS in situations where their utility is likely to be most valuable.

On behalf of the Australian fire and emergency sector, FRV established a project during 2024 to explore how BVLOS RPAS could be operated safely and effectively, including at night, to enhance service delivery. The project was funded by FRV and the Australian Government. In-kind support was provided by the Australian Association for Uncrewed Systems (AAUS) and the Australian RPAS industry.

The cornerstone of the project was an operational trial of BVLOS RPAS undertaking tasks in a simulated emergency management scenario in western Victoria. The operational trial, conducted between July 2025 and October 2025, saw multiple RPAS undertaking BVLOS operations during daylight and at night. This allowed FRV to examine the utility of BVLOS RPAS and the intersection between regulatory considerations and operational considerations, and to gather material that will inform the development of systems, processes and procedures for effective operation of RPA BVLOS.

The trial demonstrated that BVLOS RPAS can significantly enhance emergency response by providing intelligence, surveillance, and reconnaissance (ISR) capabilities beyond the limits of visual observers. Although not tested in the trial, BVLOS RPAS will clearly be useful in a range of other tasks. BVLOS RPAS offer unique advantages at night, in low visibility, or in conditions unsuitable for conventional aircraft. BVLOS RPAS are unlikely to substitute for conventional aircraft in the near future, however can provide an important complementary capability.

Trial flights highlighted operational constraints associated with BVLOS RPAS including regulatory restrictions, infrastructure and personnel requirements, sensitivity to weather conditions such as wind speed, communication limitations and range and endurance. Operational constraints must be carefully addressed when planning and executing BVLOS operations.

It was identified that the current standard, published Civil Aviation Safety Authority (CASA) approval process for BVLOS operations is complex and lengthy and not well aligned with the rapid deployment and other requirements of emergency management. CASA is prepared to approve operations at short notice during ongoing emergencies, however this approach does not support urgent operations and does not provide the consistency or certainty required to underpin capability development and adoption. The key recommendation of the project is that CASA, with support from the RPAS industry and the fire and emergency management sector, should develop alternative streamlined authorisation pathways. It is suggested that development of alternative pathways should focus on enabling approved operators to conduct BVLOS operations under defined circumstances without seeking further authorisation. The project also identified that some constraints that are often applied to BVLOS RPAS operations via rigid application of the regulatory approval process, such as operating area limitations or height limits may not always be cogent or may not materially reduce risk. Closer attention to some of these issues is warranted.

FRV took the opportunity to demonstrate aspects of electronic conspicuity (EC) of aircraft alongside trial operations. The project concluded that widespread adoption of EC and compatible technologies should be prioritised to improve safety and efficiency of all fire and emergency RPAS operations. EC will also be an important factor in enabling and enhancing safe integration of RPAS with conventional aircraft at emergency events.

Overall, the FRV RPAS BVLOS trial confirmed that while BVLOS operations face regulatory and technical hurdles, they present a valuable emerging capability for Australian fire and emergency management. With targeted reforms, further trials, and the adoption of enabling technologies, BVLOS RPAS can strengthen community safety, resilience, and operational effectiveness.

Image: Wedgetail Aerospace

4.3 Observations, findings and recommendations

The following summary table reproduces observations, findings and recommendations from the main body of the report for ready reference:

OBSERVATION 1

There are significant operational limitations and considerations around flying RPAS BVLOS. Careful attention must be paid to the capabilities and limitations of individual RPAS to ensure that they are suited to a particular mission.

FINDING 1

BVLOS RPAS can provide a capability to gather information that is likely to be critical to emergency response management, emergency response planning and keeping communities informed about emergency incidents, in some situations.

Although not directly tested in this project, BVLOS RPAS are also likely to provide other important capabilities to support fire and emergency management.

RECOMMENDATION 1

Australian fire and emergency agencies should continue to evaluate BVLOS RPAS capabilities and to consider utilisation of RPAS BVLOS capabilities where appropriate.

OBSERVATION 2

Examples of both the medium RPA helicopter category and the small powered-lift category of RPA completed their assigned tasks during trial flight exercises. RPAS of both categories appear to offer utility for fire and emergency BVLOS operations, provided that operating limitations are appropriately considered when planning and executing missions. At this stage, the project is unable to draw conclusions on the relative merits of different categories of RPA. Ideally this would be the subject of further research and evaluation.

RECOMMENDATION 2

As far as practicable, Australian fire and emergency agencies should publicly articulate their information needs and publish (and regularly review and update) data and information product standards and product integration standards and procedures.

RECOMMENDATION 3

CASA consider formal inclusion of an option for providing feedback to an applicant, where applicable, at an early stage of the published standard RPAS BVLOS operations authorisation process.

OBSERVATION 3

There is currently no clear mechanism in Australia for balancing aviation related risk with broader community risk in emergency situations, when making decisions regarding RPA operations.

FINDING 2

The current published standard process for CASA authorisation of RPAS BVLOS operations is not compatible with emergency management (and is likely not intended to be). While alternative, more timely pathways are available, these are not seen as sustainable longer-term solutions.

RECOMMENDATION 4

Key recommendation ☆

CASA, with support from the RPAS industry and the fire and emergency sector, continue to develop sustainable, practical RPAS BVLOS flight authorisation procedures that will provide for timely authorisation of BVLOS flights for emergency management purposes.

A key objective should be pre-authorisation of suitable ReOC holders to conduct RPAS BVLOS flights in defined circumstances.

4.3 Observations, findings and recommendations (continued)

OBSERVATION 4

There are existing procedures for RPA to enter controlled airspace. RPA that have the capacity to operate in controlled airspace without undue delay (i.e. can take advantage of automated approvals or are equipped to meet Airservices Australia and CASA criteria for non-automated approval or are equipped to meet military airspace authority requirements) will offer improved utility for fire and emergency support in many circumstances.

OBSERVATION 5

Any future process for providing BVLOS flight authorisations in timeframes consistent with emergency management requirements should also make provision for providing parallel, timely authorisations for BVLOS flight in CTA, where required.

OBSERVATION 6

There would be benefit in the fire and emergency sector, the RPA industry and Airservices Australia establishing an ongoing formal liaison mechanism. This could potentially be achieved by inviting participation in relevant sessions of existing mechanisms.

OBSERVATION 7

Where there is a requirement for a BVLOS RPAS to operate from or in the vicinity of an uncontrolled aerodrome, this can be practical and safe, provided that appropriate procedures are followed.

OBSERVATION 8

Any future process for providing RPAS BVLOS flight authorisations in timeframes consistent with emergency management requirements should also make provision for providing parallel, timely authorisations for BVLOS RPAS flight from or in the vicinity of uncontrolled aerodromes, where required.

OBSERVATION 9

Further developing the capacity for RPA to fly BVLOS in non-Visual Meteorological Conditions is likely to significantly increase the utility of RPAS in fire and emergency management.

FINDING 3

RPAS BVLOS flight at night is practical and safe, provided that appropriate, proven procedures are followed and appropriate facilities are in place.

OBSERVATION 10

RPAS BVLOS flight for ISR purposes can be safely conducted at night without requiring prior reconnaissance of the area of operations in daylight, provided that appropriate procedures are followed.

OBSERVATION 11

Further developing the capacity for RPA to routinely fly BVLOS at night is likely to increase the utility of RPAS in fire and emergency management.

FINDING 4

SORA provides a workable framework for assessment and planning mitigation of risk for BVLOS RPA operations. However, detailed application of SORA, particularly in relation to assessment of ground risks in areas of relatively low population, should allow flexibility to consider and accommodate reasonable alternative scenarios.

OBSERVATION 12

Where there is a requirement for a BVLOS RPAS to cross transport corridors to support fire or emergency activities, the RPA operation (and ground conditions if necessary) can be managed to ensure that the risk to persons on the ground is not materially increased.

OBSERVATION 13

A requirement for a BVLOS RPA to remain at or below 500' AGL is likely to generate operational inefficiencies and may not necessarily reduce air risks. Very careful consideration should be given to likely hazards and risks before incorporating this stipulation in relevant CONOPS and Instruments of Approval, including area approvals.

OBSERVATION 14

Issuing a NOTAM advising other airspace users of a RPAS BVLOS operation is a practical and readily achievable risk reduction measure. Issuing a suitable NOTAM should be regarded as standard procedure for RPAS operating BVLOS in support of fire and emergency management.

OBSERVATION 15

Continuously monitoring appropriate VHF-AM radio frequencies to optimise awareness of other airspace users during RPAS BVLOS operations is a practical and achievable risk reduction measure and should be considered standard procedure when RPAS are operating BVLOS in support of fire and emergency management.

OBSERVATION 16

Regularly broadcasting, and communicating as required, on appropriate VHF-AM radio frequencies to help assure airspace deconfliction is a practical and achievable risk reduction measure and should be regarded as standard procedure when RPAS are operating BVLOS in support of fire and emergency management.

OBSERVATION 17

Declaration of a Temporary Restricted Area or a Temporary Danger Area is likely to provide advantageous air risk mitigation for RPA in certain circumstances. This measure should be considered, and implemented when appropriate, when RPAS are operating BVLOS in support of fire and emergency management.

OBSERVATION 18

A requirement to deploy visual observers (VOB) for BVLOS RPA operations, other than in the immediate vicinity of launch and recovery sites, is unlikely to be practical in many fire and emergency management situations. More practical air risk mitigation measures are available.

OBSERVATION 19

A requirement to limit BVLOS RPA flights to a specified time-of-day or day-of-the-week is unlikely to be compatible with most fire and emergency management operations. More practical air risk mitigation measures are available.

OBSERVATION 20

The project noted some uncertainty about the general applicability of mixed flight authorisations. The project did not observe any reason why mixed flight authorisations should not apply if required.

RECOMMENDATION 5

CASA and the RPA industry collaborate to arrange for consistent guidance on the applicability of mixed flight authorisations involving BVLOS RPAS operations.

OBSERVATION 21

Modelling of control and payload communications integrity in software prior to flight is a useful measure to assure safety of BVLOS flight and to ensure that a flight will meet mission objectives.

OBSERVATION 22

For many fire and emergency management support operations, RPAS equipped with high-reliability, redundant control and payload communication systems that do not always depend on ground-based infrastructure in the vicinity of the operating area are likely to offer greater utility.

4.3 Observations, findings and recommendations (continued)

OBSERVATION 23

It is crucial the operators of BVLOS RPA access and use up-to-date vertical obstruction data to guide BVLOS flights. Operators should also not assume that all vertical obstructions will be recorded and should take appropriate precautions.

OBSERVATION 24

Operators of BVLOS RPAS do need to consider risks of electromagnetic interference to the operation of their RPA and take appropriate precautions. Operational risk mitigation procedures are available and are likely to allow for completion of fire and emergency tasks in most circumstances.

FINDING 5

Broad adoption of ADS-B technology has potential to significantly enhance the safety of BVLOS and non-BVLOS RPA operations.

FINDING 6

ADS-B technology has potential to help enable airspace integration of BVLOS and non-BVLOS RPA and conventional aircraft.

RECOMMENDATION 6

CASA, Airservices Australia, the RPAS industry and the fire and emergency sector continue to facilitate and promote broader adoption of ADS-B technology by airspace users in Australia, and to remove barriers to adoption of ADS-B technology.

RECOMMENDATION 7

Relevant aviation industry associations work with ADS-B integrators and other providers of aircraft position data (such as Electronic Flight Bag providers and third-party RPAS support providers) to remove commercial barriers to exchange of safety-related data.

RECOMMENDATION 8

The RPA industry in Australia work with ADS-B data integrators and other providers of aircraft position data to develop technical standards for Virtual ADS-B (position data from RPA Ground Control Stations) such that it can be easily integrated with ADS-B data.

RECOMMENDATION 9

Fire and emergency agencies conducting RPA operations; and RPA operators, consider deploying portable ADS-B receivers with traffic displays (or airborne receivers where appropriate) alongside all RPAS operations as standard operating practice. Where possible, portable ADS-B receivers should also feed received ADS-B data to appropriate data integrators.

RECOMMENDATION 10

Fire and emergency agencies conducting RPA BVLOS operations consider requiring the RPA to be equipped, where practicable, with an ADS-B receiver that forwards received data to the Ground Control Station and to ADSB integrators.

RECOMMENDATION 11

Fire and emergency agencies conducting RPA BVLOS operations consider requiring the RPA to be equipped, where practicable, with an ADS-B Out device.

OBSERVATION 25

Fire and emergency agencies could consider establishing low-cost networked ADS-B receivers at a range of fixed sites such as rural fire stations and forward received data to appropriate ADS-B data integrators. Priority should be given to complementing existing coverage.

OBSERVATION 26

Automatic see-and-avoid technology onboard BVLOS RPAS operating at fire and emergency events would likely further reduce air risks and address some concerns of other airspace users. Ideally, the RPAS industry would continue to develop and test this functionality.

Image: Wedgetail Aerospace

5.

Background

5.1 Introduction

The fire and emergency management sector in Australia routinely employs aerial resources to support critical service delivery. Aerial resources provide speed and weight of response, access and perspective. Aerial resources may be owned by the respective agencies or provided as a service by third parties, normally commercial aircraft operators.
In recent years, the use of uncrewed, remotely piloted aircraft systems (RPAS or "drones") has increased significantly as platform and payload capabilities have improved and relative costs have decreased.

RPAS now routinely play important roles in supporting emergency response. Principally, RPA equipped with suitable sensor payloads are used to enhance the gathering of information and intelligence at emergency events, in-turn informing response planning and enabling provision of accurate and timely information to affected communities. Other typical roles for RPAS include delivery of packages to inaccessible locations, deployment of life saving equipment, deployment of aerial incendiaries for bushfire control, communications enhancement and atmospheric sampling.

Regulatory, operational and safety considerations significantly limit the situations in which RPA may operate beyond the visual line-of-sight of the operating pilot (BVLOS). By definition, this limits the ability of fire and emergency agencies to employ RPAS in situations where their utility is likely to be most critical, such as where timely information could only be obtained through use of RPA that are operating outside the view of the pilot or ground observers.

The Australian fire and emergency management sector is therefore keen to explore avenues that will practically enable suitable RPA, equipped with appropriate payloads, to legally, effectively and safely operate in an emergency management context, beyond visual line-of-sight.

5.1.1. Fire Rescue Victoria (FRV)

Fire Rescue Victoria is responsible for serving and protecting communities across Melbourne and Victoria's major regional centres. FRV has pioneered and developed the use of RPAS in support of fire, rescue and emergency response activities in Australia for more than a decade and owns and operates RPAS. FRV (under the former Metropolitan Fire Brigade) was the first emergency response organisation in Australia to obtain an RPAS Operating Certificate (now known as ReOC) and was amongst the first public organisations to certify their own RPA pilots.

FRV works in partnership with other emergency management organisations that routinely utilise aerial resources such as Emergency Management Victoria, Victoria Police, the Country Fire Authority, Forest Fire Management Victoria, Victoria State Emergency Service and Life Saving Victoria. FRV also maintains close liaison with related agencies in other Australian states and territories.

In recent years, the use of uncrewed, remotely piloted aircraft systems has increased significantly as platform and payload capabilities have improved and relative costs have decreased.

5.2 The RPAS BVLOS project

To further the safe and effective utilisation of RPAS in support of the management of fire, rescue and other emergency incidents, FRV initiated a project to trial the operation of RPAS beyond visual line of sight in simulated emergency response situations. The broad objectives of the project are to:

- inform the development of doctrine, systems, plans and procedures that will practically enable effective, legal and safe use of RPAS beyond visual line-of-sight to support fire and emergency management activities
- identify and refine key considerations in making decisions around the utilisation of RPAS in situations that may require BVLOS flight
- inform assessment of the suitability of various classes and characteristics of RPAS for utilisation by the emergency management sector in the future
- inform future decision making and potential business case development for acquiring and utilising RPAS capabilities.

Funding for the project was provided by FRV and by the Australian Government's State and Regional Priority Projects program through the National Partnership Agreement for Disaster Risk Reduction[(1)] , facilitated by Emergency Management Victoria.

In-kind support was provided by the Australian RPAS industry through the Australian Association for Uncrewed Systems (AAUS) and the individual RPAS operators who participated in the operational trial.

The Australian Civil Aviation Safety Authority (CASA) also collaborated with the project team and provided valuable advice and support.

5.3 Operational trial

The introduction of BVLOS RPAS could be compared with the introduction of driverless cars to public roads around the world. Both involve, and depend on, relatively new technology that is still being developed and refined. Both are the subject of intense scrutiny by rightly risk-averse regulators. Implementation will necessarily be iterative and requires testing and proving in controlled and simulated environments before progressively rolling out to real-world environments. Progressive rollout also provides socialisation, allowing sectors of the community who may have been less than comfortable to become used to the idea and trusting of the technology. Ultimately both driverless cars and BVLOS RPAS will become mainstream capabilities and will offer significant safety and economic benefits to communities.

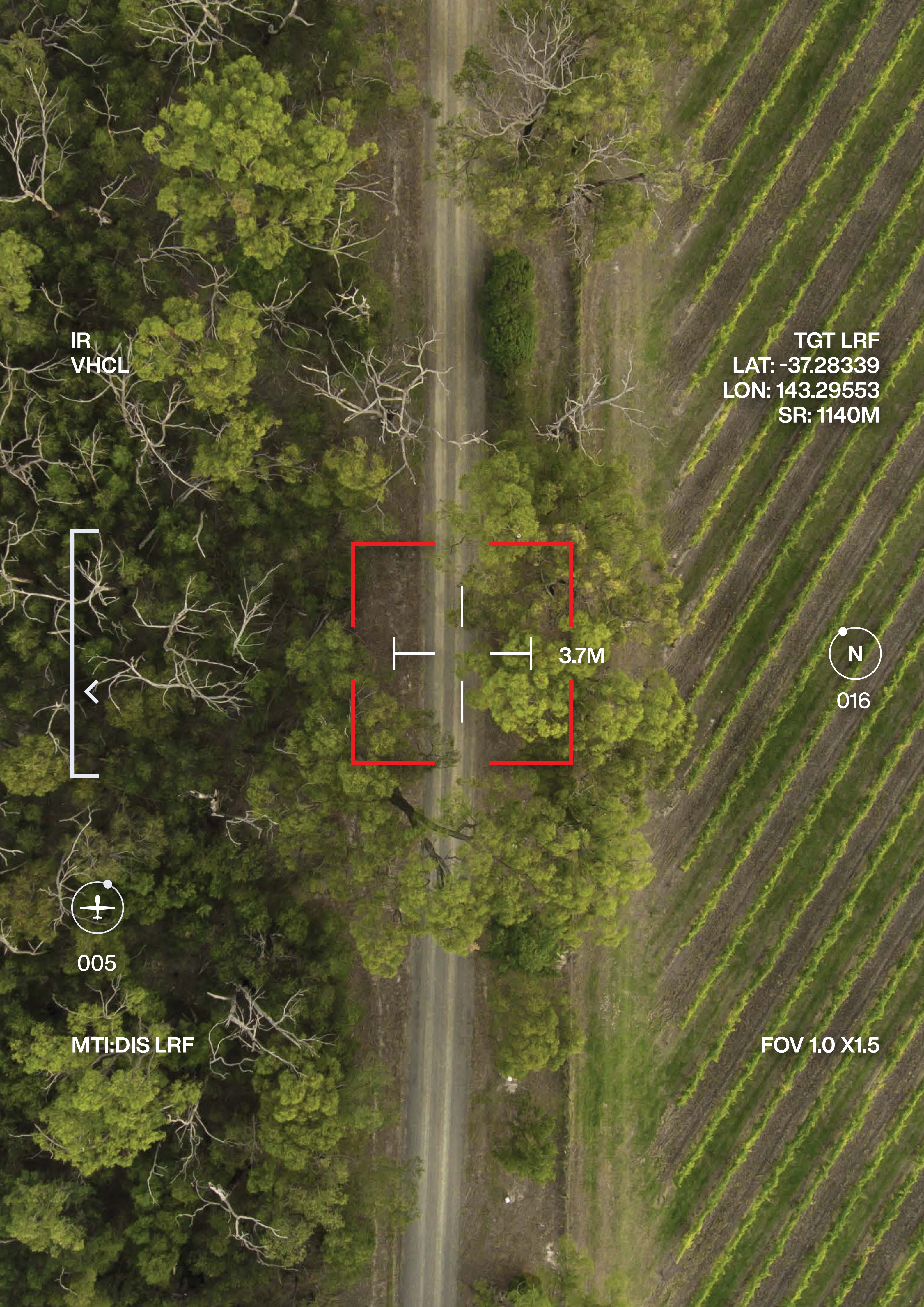
In that context, the principal component of the FRV RPAS BVLOS project was a series of operational trials whereby selected RPAS were deployed BVLOS to simulated emergency management scenarios, in as close to real-world circumstances as were safe and reasonably practical.

Deliberately, the operational trials were not conducted in closed or protected airspace. This represents a progression from some previous BVLOS RPAS trials. Likewise, although the emergency management scenarios were simulated, they were derived from a recent, real-world bushfire that occurred at the trial location.

While the operational trials were based on a simulated bushfire situation, it is expected that the learnings will still be applicable across a wide range of emergency and disaster management situations.

Although it was planned that actual BVLOS RPAS flights would be conducted as part of the trial, the successful completion of these flights was not in itself a required outcome, nor did the project intend to technically evaluate any individual RPA or payload in operation. Rather, the primary interest was the journey that enabled operational trial flights to be achieved (or not achieved), as this experience would inform the development of doctrine, systems and processes to enable future safe and effective BVLOS operations. In that sense, a key focus of the trial was the process for obtaining regulatory approval for the BVLOS RPAS flights and examining the intersection between regulatory considerations and operational considerations.

(1) In late 2024 the work of the National Partnership Agreement on Disaster Risk Reduction (NPA) transitioned to the Disaster Ready Fund.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6.

Regulatory environment

6.1 Setting

The regulatory environment surrounding use of RPAS in Australia is complex, highly nuanced and continues to evolve.

Civilian operation of RPA is primarily regulated by Part 101 of the Civil Aviation Safety Regulations 1998[(2)] (CASR) made under the Commonwealth Civil Aviation Act 1998. However, RPA operation may also be governed or influenced by other Parts of the CASR and a variety of other federal and state legislation; as well as through state and territory government fire and emergency management legislation, regulations and procedural doctrine.

Examples of other legislation or rules that may impact RPAS BVLOS operations include:

- Air Services Act 1995 (C'th)
- Radiocommunications Act 1992 (C'th)
- Privacy and surveillance device related laws and regulations (C'th and state)
- Occupational health and workplace safety related laws and regulations (C'th and state)
- Critical Infrastructure protection regulations (C'th and state)
- Electrical safety regulations (state)
- Local laws that may influence or limit the use of, or attempt to limit use of, RPA in some circumstances. These may include:
  - local government ordinances or by-laws
  - rules and regulations relating to national parks and other protected areas
  - rules and regulations made under various state legislative instruments governing prisons, corrections and youth justice centres.

This project focusses primarily on CASR Part 101 which is the statute that ultimately enables BVLOS flight by RPA in Australia.

6.2 Regulatory requirements for BVLOS

It is beyond the scope of this report to outline all relevant aspects of CASR Part 101 and associated instruments, which are detailed and extensive. These are well described and explained on the CASA website[(3)] and in related CASA publications. However, the following highly summarised key provisions provide some context:

- CASR Part 101 contains a general stipulation requiring that "a person must not operate an unmanned aircraft in a way that creates a hazard to another aircraft, another person, or property"
- Only organisations that hold a Remotely piloted aircraft Operator's Certificate (ReOC) issued by CASA may undertake RPAS BVLOS operations
- The operating organisation must maintain an RPA Operations Manual, approved by CASA, that details procedures (including planning and risk assessment) for BVLOS flights. The Operations Manual must align with the Part 101 Manual of Standards (MOS)[(4)] published by CASA
- The pilot of any BVLOS RPA flight must hold a Remotely piloted aircraft Pilot Licence (RePL) and is required to undergo additional training, largely equivalent to that required to pilot a conventional aircraft flying under the Instrument Flight Rules
- The RPA pilot (or a suitable person in the operating crew) must also hold an Aeronautical Radio Operator Certificate (AROC) or equivalent
- Specific additional requirements apply to RPA flight at night[(5)]. In summary these require that night flights only be conducted by a ReOC holder who has appropriate procedures in their approved Operations Manual; and flown by approved RePL holders who have received additional training regarding RPA night operations
- BVLOS RPA can be authorised to operate from and in the vicinity of aerodromes. Again, there are specific additional requirements and limitations
- BVLOS RPA can be authorised to operate in controlled airspace. Generally, this will require prior consultation with Airservices Australia (ASA) or the appropriate Australian Defence Force airspace authority, although CASA and ASA are in the process of implementing systems for automated approval. In some circumstances the RPA will be required to be equipped with approved electronic conspicuity equipment. Additional pilot training is required for RPA flight in controlled airspace
- Importantly, each actual BVLOS RPAS operation (a set of planned BVLOS flights) must be authorised by CASA. In most instances this requires an application to CASA for the issue of an Instrument authorising the specific BVLOS operation. The Instrument may specify certain limitations or restrictions on flights.

(2) https://www.legislation.gov.au/F1998B00220/latest/text/3, accessed 14 August 2025.

(3) https://www.casa.gov.au/drones/flight-authorisations/beyond-visual-line-sight-operations#Therequirements, accessed 14 August 2025.

(4) Typical additional requirements applicable to night flight are illustrated by CASA Instrument 01/17 (https://www.legislation.gov.au/F2017N00016/latest/text https://www.legislation.gov.au/F2019L00593/asmade/text, accessed 25 August 2025.

(5) CASA Instrument 01/17 version commencing 3 August 2023, accessed 25 August 2025.

In some ways, this is a key point of difference from the way in which conventional aviation is regulated. In most instances, at least in general aviation, once an aircraft operator has been approved to conduct a particular type of operation the operator can make their own decisions about proceeding with flights

- CASA does have a capacity to in-effect pre-authorise BVLOS flights conducted by approved operators in defined areas. It is understood that, at the time of writing, at least one Instrument has been issued that allows for BVLOS RPA operations without further approval in association with aerial search and rescue and allied activities by an individual operator in a designated area of New South Wales. CASA has also recently flagged that other broad area approval pathways are being developed[6].
- It is worth noting that within the CASR there are categories of RPA (e.g. Exempt RPA) and sets of flight conditions (e.g. the RPA Standard Operating Conditions or SOC) that – under certain circumstances - enable RPA flight with relatively few restrictions. None of these rule sets currently provide for BVLOS flight
- CASA has several pathways available for assessing risks associated with BVLOS RPA flight and subsequently authorising operations. These pathways do intersect, but may be broadly described as:

  a. Specific Operations Risk Assessment (SORA), based on an internationally agreed, standard framework for assessing ground and air risks of planned RPA operations
  b. BVLOS standard scenarios, which are defined situations where ground and air risks have been pre-assessed (generally using the SORA methodology)
  c. Advanced operations, where the nature of the operation means that the above approaches to risk assessment are difficult to apply and specific detailed assessment is required.

6.3 SORA

SORA[7] is the main risk assessment methodology used by CASA when considering applications for authorisation of RPA BVLOS flights. SORA also often underpins assessments made via other pathways.

SORA is a product of the Joint Authorities for Rulemaking on Unmanned Systems (JARUS), an international group which develops harmonised guidance material for the safe operation of RPA. JARUS does not create binding guidance or regulations. Countries may choose whether to implement JARUS products or adapt them into local frameworks or regulations.

In essence, SORA examines ground risks (risk to persons on the ground) and air risks (risks to other airspace users) of proposed flights, based on a Concept of Operations (CONOPS) developed by the RPAS operator.

Other important components built into SORA include:

a. **Operational safety objectives**
SORA uses operational safety objectives (OSO) to reduce risks associated with abnormal and out-of-control situations.

b. **Containment**
Containment considers risks to people within an adjacent area if the operational safety objectives fail.

c. **Emergency response plans**
An emergency response plan is required to cover response to abnormal or out-of-control situations.

Assessment of ground risk is linked to the likelihood of the RPA to cause injury should it strike the ground and therefore considers the potential kinetic energy of the RPA, which in-turn is related to the size and possible speed of the vehicle. Ground risk assessment also considers the population density in the area, including in a ground risk buffer or contingency zone (i.e. where the RPA may impact the ground in an abnormal situation).

Assessment of air risk considers the type and likelihood of an encounter with another airspace user, including in a buffer or contingency airspace volume.

For both ground risk and air risk an intrinsic or baseline risk is calculated. Final or residual risk classes are then determined after applying risk mitigations. Residual ground risks and air risks are combined to determine an overall risk rating, on a scale of 1 to 6 (written as I to VI), referred to as Specific Assurance and Integrity Level or SAIL, where Level VI represents the highest level of potential risk.

(6) https://www.casa.gov.au/broad-area-bvlos-operations, accessed 01 October 2025.

(7) This is very much a simplified outline of SORA, provided for convenience. A flowchart reproduced from SORA version 2.5 is provided at Appendix 1. A full description is available at https://jarus-rpas.org/wp-content/uploads/2024/06/SORA-v2.5-Main-Body-Release-JAR_doc_25.pdf accessed 28 August 2025.

In very general terms, it is understood that CASA will normally authorise BVLOS operations rated at SAIL I and SAIL II. SAIL III and above applications are likely to require additional assessment (at extra cost) and possible adjustments or extra risk mitigation, but this will depend on the individual circumstances.

The current published version of SORA is 2.5. At the time of this project, CASA had adopted version 2.0 and had flagged an intention to adopt version 2.5 later in 2025[8]. One issue with version 2.0 centres around detailed guidance for determining population density in the proposed area of operations. The SORA guidance does not align neatly with Australia's demographics and available statistical information. In the meantime, this has been at least partly addressed by adopting elements of version 2.5 through a CASA Temporary Management Instruction (TMI)[9]. This TMI also provides for the application of ground risk mitigation strategies that are not provided in SORA 2.0.

It is important to recognise that SORA does not guarantee zero risk. The process has primarily been formulated on the concept that RPAS operations should not pose more risk to third parties than conventional crewed aviation. For ground risk, this is less than one fatality per million hours of operation. For air risk it is less than one mid-air collision per 10 million flight hours for operations that are conducted primarily in uncontrolled airspace.

It is also important to note that the CASR do not require CASA to adopt any particular risk assessment methodology such as SORA.

6.4 Authorisation processes

The current standard published process for authorising RPAS BVLOS operations assumes that the SORA methodology will be applied and requires lodging an application in advance with CASA. The application will normally be required to include a CONOPS, the operator's own assessments of inherent and residual air and ground risks, details of planned risk mitigators and the calculated overall SAIL. Evidence supporting the operator's risk assessments and other documents such as an Emergency Response Plan are also required.

Following initial submission of the application, CASA will undertake an assessment of the completeness of the application and the time required to evaluate and potentially approve the application. CASA will then issue an estimate of costs to continue to process the application. Upon the operator accepting the cost estimate, the application is queued for detailed evaluation. Once the application has been assessed and approved, an Instrument of Approval authorising BVLOS flight in accordance with the CONOPS (or revised CONOPS) and in a defined area of operations is issued to the ReOC holder. The Instrument will often apply additional conditions to the authorisation and will have a specified validity period.

Applications are normally dealt with in the order in which they are received by CASA. At the time of preparation of this report the estimated elapsed total time to process an application that envisaged a SAIL II operation was in the order of five to six months. CASA does have the ability to process BVLOS flight authorisations in shorter timeframes in specific circumstances, e.g. in the case of a significant ongoing natural disaster or emergency. This abbreviated, fast-track process has reportedly been exercised on several previous occasions.

(8) https://www.casa.gov.au/rpas-operations-authorisation-assessment-methodology accessed 28 August 2025.

(9) https://www.casa.gov.au/sora-20-ground-risk-assessment-requirements-and-alternate-criteria accessed 28 August 2025.

7.

BVLOS operational trial

7.1 Context

The cornerstone of the FRV RPAS BVLOS project was an operational trial involving a series of day and night BVLOS flights by different RPAS at a simulated emergency event in western Victoria during 2025.

It is again emphasised that it was not the purpose of the operational trial to evaluate the technical capabilities or performance of individual platforms or payloads, but rather to investigate and understand:

- operational considerations associated with BVLOS flight by RPAS and the intersection between regulatory and operational factors; and
- overall capabilities and limitations of types and classes of RPA platforms when operating BVLOS.

The process of obtaining (or not obtaining) regulatory approval for conducting BVLOS operations was therefore very much considered to be part of the operational trial, as this would allow exploration of operational factors and limitations that were dictated by regulatory considerations. Ultimately this will help to practically operationalise risk management and mitigation measures.

It is reasonable to question how much relevant experience could realistically be obtained in simulated emergency scenarios, when regulatory approvals for the flights would be obtained well in advance through a process that would clearly not be viable in real-world emergency situations. However, the project expected that the experience and information obtained using simulation scenarios would still be valuable in establishing a viable path to practical and effective utilisation of BVLOS RPAS at actual emergency events, and indeed this proved to be the case. As will be seen from discussion later in this report, the trial contributed towards identifying considerations around safe, effective and legal use of BVLOS in emergencies, and will help to establish the systems, procedures and practices that will be required. The operational trial also contributed to understanding the utility and limitations of different approaches to the conduct of BVLOS flights, and to understanding capabilities and limitations of RPAS in BVLOS flight.

7.2 Industry partners

FRV partnered with the RPAS industry to conduct the operational trial. Key expectations of RPAS industry partners included:

i. obtaining the necessary advance regulatory approvals to operate RPAS BVLOS in the trial
ii. mobilising and operating suitable RPAS BVLOS to acquire and transmit imagery and other data in a range of simulated emergency management scenarios
iii. providing appropriate support systems and infrastructure to enable effective turnkey operation of RPAS in simulated emergency situations
iv. collecting, collating and delivering data and information to assist with objective evaluation and analysis of the trial.

Industry partners were reimbursed for expenses directly incurred in completing required project activities and were otherwise required to provide in-kind contributions.

Industry partners were asked to detail their experiences in the lead-up to and during the trial through a series of structured questionnaires.

RPAS industry partners are referred to in this report as trial participants.

7.3 Specifications

Technical specifications for trial participants and their RPAS were set to ensure that the ReOC holder and the RPAS utilised in the trial could perform tasks that might reasonably be required in a typical emergency management scenario.

The technical specifications are reproduced at Appendix 2. In summary:

- Trial participants were required to hold a ReOC endorsed for BVLOS operations or to be capable of obtaining a suitable ReOC in time for the trial.
- Key requirements for the RPAS included:
  - ability to operate BVLOS (while maintaining continuous control and data communications) at a minimum range of 15 km from the launch and recovery site(s); and
  - endurance for a minimum of 30 minutes flight in the task area, plus transit to/from launch and recovery sites.
- Trial participants were expected to have their RPAS acquire geo-referenced imagery or equivalent data at the simulated emergency event and to communicate information products or data from the RPAS in near-real-time.

7.4 Selection of participants

Industry participants were selected through a publicly advertised Expressions of Interest (EOI) process.

In total, 26 organisations submitted a valid EOI. Nine organisations were selected as trial participants. Selection of participants aimed to achieve a representative range of organisational experience with BVLOS, as well as a range of RPA platform types and categories.

7.5 Trial scenario

Although the project objectives were based around examining RPAS BVLOS operations in a range of emergency management situations, it was important to have a common, standardised scenario for the trial to enable useful comparisons between different pathways to approval, differing organisational approaches and different solutions. A bushfire emergency was chosen as the simulation scenario for several reasons, including:

- bushfires offer a wide variety of potential RPAS taskings (for example: fire detection, hotspot mapping, threat assessment, asset location, hazard mapping, edge mapping, damage assessment, ground crew safety monitoring etc.)
- simulated bushfires were considered to offer the best overall scope to test systems, procedures and processes that could then be extrapolated or adapted to other emergency situations
- there are established, proven systems and procedures for coordinating airspace use at bushfires.

The trial exercises were based around the first 24 hours of the Bayindeen-Rocky Road bushfire that started in western Victoria at around 10:30 on 22 February 2024. This fire spread rapidly to the south and southeast under the influence of strong and gusty north to northwesterly winds, through private land and into the Mt Cole State Forest and Mt Buangor State Park. By 19:00 on the first day the fire was over 6,300 hectares in size. A southwesterly wind change during the evening turned the fire in a northeasterly direction. The fire was reported to have generated spot fires at times up to 15 km ahead of the main fire. The fire was declared contained on 29 February 2024, although significant resources continued to be engaged in recovery after that time.

About 22,000 hectares were burned in total, approximately 5,780 hectares being private land. Direct losses were estimated at eight primary residences, ten outbuildings, 300 sheep, 540 beehives and 810km of fencing.

Within the general locality of the Bayindeen-Rocky Road fire a planned area of operations for the RPAS BVLOS trial was delineated. This area was selected to provide terrain and cultural features that were broadly representative of the area affected by the original bushfire, as well as to provide opportunities for a variety of tasks to be assigned to the BVLOS RPAS during the trial.

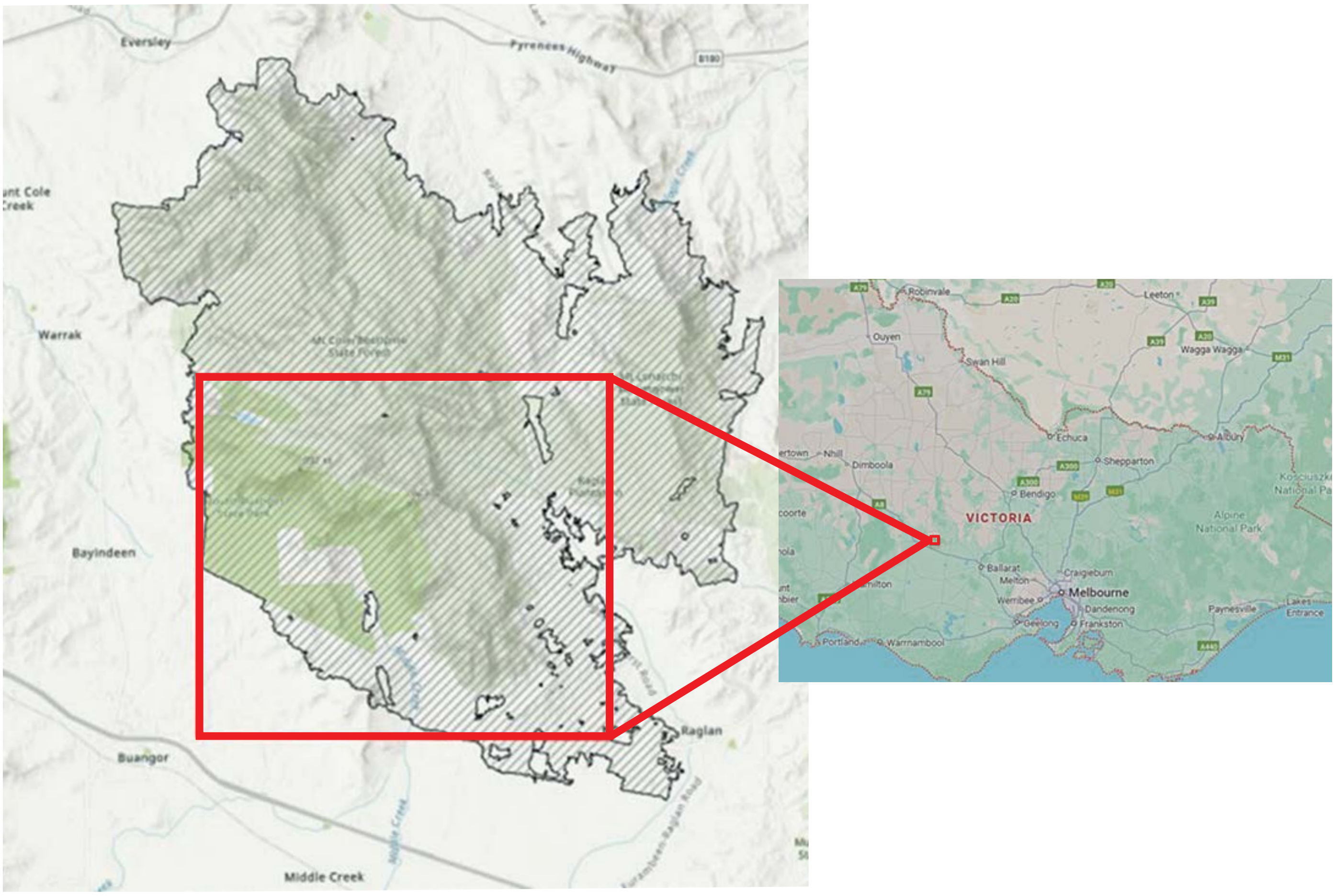
General view of southwestern flank of the Bayindeen-Rocky Road fire on 22 February 2024 – Image: CFA Beaufort

In turn, this would allow participants to demonstrate how their RPAS met the minimum technical specifications.

The general location and final perimeter of the Bayindeen-Rocky Road fire, along with the FRV initially planned area of operations for the RPAS BVLOS trial is illustrated below.

The planned potential area of operations for trial flights (excluding transit routes to and from launch and recovery sites, where required) contained heavily undulating terrain generally between approximately 300 metres (985') Above Mean Sea Level (AMSL) and 1000 metres (3,280') AMSL and a mixture of forested land and farming properties.

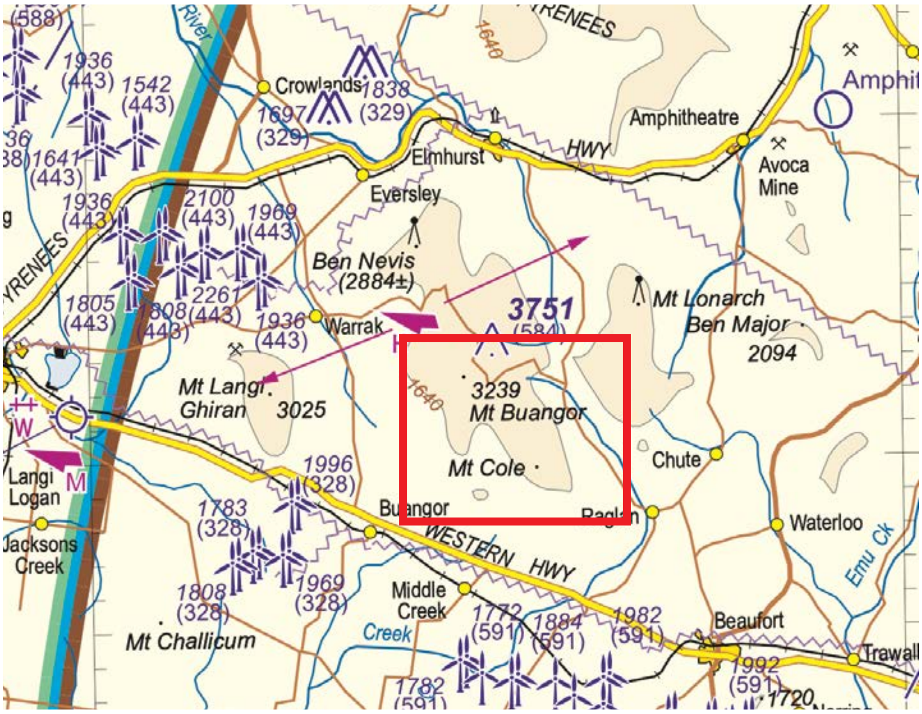
Overall population density in the area could reasonably be described as relatively low[10].



Locality of Bayindeen-Rocky Road fire of February 2024 showing final area burnt (black hatched area) and planned RPAS BVLOS trial area of operations (red lines) – Images: FRV and Google Maps

(10) In plain English. This report has deliberately avoided using the relative population density descriptors defined in SORA and the CASA TMI such as scarcely populated, lightly populated, and sparsely populated.

General view towards the trial planned area of operations, looking north from southern boundary. – Image: Mt Cole Cottages.



Extract of Melbourne Visual Navigation Chart 12 June 2025 annotated with trial planned area of operations (red lines), showing presence of wind turbines and possible hang-gliding operations – Image: Airservices Australia annotated by FRV

The entire planned area of operations comprised uncontrolled (Class G) airspace up to at least 8,500' AMSL. Participants were not precluded from operating in the controlled airspace above that level if necessary to achieve task objectives, however all participants ultimately chose to operate entirely within Class G (uncontrolled) airspace.

The general area of the trial included several specific potential flight hazards, such as wind turbines (up to 591' AGL or 2,260' AMSL) plus a higher-than-normal probability of hang-gliding operations.

The planned area of operations was in proximity to several published standard routes for conventional aircraft flying under the Instrument Flight Rules (IFR). Hypothetically, IFR aircraft could be flying these routes at a minimum of 4,800' AMSL, although higher altitudes would normally be adopted.

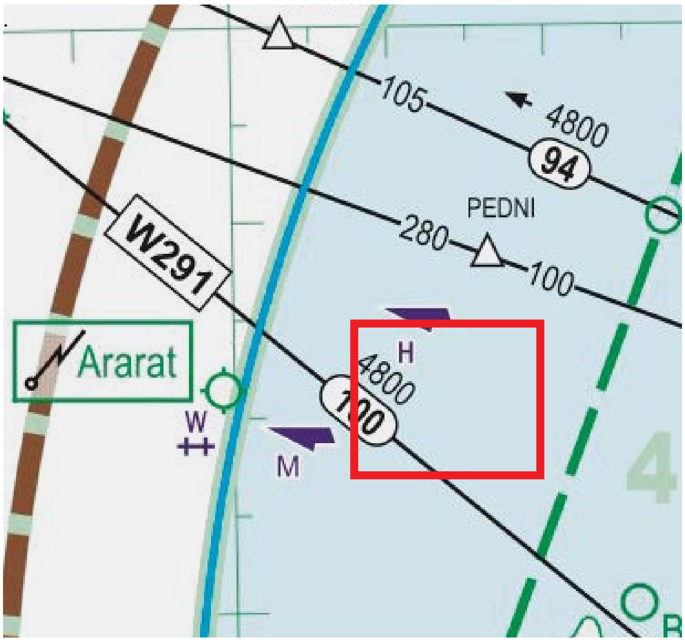
Published standard IFR routes in the vicinity of the planned area of operations for the trial were slightly amended between the time that most participants developed their CONOPS and the time of the operational trial flights. Ultimately this had no impact on approvals or trial operations, as the respective minimum altitudes for IFR aircraft (known as Lowest Safe Altitudes) remained unchanged. However, this does illustrate some of the issues that could occur when the operating environment changes during extended flight authorisation processes.

The project chose ISR tasks for trial flights. There will certainly be other valid tasks for BVLOS RPAS at emergency events, however it was necessary to have some standardisation of tasking to enable useful comparisons of different approaches and methods. The use of RPAS for information gathering remains the most likely application of RPAS at emergency events in the short to medium term. FRV and other emergency agencies also have considerable experience in use of RPAS for information gathering, and it was anticipated that this would enable useful comparisons of the utility of non-BVLOS and BVLOS solutions.

The simulation scenario required BVLOS RPAS to undertake ISR tasks using Electro Optical and Infra Red (EO/IR) gimballed sensors. Assigned tasks included locating ground crews and mapping fire affected areas.

Participants also engaged in a desktop ISR exercise which involved using a BVLOS RPAS to assess damage to critical communications infrastructure at a hilltop location where there was a possibility that electromagnetic interference (EMI) from on-site radio transmissions could affect RPAS control integrity.

More detail on taskings is provided at section 8.2.



Extract from AIP Enroute Low Chart 2 12 June 2025 annotated with trial planned area of operations (red lines) and showing published IFR standard routes (black lines) applicable at the time of trial flights. – Image: Airservices Australia annotated by FRV.

7.6 Pathway to approvals

Having selected nine industry participants, FRV provided these RPAS operators with information about the simulated scenario and details of the planned area of operations.

As far as practicable, the level of information provided to the operators was designed to be consistent with the type of information that might be initially provided by a fire or emergency service when engaging an aircraft operator for real-world missions. To reflect actual emergency situations, specific detailed tasks and targets within the planned area of operations were only made available to participants immediately before individual trial flights.

The simulation scenario required that the technical specifications (Appendix 2) be met but allowed operators to choose launch and recovery sites and ground station locations appropriate to their RPA and to choose suitable flight paths between launch and recovery sites and the area of operations as required.

It was impractical to simulate the weather conditions that prevailed at the time of the Bayindeen-Rocky Road fire. Participants were able to assume that the weather conditions for the simulation exercise flights would be the actual weather at the time of flight.

Operators then developed appropriate CONOPS, assessed inherent[11] ground and air risks using SORA, determined appropriate risk controls and mitigations and calculated the expected overall SAIL of their proposed BVLOS operations. This information was then combined with other required documents, such as emergency response plans and stakeholder engagement plans and submitted to CASA.

In some instances, operators lodged multiple applications (or sub-applications) as they proposed to use different classes of RPA or different operational risk mitigations.

Table 1 on the next page summarises key steps in the approval process for each participant.

Ultimately three participants obtained approvals for trial flights within timeframes that could be accommodated by the project. All applications that were approved included some form of operational limitation. Key limitations and related operational considerations are detailed in section 8.

7.7 Electronic conspicuity demonstration

During planning for the BVLOS operational trial it became apparent that electronic conspicuity (EC)[12] technology was likely to play a significant role in mitigating air risks during future RPAS BVLOS operations, and in safely integrating RPA (VLOS and BVLOS) with conventional aircraft operating in support of emergency response. This is consistent with views expressed by the RPAS industry in Australia[13]. The FRV project therefore took the opportunity to demonstrate aspects of EC alongside BVLOS trial flights. The EC demonstration aimed to expand the experience and knowledge around aspects of electronic conspicuity of RPA in operational situations, including:

- the overall effectiveness of EC in improving situation awareness for pilots and air resource supervisors or coordinators
- the effectiveness of various approaches for receiving, processing and displaying EC data, and
- the utility and practicality of temporary, field-based ADS-B receivers.

The electronic conspicuity demonstration is discussed in more detail at section 10.

(11) The term "inherent" is used here in the general, plain English sense.

(12) In this report the term "EC" is used in the general sense – i.e. to cover all forms of electronic conspicuity including ADS-B and virtual ADS-B.

(13) E.g. AAUS submission to the ADSB working group, AAUS 28 February 2025, accessed 02 September 2025.

TABLE 1 APPROVAL PATHWAYS

Participant [14]	RPAS	SAIL on initial application	Date application lodged with CASA	Fee estimate received	Instrument of approval issued Validity period
Wedgetail Aerospace	Medium RPA helicopter	II	09 December 2024	12 December 2024	16 May 2024 Valid 16 May to 31 August 2025
Toll Uncrewed Systems	Small powered lift and small multirotor	II	11 February 2025	03 March 2024	10 July 2025 Valid 10 July to 31 August 2025
Silvertone	Small RPA aeroplane	II	18 December 2024 Application updated 15 January and 10 July 2025 (extra information provided at request of CASA)	02 May 2025	15 July 2025 Valid 15 July to 31 October 2025
Yamaha	Medium RPA helicopter	III	13 December 2024 Significantly revised application submitted (envisaging SAIL II) 25 June 2025	15 April 2025	Approval not obtained in project timeframe, application subsequently withdrawn
Carbonix	Medium powered lift	II	12 February 2025		Application withdrawn due to logistical and/or commercial considerations
Ninox	Medium powered lift				Application not lodged due to logistical and/or commercial considerations
UASCi	Small RPA aeroplane				Application not lodged due to logistical and/or commercial considerations
Burnbot	Medium multirotor		1 April 2025		Application not proceeded with due to logistical and/or commercial considerations
Quantum Systems	Small powered lift				Application not lodged due to logistical and/or commercial considerations

(14) Trading or familiar names are used to refer to trial participants in this report. In some instances, this may be different from the name of the legal entity and/or the name of the ReOC holder under which trial flights were conducted.

8.

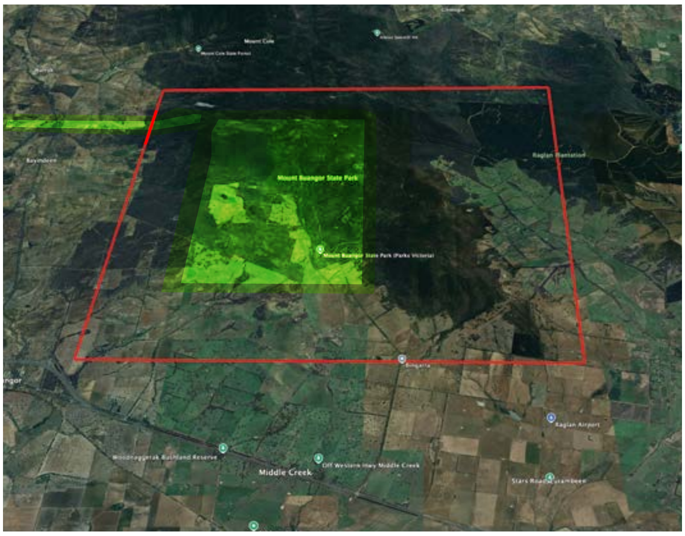
Trial operations

8.1 Approvals

As noted in Table 1 in section 7, ultimately three industry participants received CASA authorisation to conduct operational trial flights within timeframes that could be accommodated by the project. Further details of these participants and their approvals are provided in Table 2.

In all three cases, the area of operations for the RPA authorised in the CASA Instruments of Approval was reduced from the planned area originally identified to the participants by FRV. In short, participants found it necessary to reduce the areas of operation to avoid certain localities where the assessed density of the population on the ground may have resulted in an intrinsic ground risk classification that could most likely not be accommodated in a SAIL II application. In some instances, this assessment was made by the participants themselves before submitting their application to CASA, in one instance the application was modified at the suggestion of CASA. The reduced areas of operation also reflected the need to apply buffer zones (contingency volumes) to allow for the possibility of an abnormal situation with an RPA.

Participants indicated that they expected that the simulated emergency ISR taskings could still be achieved within the respective reduced areas of operation, as the EO/IR sensors would still be able to “see” the terrain outside of the approved operating area. This aspect is discussed further in section 9.



Example 1 of reduced area of operations. Red lines outline the FRV originally planned area, green shading is the approved area of operations, yellow shading is the contingency volume
Image: Trial of participant and Google Earth

Example 2 of . Red lines outline the FRV originally planned area, yellow lines outline the approved area of operations including contingency volume
Image: Trial participant and Google Earth

In all three cases, the area of operations for the RPA authorised in the CASA Instruments of Approval was reduced from the planned area originally identified.

TABLE 2 OPERATIONAL TRIAL PARTICIPANTS AND APPROVALS

Participant (Operational base)	Approved RPA(s) Payload Launch/recovery site Communications (control and payload)		Significant operational considerations or limitations[15]
Wedgetail Aerospace (Perth, WA)	Medium RPA helicopter: Anavia HT100 (liquid fuel) Gimballed EO/IR sensor Raglan airfield LOS[16]/mesh radio plus LTE	Day and Night	Flights must be conducted **not below 400' AGL** (except during launch and recovery) Flights must be conducted **not above 4300' AMSL** Restricted geographic area of operation (reduced from FRV planned tasking area) plus a narrow corridor from launch/recovery site Flights must be conducted in VMC
Toll Uncrewed Systems (Brisbane, QLD)	Small multirotor: DJI variants Small powered lift: ASQ Cetus 240 and ASQ Great Shark 330 (battery electric) (Trial flights were flown by ASQ Great Shark 330 with gimballed EO/IR sensor) Various roadside sites Dual band LOS/mesh radio	Day	Flights must be conducted **not below 400' AGL** (except during launch and recovery) Flights must be conducted **not above 500' AGL** Restricted geographic area of operation (reduced from FRV planned tasking area) Flights must be conducted in VMC
		Night	Flights must be conducted **not below 400' AGL** (except during launch and recovery) Flights must be conducted **not above 4500' AMSL** Restricted geographic area of operation (reduced from FRV planned tasking area) Flights must be conducted in VMC
Silvertone (Wagga Wagga, NSW)	Small RPA aeroplane: Flamingo (liquid fuel) Gimballed EO/IR sensor Ararat Aerodrome Dual band LOS/mesh radio plus LTE	Day and Night	Flights must be conducted **not below 400' AGL** (except during launch and recovery) Flights must be conducted **not above 6,000' AMSL** Flights must be conducted **on weekdays outside the period between 11:00 and 15:00 daily** Restricted geographic area of operation (significantly reduced from FRV planned tasking area) plus a narrow corridor from launch/recovery site **10 ground observers** required Flights must be conducted in VMC Operations must not be conducted during a **relevant event**[17]

(15) Significant operational considerations or limitations may be either those included by CASA in Instruments of Approval or those incorporated by the ReOC holder in their CONOPS during the application process in order to maintain a planned SAIL or to conform to their Operations Manual.

(16) "LOS" in this table refers to radio line of 'sight'; "/mesh" means that an option was available to increase radio coverage by establishing additional meshed radio nodes.

(17) A relevant event refers to the operation of a crewed aircraft in the vicinity of the aerodrome used for launch and recovery of the RPA.

In addition to the operating conditions and limitations of each individual approval, all CASA authorisations required:

- that a Notice to Air [Missions] (NOTAM) be issued advising other airspace users of the trial flights
- flights be conducted outside controlled airspace (OCTA), noting that none of the approved operators sought approval for operations within controlled airspace.

Although not explicit in the Instruments of Approval, in-effect all trial flights were required to be conducted in Visual Meteorological Conditions (VMC)(18), as the participant's respective Operations Manuals did not include suitable provisions for non-VMC BVLOS flight by the RPA used in the trial. Approval to conduct operational trial flights in non-VMC was not sought by the participants.

8.2 Flights

8.2.1. Testing

Each participant had an opportunity to setup and test fly their RPAS in the general area of the trial prior to engagement in simulated emergency tasks. In one instance, a participant identified technical issues with their RPA during testing. Rectification was successfully completed but resulted in some delay to scheduling trial flights for that RPA.

8.2.2. Tasking

Simulated emergency tasks within the FRV planned area of operations were provided to the participants in a timeframe consistent with emergency management.

The simulation exercises were designed to ensure that each participant had an opportunity to demonstrate that their RPAS met the Technical Specifications originally prescribed (Appendix 2).

Tasks provided to each operator included.

i. Search a specified sub-area (of approximately 2.5 km x 2.0 km) and locate a ground vehicle and crew that has lost communication with their supervisor, given the last known location of the vehicle; report latitude/longitude of the vehicle when located; maintain observation of the vehicle and crew for 30 minutes
ii. Map a defined area affected by bushfire (simulated by tracks and vegetation edges); determine the approximate area of the simulated bushfire in hectares and the approximate length of perimeter and report the key co-ordinates
iii. Locate a ground crew that had been previously dispatched to establish a Sector Control Point; on locating the crew assess road conditions and provide driving directions if required.

In some cases, more than one task was assigned and completed in a single mission.

In addition, each participant was required to work through a desktop exercise, simulating in real-time how they would utilise their RPAS to undertake a detailed assessment of fire damage to critical communications infrastructure at a specific, high elevation location within the area of operation (Lookout Hill, 3,747' AMSL including communications towers of 581' AGL), where there was a possibility that the operation of the RPAS may be compromised by Electro Magnetic Interference (EMI). Participants were provided with published information regarding licensed EM emissions from the site.

(18) Interpretation of VMC criteria for RPA may be different from that applied for conventional aircraft. VMC is defined for each ReOC holder in their approved Operations Manual. Default criteria are 5,000m visibility and clear of cloud.

8.2.3. Flying operations

Weather conditions created some delays to scheduling of trial flights, with principal concerns being:

i. forecast wind speeds exceeding take-off and landing limitations for the respective RPA
ii. forecast relatively strong upper winds creating lee turbulence and downdrafts in the operating area that may have affected safety of the RPA or the ability of the RPA to outclimb terrain
iii. on some days, forecast low cloud and rain showers.

Ultimately, formally tasked trial flights were flown on Thursday 24 July 2025 and Monday 11 August 2025. On each day flights were flown during daylight and at night (after the end of civil twilight).

Due to weather, staffing and logistical constraints, the planned, approved fight operations for one of the three approved participants could not proceed at the scheduled times. Instead, simulated flight exercises, paralleling the actual flight exercises, were undertaken on Thursday 2 October 2025.

Onsite safety briefing prior to operation of Wedgetail Aerospace Anavia HT-100 on 24 July 2025 – Image: FRV

Toll ASQ Great Shark 330 being prepared for operations 11 August 2025 – Image: FRV

Meteorological conditions were similar on both flying days, being:

Daylight flights

- fine
- visibility 10 km or greater
- occasionally a few (3 oktas or less) cumulus clouds with bases mainly around 2,000’ AGL
- ambient temperature between 0°C and 15°C, brief ground frost
- relative humidity mainly between 21% and 32%
- wind at 2 m AGL (approximately 300 m or 1,000’ AMSL) generally north to northwest 2 to 4 m/s (7 to 15 km/h) with occasional gusts to 7 m/s (25 km/h)
- wind at 915 m (3,000’) AMSL generally west to northwest 5 to 8 m/s (18 to 29 km/h) occasionally increasing up to 11 m/s (40 km/h).

Night flights

- fine
- visibility 10 km or greater; nil moon
- clear skies
- ambient temperature approximately 7°C
- relative humidity approx. 35%
- wind at 2 m AGL (at approximately 300 m or 1,000’ AMSL) generally north to northwest up to 3 m/s (11 km/h)
- wind at 915 m (3,000’) AMSL generally west to northwest 3 to 6 m/s (11 to 22 km/h) occasionally increasing up to 7 m/s (25 km/h).

TABLE 3 SUMMARY OF FORMALLY TASKED BVLOS FLIGHTS

(time in actual flight in h:mm, excludes test and demonstration flying, excludes simulated flights)

	Total nº of BVLOS flights	Total time in BVLOS flight	Longest single BVLOS flight
Daylight	3	3:12	1:35
Night	2	1:10	0:44
Total	**5**	**4:22**	

8.2.4. Abnormal operations

Each RPA flown in the operational trial experienced (non-simulated) abnormal operations during at least one flight, requiring initiation of recovery procedures and a precautionary, earlier-than-planned return to the launch site. In both cases the RPA had already completed assigned exercise tasks. The abnormal events remain under investigation but were likely associated with transient glitches in onboard (non-payload related) sensors or software. In one case, the event appeared to follow a short-term loss of communications due to terrain shielding, following which a (non-essential) onboard status monitoring system failed to properly re-boot.

Importantly, none of these abnormal operations led to loss of control or failure to complete the assigned tasks. In all cases appropriate abnormal operations procedures were followed, the RPAS behaved as expected, and the RPA were safely returned to their respective launch sites.

9. Discussion and analysis

9.1 General utility of BVLOS RPAS

During trial flights (and desktop simulations of trial flights, where applicable) all RPAS were able to safely and satisfactorily complete their assigned simulated emergency ISR exercises while flying BVLOS, including at night. As such, each RPAS demonstrated an ability to acquire useful information literally beyond-visual-line-of-sight or, in other words, in situations where other means of intelligence gathering may be limited.

The trial therefore confirmed in a general sense that BVLOS RPAS can provide a capability to gather information that is likely to be critical to emergency management response planning and keeping communities informed about emergency incidents.

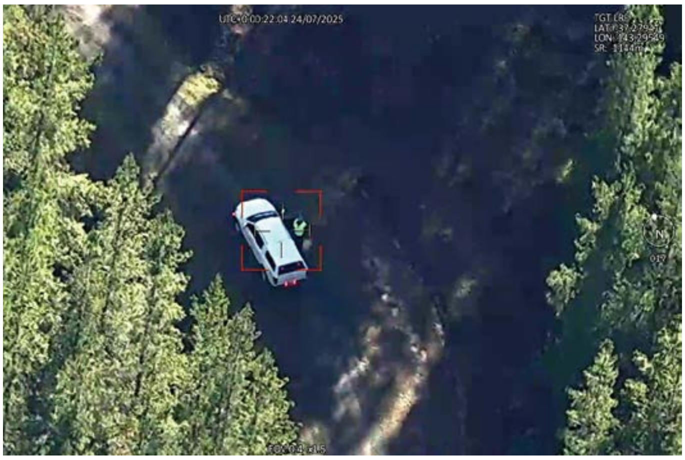
It was noted that in some instances the strength of the prevailing or forecast wind at ground level resulted in delays in launching RPA on scheduled flights. Technically neither RPA flown met the specification that required launch and recovery in winds of up to 25 knots. The strength of the wind at upper levels also either created turbulence or headwinds which approached the operating limits of the RPA or potentially compromised the range or endurance of the RPA.

It is likely that wind speeds typically encountered in emergency situations, especially during bushfires or storm-related events, would often be greater than the winds that prevailed at the time of the trials. This is not to say that BVLOS RPAS would not be useful at such events.

There are often periods of more benign conditions during extended emergencies, and these periods will tend to coincide with the conditions where BVLOS RPAS will potentially provide the greatest utility for information gathering, especially at night or in low visibility.

Also, although not flown in this operational trial, there are BVLOS-capable RPAS available that can fly in a wider range of wind conditions, albeit these tend to be larger platforms which in turn may introduce additional ground risk considerations. This class of larger RPA potentially includes remotely piloted or optionally piloted conventional aircraft, which are already in military use and are likely to become available to fire and emergency agencies in the next few years.

It is difficult to resist a comparison of the utility of BVLOS RPAS generally to the utility offered by conventional aircraft. Conventional aircraft would have been able to complete the assigned simulated emergency tasks with less “overhead” than the BVLOS RPAS trialled and likely at lower cost. Conventional aircraft would not have been subject to a lengthy, complex prior approval process. All BVLOS RPAS deployed required at least three personnel to operate, along with sophisticated ground-based infrastructure and communications that had to be mobilised in advance. Each flight required careful pre-planning and modelling of conditions before launch. All RPAS flights were subject to significant operational constraints and limitations (these are discussed further below) that would not have affected conventional aircraft. Generally, conventional aircraft can operate in more demanding meteorological conditions. As such, it is generally accepted that BVLOS RPAS are unlikely to substitute for conventional aircraft for information gathering in emergency management on any widespread basis soon, although this will certainly change as RPAS and their payloads become more capable over time, and as costs and overheads reduce.



Screengrabs of visual and infrared imagery of simulated lost ground crew during trial exercises – Images: Wedgetail Aerospace

The trial therefore confirmed in a general sense that BVLOS RPAS can provide a capability to gather information that is likely to be critical to emergency management response planning and keeping communities informed about emergency incidents.

Experience gained in the trial did, however, reinforce that there are clearly high-value missions that BVLOS RPAS could undertake that are not well suited to conventional aircraft or would be complementary to the utility of conventional aircraft. These types of missions constitute the niche where BVLOS RPAS are likely to offer the greatest utility. Examples are:

- gathering information at night
- gathering information in low visibility (e.g. smoke, haze, fog, mist)
- gathering information where low cloud precludes use of conventional aircraft; or prevents safe transit to the target area
- gathering information in certain meteorological conditions not conducive to conventional aircraft safety (such as thunderstorms, noting that BVLOS RPAS have previously been flown in extreme weather in the past for meteorological observation[(19)])
- gathering detailed tactical information to complement strategic or overview information gathered by other aircraft
- providing continuous or supplementary surveillance when fatigue management, fuelling or maintenance considerations limit conventional aircraft operations; or where conventional aircraft availability is otherwise limited
- gathering strategic information from high altitude, using specialist payloads.

Although not tested in the trial, by extrapolation it is also reasonable to conclude that in a fire and emergency management environment BVLOS RPAS will also be useful for tasks such as:

- atmospheric sampling (either for presence of hazardous materials, or to support meteorological or smoke movement predictions)
- dropping incendiaries for backburning or burning-out at bushfires
- package delivery (e.g. urgently required medical supplies or lifesaving equipment)
- radio communications supplementation (e.g. airborne radio repeaters, mobile phone cells).

OBSERVATION 1

There are significant operational limitations and considerations around flying RPAS BVLOS. Careful attention must be paid to the capabilities and limitations of individual RPAS to ensure that they are suited to a particular mission.

FINDING 1

BVLOS RPAS can provide a capability to gather information that is likely to be critical to emergency response management, emergency response planning and keeping communities informed about emergency incidents, in some situations.

Although not directly tested in this project, BVLOS RPAS are also likely to provide other important capabilities to support fire and emergency management.

RECOMMENDATION 1

Australian fire and emergency agencies should continue to evaluate BVLOS RPAS capabilities and to consider utilisation of RPAS BVLOS capabilities where appropriate.

9.2 Comparative utility

Ultimately the project only had the opportunity to fly two categories of RPA (medium RPA helicopter and small powered lift) in formal trial exercises. RPAS of both categories completed assigned tasks with similar efficiency, in similar timeframes, during daylight and at night.

The powered lift RPA exhibited slightly more tolerance to wind speed at the launch and recovery site and at altitude. However, each was subject to different limitations imposed by their respective instruments of approval (for example the powered lift RPA was subject to a not-above 500' AGL altitude restriction during daylight), making it difficult to draw reliable conclusions regarding the relative merits of each category. This aspect should be further examined in future trials and demonstrations.

As noted above, RPA that exhibit greater tolerance to wind speed are generally more likely to find a role in fire and emergency management. However, this will not always be the case as missions well-suited to BVLOS RPAS are still likely to be required at times of relatively low wind speed.

(19) For example: Revolutionising Storm Forecasts: Drones on the Meteorological Frontier Boneym Thomas, Bureau of Meteorology, Australia 2024, Accessed 16 September. 2025.

The operating endurance or range of individual RPA is another factor to consider. This needs to be evaluated in the context that BVLOS RPAS will usually require relatively generous contingency reserves of fuel or battery power to assure safe flight and return to the recovery site. Further, it was well demonstrated during the operational trial that atmospheric conditions such as turbulence, prevailing wind and temperature can have a significant effect on RPA endurance and range. Most RPA will tend to consume more energy in windy or turbulent conditions. Again, in very general terms, BVLOS RPA that have longer endurance and range are more likely to offer utility for fire and emergency management tasks, especially for those ISR missions where time-on-station is important. However, there will also certainly be missions where relatively low endurance or range is quite adequate. From the experience gained in the trial, a reasonable proposition is that BVLOS RPA utilised for ISR in emergency management situations will mostly require an endurance of at least of two hours, plus reserves.

Although not tested in this project, it is apparent that greater tolerance to wind and longer endurance or range is generally (but certainly not exclusively) associated with larger or heavier RPA. Larger RPA, however, will mostly have greater kinetic energy and therefore will require greater ground risk mitigation to achieve an acceptable SAIL. On the other hand, many larger RPA will have more sophisticated construction and control and communication systems, which may help reduce some risks.

OBSERVATION 2

Examples of both the medium RPA helicopter category and the small powered-lift category of RPA completed their assigned tasks during trial flight exercises. RPAS of both categories appear to offer utility for fire and emergency BVLOS operations, provided that operating limitations are appropriately considered when planning and executing missions. At this stage, the project is unable to draw conclusions on the relative merits of different categories of RPA. Ideally this would be the subject of further research and evaluation.

9.3 Integration of data

Most Australian fire and emergency management agencies maintain sophisticated geographic information systems and operational management systems for processing, integrating and distributing and displaying information products.

All trial participants were able to display information acquired by their BVLOS RPAS on screens at the Ground Control Station (GCS) in real-time. The trial did not attempt to deliver the information gathered by the RPAS directly into agency systems, however it was concluded that this integration would have been relatively straightforward provided that the appropriate entry points were defined and data standards specified. Trial participants confirmed that appropriate industry-standard embedded metadata was available within the information products generated from their RPAS.

During the trial, participants did demonstrate a range of other systems for displaying and distributing the information gathered. Mostly these involved some form of distribution of live real-time video or images (with onscreen metadata) via the internet to registered users of a data sharing platform. It is worth noting that these systems required connection of the RPAS GCS to the internet via portable satellite-based communications, which in turn proved to be capable and reliable. This type of remote live streaming or image distribution will be useful in many situations, especially where the RPAS is operating directly in support of a local incident command structure. The project observed, however, that there will be many occasions where the value of information gathered by RPAS will be significantly increased if it can be seamlessly integrated into agency systems in near-real-time.

Arguably, the fire and emergency sector could improve the articulation of information needs, the information products required and product specifications; and how information products generated by external sources including RPAS could be more-or-less automatically ingested into existing agency information systems. These specifications likely already exist in many agencies but are not always in a form that is accessible to the RPAS sector or other ISR providers.

RECOMMENDATION 2

As far as practicable, Australian fire and emergency agencies should publicly articulate their information needs and publish (and regularly review and update) data and information product standards and product integration standards and procedures.

9.4 Flight authorisation process

As described above, industry participants were required to seek authorisation from CASA for operational trial flights. This involved developing and submitting detailed applications to CASA. All successful applications took more than five months to process, for what could be argued were relatively straightforward and low-risk flights. The timeliness of the current, published standard CASA process for authorisation of BVLOS flights by RPAS is clearly not compatible with emergency management requirements. It is reasonable to assume that the currently published standard process was not intended to service emergency situations.

CASA is prepared to authorise RPAS BVLOS flights at short notice in ongoing emergency situations and has reportedly done so on several occasions in the past. However, this approach does not appear to provide a sustainable or transparent longer-term solution or provide the consistency and reliability that is required to underpin capability development and procurement. The project formed the view that ultimately some form of structured pre-authorisation for ReOC holders to conduct BVLOS flights in emergency management situations will be required if BVLOS RPAS are to become a mainstream capability supporting fire and emergency management in Australia.

Enduring area authorisations provide a possible pathway, whereby CASA provides ongoing authorisation for approved operators to undertake RPAS BVLOS flights within a defined geographic area or in accordance with a defined set of conditions. It is understood that the previously mentioned (section 6.2) area approval has proven to be an effective approach in a specific geographic area. Again, however, enduring geographic area authorisations are only likely to be applicable in a limited range of fire and emergency situations, which are generally unpredictable in location and scale.

The relative rigidity of the published authorisation process and resultant Instruments of Approval is also not well aligned with the emergency management context. While the SORA methodology does make some provision for dynamic situations such as where population density changes during an emergency event through relocations or evacuations, the long lead times effectively require an applicant to assume "worst case scenario" (e.g. that people are actually present at a population node) at the time of application, possibly many months in advance of the actual operation, and authorisations are constructed on that basis. However, that scenario may not exist at the time that flights are conducted. Previously it was mentioned (in relation to changes in IFR standard routes) that other aspects of the operating environment may change in between the development of a CONOPS and issuing of a flight authorisation. Flight authorisations that were in-effect issued by a pre-approved ReOC holder immediately prior to flight would not be affected to the same extent by changes in the operating environment.

Some apparent inconsistencies in CASA Instruments of Approval issued for operational trial flights were observed. An example would be that one participant was authorised to fly their RPA up to 4,300' AMSL during daylight, whereas a different participant was limited to flight at or below 500' AGL during daylight. It is accepted that the final authorisations reflect overall, combined risk levels and that the different risks associated with flying height may have been balanced elsewhere. Nonetheless the project did not observe any obvious reason why the second participant should not also have been authorised to fly up to 4,300' AGL. Arguably this may have reduced some risks (refer to discussion at 9.5.6.1 below). Another example related to the requirement for ground observers in one Instrument of Approval, while ground observers were not required for other participants.

It is possible that these apparent inconsistencies to some degree reflect assumptions made by each participant in their application for authorisation. In effect, the current standard CASA authorisation process requires applicants to develop their CONOPS based on some assumptions about the risk controls that will be required to achieve an acceptable SAIL. Controls proffered by the operator that may not actually be required in the final analysis could still end up being built into the approval. One possible way of dealing with this issue, within the published standard approval process, would be for CASA to provide some initial feedback to applicants after receiving an application, thereby allowing applications to be refined before proceeding to detailed assessment. CASA provided preliminary feedback of this type to at least one trial participant and this feedback was considered by that participant to be most useful. This type of feedback may also ultimately reduce application assessment and processing times later in the process.

RECOMMENDATION 3

CASA consider formal inclusion of an option for providing feedback to an applicant, where applicable, at an early stage of the published standard RPAS BVLOS operations authorisation process.

The project team could not help but question the merits of requiring a specific CASA authorisation for an operator to conduct individual BVLOS flights or a series of flights.

The RPAS operators who participated in the operational trials are highly capable, professional organisations with sophisticated systems including for flight planning and operational control, safety management and risk management. They have considerable investment in hardware and infrastructure. The RPAS flown were highly developed platforms with sophisticated control systems and redundancy. Backup systems and recovery from abnormal operations were successfully demonstrated during the trial. RPAS operators planning BVLOS flights are already making their own assessments of air risks and ground risks and applying controls using the SORA methodology, based on a CONOPS also developed by the operator, as this material is required to be submitted at the start of the published flight authorisation process.

A process more consistent with conventional general aviation would see CASA authorising an RPA operator to conduct BVLOS flights more generally, through the ReOC and approved Operations Manual processes, and allowing the operator and approved pilots to then authorise individual BVLOS operations within prescribed parameters, using a prescribed risk assessment methodology. This type of approach would also be more consistent with the way other similar jurisdictions[20], appear to be heading and would presumably allow CASA to direct additional resources to more complex operations and to focus on ensuring that operators who are generally approved to authorise and conduct BVLOS operations continue to meet appropriate standards. As noted earlier, CASA has recently indicated that they are now exploring pathways towards enduring approvals for broad area operations[21].

SORA certainly appears to provide a reasonable framework for assessing risks of RPAS BVLOS flights, however it could be argued that there is some room to apply certain elements more flexibly, at least in the emergency management context. One issue is around the interpretation of population density used to determine intrinsic ground risk. Despite occasional instances of possibly slightly elevated population (e.g. a camp or function centre), by any reasonable measure the overall population density of the originally proposed trial operating area could be described as relatively low. However, to achieve SAIL II it was still necessary for all applicants to "carve-out" certain localities from the area of operations, potentially affecting achievement of mission objectives. The project formed the view that constraining the area of operations in this manner did not necessarily manifestly reduce overall risk, or that practices were available to manage ground risks within a less constrained area of operation. This is discussed in more detail at section 9.5.5.

In considering emergency management operations, it could be argued that there is also a need to balance aviation risks with risks to people and communities associated with the emergency itself. This is an inherent dilemma. Would the wider Australian community accept higher-than-normal risk for an aviation operation if that operation would potentially reduce the overall risk to a local community by providing critical information about a bushfire or flood? There does not appear to be an obvious mechanism or pathway for making this type of decision. The project understands that such decisions would effectively be outside CASA's legislative mandate, which is focussed only on aviation safety.

OBSERVATION 3

There is currently no clear mechanism in Australia for balancing aviation related risk with broader community risk in emergency situations, when making decisions regarding RPA operations.

FINDING 2

The current published standard process for CASA authorisation of RPAS BVLOS operations is not compatible with emergency management (and is likely not intended to be). While alternative, more timely pathways are available, these are not seen as sustainable longer-term solutions.

RECOMMENDATION 4

Key recommendation

CASA, with support from the RPAS industry and the fire and emergency sector, continue to develop sustainable, practical RPAS BVLOS flight authorisation procedures that will provide for timely authorisation of BVLOS flights for emergency management purposes.

A key objective should be pre-authorisation of suitable ReOC holders to conduct RPAS BVLOS flights in defined circumstances.

(20) From 4th November 2025, low complexity BVLOS operations (mainly below 400' AGL) will be possible in Canada without requiring specific authorisation. Higher complexity BVLOS operations will still require a Special Flight Operations Certificate (SFOC), however a SFOC may be issued on an ongoing basis. https://tc.canada.ca/en/aviation/drone-safety/2025-summary-changes-canada-drone-regulations accessed 04 September 2025. In the U.S.A. the FAA has issued a Notice of proposed Rulemaking to "normalize" BVLOS operations, albeit this currently seems aimed more at applications such as food delivery. https://www.faa.gov/newsroom/beyond-visual-line-sight-bvlos, accessed 4 September 2025.

(21) https://www.casa.gov.au/broad-area-bvlos-operations, accessed 01 October 2025 (as previously referenced).

9.5 Operational considerations and limitations

9.5.1. Controlled airspace

None of the successful applications for authorisation of the operational trial flights sought approval for flight in controlled airspace[22] (CTA). The respective participants considered that the mission objectives could be met without having to enter the overlying CTA. As such, authorisation processes and procedures for entering and conducting RPAS BVLOS flight in CTA were not tested.

It can be expected that there will be demand to routinely fly RPAS BVLOS in CTA for emergency support purposes in the future. Presence of controlled airspace is normally associated with population centres, which in turn is linked to a higher prevalence of emergency situations that pose risks to communities.

The project noted that Airservices Australia (ASA) has currently published defined procedures for RPA to enter CTA[23]. ASA and CASA have also collaborated to provide automated approvals for RPA of less than 25kg MTOW operating in daylight to enter CTA associated with specified airports, in certain circumstances. ASA and CASA intend to continue to broaden the applicability of automated approvals. For circumstances where automated approvals are not applicable, ASA has undertaken that, in general terms, operations in CTA will be facilitated. Where the RPA equipment levels and capability of the RPA reflect those of conventionally piloted aircraft, ASA may also provide Air Traffic Control services. Broadly this means that the RPA must be fitted with a certified transponder or ADS-B Out device and a suitable navigation system and the RPA pilot must maintain continuous communication with Air Traffic Control. The operational trial did demonstrate that these requirements should be practical and achievable, and indeed are desirable in any case.

Trial participants reported anecdotally that Australian military airspace authorities have also generally been prepared to accommodate civilian BVLOS RPAS operating in support of emergency response in military CTA, provided that communication and conspicuity requirements are met. RPAS BVLOS trials and demonstrations have also been accommodated in military CTA.

As such, although not formally tested in the trial, it is realistic to expect that RPAS BVLOS can be safely operated in CTA to perform fire or emergency related tasks, provided that the respective ASA and CASA or military airspace authority procedures and standards are followed. In fact, operating in CTA is likely to significantly reduce air risks, and therefore lower the overall SAIL.

Although the applicability of automated approvals is expected to broaden, in the short to medium term it is likely that most RPAS BVLOS flights associated with emergency response will be of a category that will still require a specific CASA authorisation for flight in CTA. Therefore, any future process for providing BVLOS flight authorisations in timeframes consistent with emergency management should also account for providing parallel, timely authorisations for BVLOS flight in CTA, where required.

ASA is continuing to actively evolve and refine procedures for entry of RPA into controlled airspace. It would be prudent for the fire and emergency sector, the RPAS industry and ASA to maintain close liaison to ensure that further developments continue to appropriately reflect emergency management needs.

OBSERVATION 4

There are existing procedures for RPA to enter controlled airspace. RPA that have the capacity to operate in controlled airspace without undue delay (i.e. can take advantage of automated approvals or are equipped to meet Airservices Australia and CASA criteria for non-automated approval or are equipped to meet military airspace authority requirements) will offer improved utility for fire and emergency support in many circumstances.

OBSERVATION 5

Any future process for providing BVLOS flight authorisations in timeframes consistent with emergency management requirements should also make provision for providing parallel, timely authorisations for BVLOS flight in CTA, where required.

OBSERVATION 6

There would be benefit in the fire and emergency sector, the RPA industry and Airservices Australia establishing an ongoing formal liaison mechanism. This could potentially be achieved by inviting participation in relevant sessions of existing mechanisms.

(22) For the purposes of this report, controlled airspace is regarded as any civil airspace other than Class G, plus military CTA or restricted areas.
(23) https://www.airservicesaustralia.com/industry-info/unmanned-aerial-systems-in-controlled-airspace/, accessed 17 September 2025.

Image: Wedgetail Aerospace

In recent years, the use of uncrewed, remotely piloted aircraft systems has increased significantly as platform and payload capabilities have improved and relative costs have decreased.

9.5.2. Uncontrolled aerodromes

One trial participant's CONOPS envisaged RPAS BVLOS operation from Ararat airport, a licensed, uncontrolled aerodrome regularly used by conventional aircraft. In turn this operation was authorised by CASA as part of the BVLOS approval process. Ultimately this particular trial operation could not proceed due to weather, staffing and logistical issues, however a simulated operation was undertaken. Another trial participant operated from an un-licensed, uncontrolled aerodrome (Raglan aerodrome) that is not regularly used by conventional aircraft but is potentially suitable for such operations and is marked on relevant aeronautical charts.

Uncontrolled aerodromes are likely to be a "go-to" site for urgent RPA operations supporting emergency management, whether BVLOS or otherwise. Often they will have facilities and movement areas that allow an RPAS operation to be established expeditiously.

Many RPA operations from or in the vicinity of uncontrolled aerodromes will not necessarily require prior CASA authorisation, however where crewed aircraft are routinely operating, specific CASA authorisation to operate from the aerodrome may be required in some circumstances. It will generally be prudent to assume that crewed aircraft will be operating from aerodromes[24] in the vicinity of a bushfire or other emergency event.

Although not tested in the field, the project did not observe any reason why BVLOS RPAS could not operate safely from or in the vicinity of an uncontrolled aerodrome where crewed conventional aircraft were operating, including in designated no-fly zones, provided that suitable procedures were established and followed.

Therefore, any future process for providing RPAS BVLOS flight authorisations in timeframes consistent with emergency management should also account for providing parallel, timely authorisations for operations from uncontrolled aerodromes, where required.

OBSERVATION 7

Where there is a requirement for a BVLOS RPAS to operate from or in the vicinity of an uncontrolled aerodrome, this can be practical and safe, provided that appropriate procedures are followed.

OBSERVATION 8

Any future process for providing RPAS BVLOS flight authorisations in timeframes consistent with emergency management requirements should also make provision for providing parallel, timely authorisations for BVLOS RPAS flight from or in the vicinity of uncontrolled aerodromes, where required.

9.5.3. Visual Meteorological Conditions

The ability to fly RPA BVLOS in non-VMC, whether at the task location or in-transit, will be an important capability for RPAS supporting fire and emergency operations. Flight in non-VMC conditions such as fog, mist, haze, smoke or cloud is highly likely to be large part of the niche where BVLOS RPAS will provide significant utility, being able to undertake critical intelligence gathering and other tasks where alternative means, including via conventional aircraft, are less practical or limited in some way. Flight of an RPA in non-VMC conditions is BVLOS flight.

Participants did not seek to operate RPAS BVLOS in non-VMC during trial flights, and accordingly, did not seek CASA authorisation to operate in non-VMC. For the participants who conducted operational trial flights, this required maintaining a horizontal visibility greater than 5,000 metres and remaining clear of cloud, during daylight and at night.

As such, authorisation processes and procedures for conducting non-VMC RPAS BVLOS flights were not directly tested in the operational trial. Having said that, BVLOS flights conducted during the trial effectively provided a partial surrogate for non-VMC flight in that the RPA was not visible to observers for significant proportions of the flight. The project did not identify any procedural reason why non-VMC flight by suitable RPA would not be practical or safe. The project team was also briefed on several examples of where RPA flight in non-VMC had been demonstrated in the past.

As with flight in CTA, RPA flight in non-VMC is generally likely to see a reduced air risk, as there is higher probability that other aircraft in the vicinity will be following prescribed deconfliction procedures and will be electronically conspicuous.

For non-VMC flight, ReOC holders would need to incorporate appropriate procedures, including RPA pilot training requirements, in their CASA-approved Operations Manuals. In some cases, it will be necessary to evaluate the airworthiness of the RPA to fly in non VMC-conditions, or a subset of non-VMC conditions. One trial participant indicated that their RPA was technically capable of flying in haze or smoke, but not in visible moisture.

Ultimately the project formed the view that developing a capacity to fly RPAS in non-VMC will clearly improve the ability of the sector to fill an identified capability gap and to meet the needs of fire and emergency agencies.

OBSERVATION 9

Further developing the capacity for RPA to fly BVLOS in non-Visual Meteorological Conditions is likely to significantly increase the utility of RPAS in fire and emergency management.

(24) "Aerodromes" includes Helicopter Landing Sites (HLS)

9.5.4. Night operations

All participants who received CASA approval for trial flights sought and received approval to conduct trial flights at night (after the end of civil twilight), as well as during daylight.

In two cases, the approval to fly at night had less stringent conditions regarding maximum heights to be flown than the parallel daylight approval, presumably reflecting the likely lower risk of encountering un-notified air traffic at night.

During the trial, two night flights were successfully conducted on separate days by different RPA.

No unforeseen problems or issues associated with flight at night were observed. Interestingly, as each RPA was equipped with strobing or flashing recognition lights it was relatively easy in the prevailing conditions to maintain visual contact with the RPA at distances well in excess of 5 km.

Provided appropriate infrastructure is in place (such as lighting of launch and recovery sites) and appropriate procedures are followed, flight at night by BVLOS RPAS proved to be practical and safe.

Both RPAS flown at night were equipped with EO/IR gimballed sensor packages. Both cameras, even in visual EO mode, were able to clearly identify terrain features from heights above 500' AGL. Both IR sensors were able to identify temperature differentials associated with medium size animals (e.g. wallabies) on the ground. Both RPA were able to complete all assigned simulated emergency tasks at night.

One trial participant reported that their Operations Manual stipulated that reconnaissance of the area of operations during daylight is required prior to any night flight. It is assumed that this provision is primarily intended to allow for identification of uncharted vertical obstructions.

While it was practical to undertake daylight reconnaissance for trial operations, this may not always be the case during emergency response events. During the trial it was observed that, at least for ISR flights at night, it would be relatively straightforward to adopt procedures similar to those applied in conventional aviation to assure obstacle clearance without requiring a daylight reconnaissance. Mainly these procedures dictate minimum enroute flying heights (referred to as minimum safe altitudes) as well as obstacle clearance practices around take-off and landing.

As with non-VMC flight, the capacity to fly RPA BVLOS at night will improve the ability of the sector to fill a capability gap and to meet the needs of fire and emergency agencies.

FINDING 3

RPAS BVLOS flight at night is practical and safe, provided that appropriate, proven procedures are followed and appropriate facilities are in place.

OBSERVATION 10

RPAS BVLOS flight for ISR purposes can be safely conducted at night without requiring prior reconnaissance of the area of operations in daylight, provided that appropriate procedures are followed.

OBSERVATION 11

Further developing the capacity for RPA to routinely fly BVLOS at night is likely to increase the utility of RPAS in fire and emergency management.

Wedgetail Aerospace Anavia HT-100 preparing for night operations during trial – Image: FRV

Image: FRV

9.5.5. Ground risk mitigation

9.5.5.1. Area of operations

As noted earlier, the area of operations for BVLOS RPA authorised in the CASA Instruments of Approval for all trial participants was reduced from the originally planned tasking area for the trial. In applying for CASA authorisation, participants reduced the area of operations to preclude overflying localities where the density of the population on the ground was not consistent with achieving SORA SAIL II or lower. Reductions of the operational area also considered the need for buffer zones (known as contingency volumes).

As it transpired, participants who obtained an Instrument of Approval with a reduced area of operations were able to complete ISR tasks that were within the original planned tasking area but outside of each approved RPA area of operation. This was achieved by directing gimballed EO/IR sensors to look outside of the approved operating area.

A fourth participant lodged an application that did not initially reduce the area of operations but resulted in an assessed initial SAIL of III. Advice from CASA indicated that it was unlikely that a SAIL III application could be processed in a timeframe that would allow for participation in the operational trial. The participant therefore revised their application to achieve SAIL II. However, this required operating at not-above 400' AGL in a considerably reduced the area of operations, as illustrated below. It would not have been practical to complete the assigned tasks with these constraints, irrespective of sensor capabilities. As such, this participant did not proceed with the SAIL II application. The project noted that a different applicant who operated the same type and category of RPA did receive CASA authorisation for a SAIL II operation with fewer constraints on the approved area of operations and maximum flying heights.

For those participants who did receive Instruments of Approval, in each case the reduced areas of operation and the need to direct gimballed sensors outside of these areas to complete their tasks resulted in some compromises. The RPAS took longer to achieve search tasks under these conditions, with viewing angles being less than ideal. This problem is exacerbated when the operating area limitation is combined with a not-above 500' AGL stipulation for the RPA (see section 9.5.6.1), further compromising viewing angles and sensor footprints.

During the trial it proved practical for EO/IR sensors at 500' AGL to adequately identify ground features at a distance of around 2 km. All participants indicated that greater distances would be possible, however clearly there will be limits as to how far a sensor can "see", and it is generally preferable that any ISR target area is within the RPA area of operations. For some future non-ISR tasks, such as package delivery or incendiary dropping the task location will necessarily have to be in the RPA area of operations.

When operating areas are limited by ground risk considerations, depending on the type of payload, the category of RPA and the nature of the task, there is also likely to be a trade-off with approved maximum operating height or altitude. Greater height AGL will provide a potentially larger sensor footprint (albeit at lower resolution) and better view angles. However, in some cases, operating at a higher level may see a need to increase the contingency volume as the RPA could travel further during abnormal operations. This would effectively reduce the area of operations.

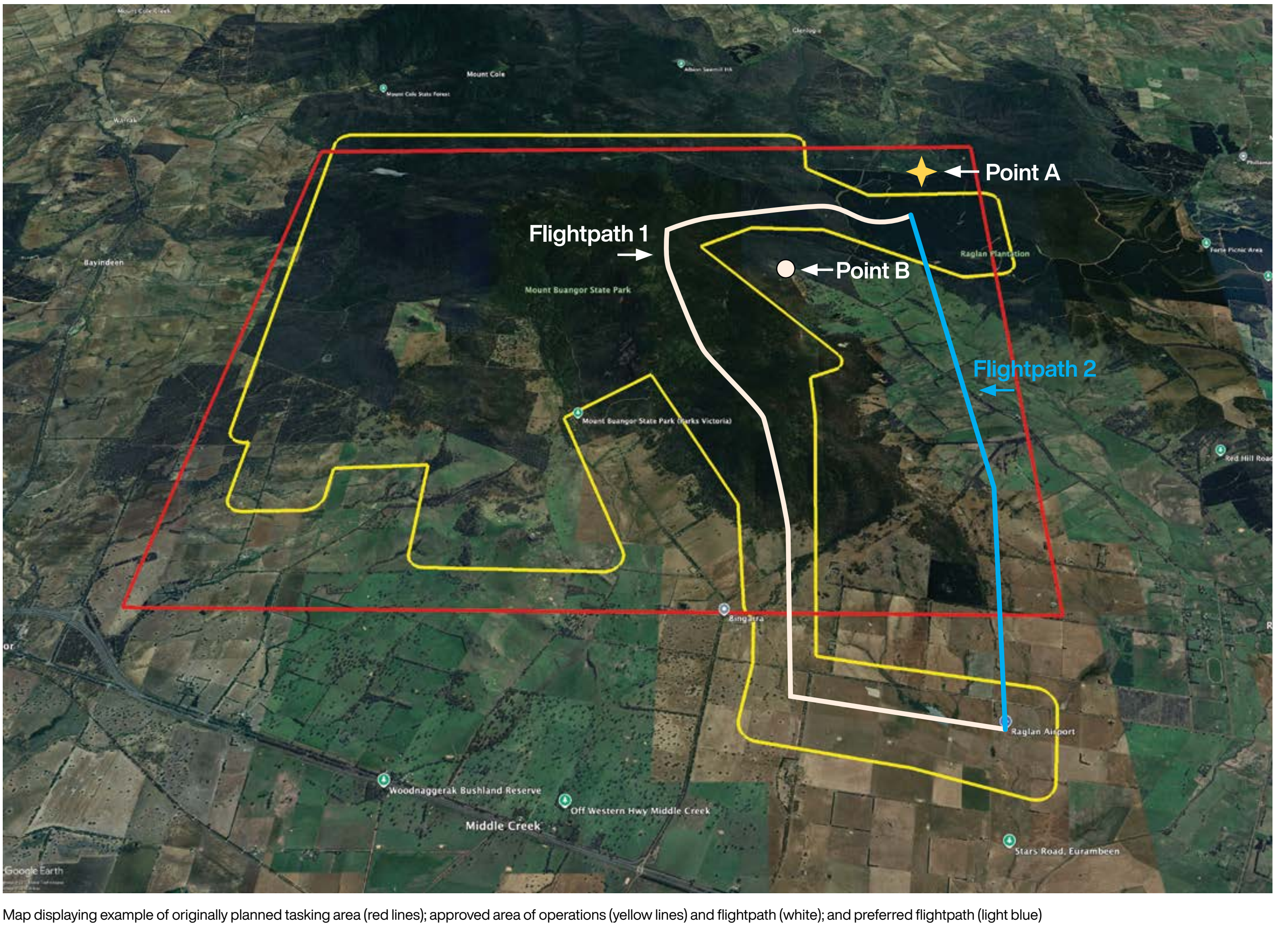
A key issue identified is that constrained areas of operation also created a need for somewhat convoluted and relatively inefficient RPA flight paths, and arguably increased risks to the RPA itself.

Map displaying trial participant's reduced area of operations (green shading) with contingency volume (yellow lines) for SAIL II application against originally planned tasking area (red lines) – Image: Trial participant, Google Earth

In the following example, the red lines delineate the originally planned FRV tasking area, and the yellow lines delineate the approved area of operation for one RPA (including contingency volumes). Note that this example represents the least restrictive area of operations approved for any trial participant.

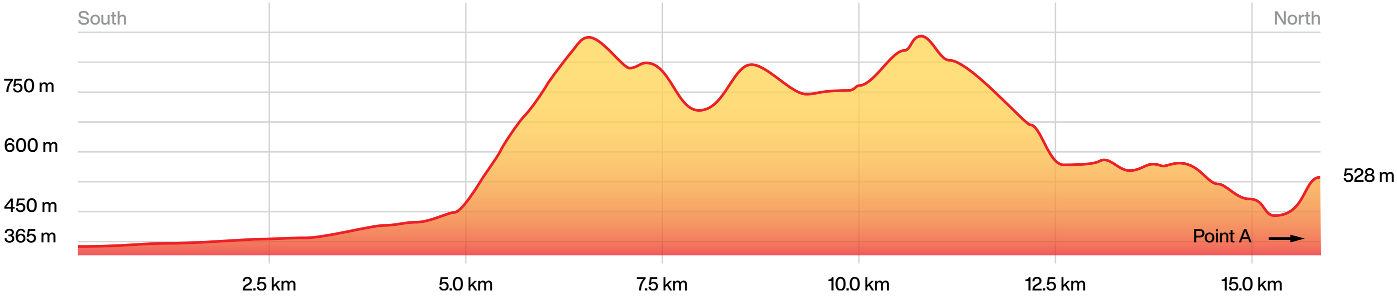
Point B is a population node (a commercial accommodation and function centre), which ultimately influenced the shape of the approved area of operations, as the associated gridded population density in that locale would have been higher than in the immediate surrounding area, albeit still relatively low.

The white line, "Flightpath 1" represents the approximate path required to be taken by the RPA to remain in the approved area of operations and reach a point where it could commence an EO/IR search task initially centred on Point A. The light blue line, "Flightpath 2", represents a hypothetical, preferred path to the same point that was discounted by ground risk considerations. Note that the approved path is some 50% longer than the preferred path.

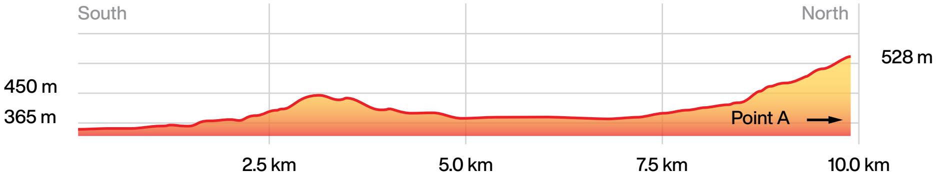


Map displaying example of originally planned tasking area (red lines); approved area of operations (yellow lines) and flightpath (white); and preferred flightpath (light blue)
Image: Google Earth annotated by trial participant and FRV

The following images compare profiles of the terrain under the same flightpaths, at approximately the same vertical and horizontal scale:



Terrain profile under flightpath 1 (RPA remains in approved operations area) – Image: Google Earth



Terrain profile under flightpath 2 (preferred flightpath) – Image: Google Earth

TABLE 4 KEY CHARACTERISTICS OF EACH FLIGHTPATH:

	Flightpath 1 (approved)	Flightpath 2 (preferred)
Length (one -way)	15.9 km	9.84 km
Starting/finishing elevation AMSL	365 m / 528 m	365 m / 528 m
Maximum elevation of terrain traversed AMSL	893 m (enroute)	528 m (at destination)
Terrain elevation gain/loss enroute	941 m / 768 m	250m / 86 m
Average slope traversed	9.9% to 11.3%	2.9% to 3.6%
Maximum slope traversed	35.7%	15.3%

Note that it would not have been practical for the exemplar RPA to follow flightpath 1 had it also been subject to a not-above 500' AGL limitation, as the climb and descent gradients required would have exceeded the capability of the RPA.

In short, an effective requirement for the RPA to fly flightpath 1 to reach the task near Point A appeared to be somewhat counterintuitive to good practice. While this route takes the RPA over more-or-less unpopulated areas, it requires the RPA to fly further and over higher, more-dissected terrain. In the conditions that prevailed in the operational trial, this subjected the RPA to stronger upper winds and significantly greater mechanical turbulence. As well as potentially posing increased risk to the RPA itself, this results in greater energy consumption and reduced endurance and range. There is also a higher probability of terrain shielding of communications links.

Although flightpath 2 does take the RPA over an area with scattered residences, the overall population density along the route could still reasonably be described as low. In addition, it was demonstrated during the trial that the RPA pilot had access to the tools required to be able to fly the RPA along that route and interactively make the adjustments necessary to avoid overflight of population nodes, with an adequate buffer, and therefore reduce ground risk.

It is also worth noting that it is understood that the population node at Point B, a small commercial accommodation business, was largely unoccupied at the time of trial flights, however there was no apparent pathway to revise the assessment of ground risk accordingly, which may in-turn have enabled increasing the approved area of operations.

It is accepted that this example is limited in scope and that insufficient data was available to perform a numerical analysis of the respective risks associated with the alternative routes. Nonetheless, the project considered that the example does illustrate some concerns regarding rigid application of SORA and the possibility of generating some arguably less-than-optimal outcomes, with the prospect of increasing overall risk in some instances.

A further caution regarding SORA is that it may potentially see RPA operators applying risk mitigations to achieve a threshold SAIL, but this does not necessarily mean that the lowest overall combined residual risk for a planned operation will be achieved.

FINDING 4

SORA provides a workable framework for assessment and planning mitigation of risk for BVLOS RPA operations. However, detailed application of SORA, particularly in relation to assessment of ground risks in areas of relatively low population, should allow flexibility to consider and accommodate reasonable alternative scenarios.

9.5.5.2. Transport corridors

Flightpaths for one participant's RPA to transit to the approved area of operations required flight over a two-lane interstate highway with a relatively high traffic volume; and an adjacent single-track railway that forms part of the Melbourne to Adelaide rail corridor. It is understood that overflight was approved on the basis that flight over these corridors at right-angles posed only a transient, very short-term risk. Also, persons in the corridors were likely to be shielded from the impact of an out-of-control RPA in that they would be within a vehicle.

The project considered this to be a suitably pragmatic approach. Limiting the ability of BVLOS RPAS to cross transport corridors is likely to be problematic in emergency situations, noting that in many instances, ground traffic volumes will be reduced in any case or can be managed if required. This is also an example of where it may be appropriate to accept an almost negligible increase in aviation-related risk in the interest of reducing overall risk to the community affected by an emergency incident.

OBSERVATION 12

Where there is a requirement for a BVLOS RPAS to cross transport corridors to support fire or emergency activities, the RPA operation (and ground conditions if necessary) can be managed to ensure that the risk to persons on the ground is not materially increased.

9.5.5.3. Parachutes

Some RPA can be fitted with parachutes to mitigate ground risks in the event of abnormal operations. This type of facility may potentially permit operation of RPAS BVLOS in areas where the population density is not otherwise compatible with an acceptable SAIL.

One of the RPA scheduled to be tested in the trial has been fitted with a parachute in a different jurisdiction. However, the project was advised that this incurred significant penalties in performance and payload and was only likely to reduce ground risk in a very limited range of circumstances. Ultimately the project was not in a position to draw any firm conclusions regarding the efficacy of parachute type devices to reduce ground risks but did note the potential performance compromises for some RPA.

9.5.6. Air Risk mitigation

9.5.6.1. Not-above 500' AGL

A condition of CASA authorisation to operate certain BVLOS trial flights was that the RPA was to remain at or below 500' AGL (and above 400' AGL). This not-above 500' AGL stipulation applied to some, but not all, daylight BVLOS flights. It did not apply to any BVLOS flights at night. It is understood that the not-above 500' AGL restriction is intended to mitigate air risk, as conventional aircraft are legally required to fly at or above 500' AGL in most circumstances. The restriction is not required at night as it is assumed that most air traffic operating at night will be either notified in advance, and/or will be electronically or visually conspicuous, and/or will be communicating on VHF-AM. In other words, the pilot of a BVLOS RPA operating at night will usually be aware of other traffic and will be able to arrange de-confliction.

During trial flight operations the not-above 500' AGL restriction proved somewhat problematic, both from an operational perspective and an air risk perspective. The project concluded that it may not always be logical to extend a not-above 500' AGL stipulation to BVLOS RPA operating at real-world emergency events in daylight or at night.

From an operational perspective, the not-above 500' AGL requirement (combined with the above-400' AGL requirement) effectively required the respective RPA to "terrain follow" in transit and within the approved area of operations. During the operational trials, which required transit over relatively steep terrain, it was found that some RPA would be incapable of meeting climb or descent gradients required to follow terrain directly (as would be the case for some conventional aircraft). One RPA that was subject to the not-above 500' stipulation would have required an initial climb (and reciprocal final descent) gradient of approximately 13% to transit to the task target area via the shortest available path that was within the approved area of operations. As with the example provided in 9.5.5.1 above, this route, over relatively steep intervening terrain, was dictated by operating area constraints associated with managing ground risks. Instead of following the shortest available approved path, in this case the RPA had to take circuitous zig-zag routes in order to achieve appropriate climb and descent rates while complying with the not-above 500' AGL stipulation and remaining within the approved operating volume. In turn this impacted endurance available to complete tasks. Had the not-above 500' limitation not been in place, the RPA could have been flown to a suitable altitude after take-off (likely while still in visual line of sight) and then via a more direct route to the task area.

Terrain following also required extra enroute climbs and descents (e.g. where it would otherwise have been possible to fly from ridgetop to ridgetop during transit) with negative impacts on operating endurance and range.

It was also clearly observed that an effective requirement to follow terrain increases the probability that the RPAS will experience shielding of control and payload communications.

During the operational trial, the airspace layer between ground level and around 500' AGL was most affected by the significant lee turbulence that prevailed in the moderate northerly winds. This had potential to affect the safety of the RPA, but also resulted in higher energy consumption, again affecting available operating endurance and range.

A requirement to remain at 500' AGL or below may reduce the effective field of view for payload sensors, increasing the time taken to complete ISR tasks. This problem is exacerbated when operational volumes are also limited in response to ground risks. Sensors may not always have the capability to "see" terrain outside of the approved operational volume when the RPAS is operating at a relatively low level.

From an air risk perspective, it is questionable whether the requirement to operate at or below 500' AGL will always manifestly reduce air risks. The operational trial project did not have the opportunity to undertake any empirical analysis of the relative risks, but intuitively it would seem possible that some components of air risk may in fact be greater when a BVLOS RPA is required to operate at or below 500' AGL.

There is a higher probability that a BVLOS RPA pilot will be aware of other airspaces users operating above 500' AGL and will therefore be able to arrange deconfliction. Traffic in the above 500' AGL band is generally more likely to be electronically conspicuous, is more likely to be aware of NOTAMs and is more likely to communicate on VHF-AM. It follows that there is potentially a higher risk of un-notified or inconspicuous traffic at 500' AGL. This was reinforced during the trial when a general aviation aircraft flew directly over an RPA launch site at 500' AGL (estimated) without communication on VHF-AM and without apparent electronic conspicuity (noting that such communication and conspicuity was not legally required in those circumstances). It also seems likely that the probability of encountering un-notified recreational air traffic, such as hang gliders, paragliders and so on is increased at relatively low levels. Likewise, there is a higher probability of a BVLOS RPA encountering a vertical obstruction at or below 500' AGL. Some wind turbines and communication towers in the vicinity of the trial operating areas extended to above 500' AGL.

Further, it is likely at an emergency event that a proportion of the air traffic associated with the incident will be flying at or below 500' AGL. An obvious example is firebombing aircraft operating at a bushfire.

OBSERVATION 13

A requirement for a BVLOS RPA to remain at or below 500' AGL is likely to generate operational inefficiencies and may not necessarily reduce air risk. Very careful consideration should be given to likely hazards and risks before incorporating this stipulation in relevant CONOPS and Instruments of Approval, including area approvals.

9.5.6.2. Above 400' AGL

A condition of all CASA authorisations to operate all BVLOS trial flights was that the RPA was to remain above 400' AGL (except during launch and recovery). It is assumed that this measure is aimed at reducing the risk of confliction with other RPA and vertical obstructions.

The density of RPA operations can generally be expected to be relatively high below 400' AGL as the Standard Operating Conditions for RPA, which apply to non-complex operations, limit flights to below 400' AGL. Likewise, the above 400' AGL stipulation reduces the risk of collision with un-notified vertical obstructions, which may extend up to 330' AGL.

The operational trial did not provide an opportunity to properly evaluate this stipulation, other than to observe that maintaining a minimum height in flight of 400' AGL did ensure that the RPA cleared vertical obstructions in the area. As far as FRV and the participants were aware, all relevant vertical obstructions were mapped on relevant charts or recorded in appropriate databases. No un-notified RPA were observed in the operating area during trial flights.

9.5.6.3. NOTAM

Instruments of Approval for all operational trial flights required that a Notice to Air [Missions] (NOTAM) be issued, advising other airspace users of the potential presence of BVLOS RPAS in the vicinity of the planned areas of operation[25]. During the operational trial, NOTAMs were issued around 12 hours prior to planned flights and maintained until flights on a particular day had been completed. Trial participants arranged the respective NOTAMs. Requesting and issuing NOTAMs proved to be a straightforward process. During trial operations, several other airspace users contacted by VHF-AM indicated that they were aware of RPA operations, having accessed the relevant NOTAM.

The project concluded that issuing of NOTAMs provided a practical and readily achievable risk reduction measure for the trial flights, and this experience can be reasonably extrapolated to real-world emergency situations.

It is acknowledged that there are limits to the effectiveness of NOTAMs. Some airspace users may not access that information prior to flight or may otherwise not be aware of the NOTAM. In emergency management situations it will often be impractical to issue NOTAMs until immediately before BVLOS operations commence.

As the amount and density of BVLOS RPAS traffic increases over time there is arguably some possibility of "NOTAM fatigue", which will likely reduce effectiveness of the measure. This can be re-evaluated in the future. In the meantime, it is considered that issuing of a suitable advisory NOTAM should remain a feature of approved RPAS BVLOS operations that are supporting fire and emergency management, in most circumstances. Careful consideration of NOTAM wording and the timing of NOTAM issue and validity periods will help maintain effectiveness as a risk reduction measure.

OBSERVATION 14

Issuing a NOTAM advising other airspace users of a RPAS BVLOS operation is a practical and readily achievable risk reduction measure. Issuing a suitable NOTAM should be regarded as standard procedure for RPAS operating BVLOS in support of fire and emergency management.

The project concluded that issuing of NOTAMs provided a practical and readily achievable risk reduction measure for the trial flights, and this experience can be reasonably extrapolated to real-world emergency situations.

(25) In line with CASR 101.030 (https://classic.austlii.edu.au/au/legis/cth/consol_reg/casr1998333/s101.030.html, accessed 25 November 2025)

9.5.6.4. Broadcasting and communicating on VHF-AM

Approved CONOPS for all operational trial flights required that the relevant remote pilot, or their support crew, continuously monitor appropriate VHF-AM radio frequencies immediately before and during flights. Monitoring of these frequencies can alert the RPAS operating crew to the presence of otherwise un-notified aircraft and assist with maintaining overall air traffic situation awareness. The project concluded that continuous monitoring of the relevant VHF-AM frequencies provided practical and readily achievable risk reduction for trial flights, and that this experience can reasonably be extrapolated to real-world emergency situations.

Approved CONOPS for all operational trial flights also required that the relevant remote pilot, or their appropriately qualified support crew, broadcast the presence of BVLOS RPAS on appropriate VHF-AM radio frequencies. Making a broadcast on VHF-AM requires that the radio operator hold the appropriate certificate of competency. Broadcasts were made immediately prior to take-off, immediately prior to any significant change in the RPAS operation and approximately every 15 minutes during routine operations.

Transient general aviation traffic was experienced in the vicinity of the operating area during trial flights. On one occasion, two-way communication on VHF-AM with the pilot of a conventional general aviation aircraft resulted in that pilot deciding to slightly alter their planned flight path to assure separation from the RPA (noting that the final separation exceeded 10 km laterally).

The project concluded that appropriate broadcasts on the relevant VHF-AM frequencies and communication, where appropriate, with other airspace users on VHF-AM provided practical, effective and readily achievable risk reduction for trial flights, and that this experience can reasonably be extrapolated to real-world emergency management situations.

Again, there are some limitations to the effectiveness of VHF-AM communications. Some aircraft are not equipped with radios, and not all airspace users will monitor or communicate on appropriate VHF-AM frequencies. Terrain shielding of transmissions can occur. Nonetheless, the trial experience demonstrated that appropriate use of VHF-AM radio remains a valuable air risk mitigation measure.

OBSERVATION 15

Continuously monitoring appropriate VHF-AM radio frequencies to optimise awareness of other airspace users during RPAS BVLOS operations is a practical and achievable risk reduction measure and should be considered standard procedure when RPAS are operating BVLOS in support of fire and emergency management.

OBSERVATION 16

Regularly broadcasting, and communicating as required, on appropriate VHF-AM radio frequencies to help assure airspace deconfliction is a practical and achievable risk reduction measure and should be regarded as standard procedure when RPAS are operating BVLOS in support of fire and emergency management.

9.5.6.5. Designation of Airspace

Approvals to conduct RPAS BVLOS flights as part of the operational trial did not require designation of a Temporary Restricted Area (TRA) or Temporary Danger Area to mitigate air risk.

FRV preferred not to request the establishment of a TRA for the trial flights. The absence of restricted airspace more closely mirrors the likely circumstances of actual incipient emergency response operations. Restricted airspace may not be practical in some circumstances. Fire and emergency agencies are conscious of not unduly disrupting commercial aviation activities. FRV and industry partners were also keen to observe the practicality and efficacy of other air risk mitigation measures without the additional protection offered by restricted airspace. These other mitigations proved sufficient in the prevailing circumstances of the operational trial.

As with other air risk mitigations, even restricted airspace has certain limitations. Other airspace users may not be aware of the restriction. Airspace users who are not aware of restrictions are perhaps also less likely to be captured by other mitigation measures, such as VHF-AM radio communication.

Although no empirical evidence was collected, it can be reasonably assumed that establishment of a TRA or TDA would not have offered significantly greater total air risk mitigation for the operational trial flights, given the other measures in place. It is well acknowledged however, that there will be emergency management situations where declaration of TRA is entirely appropriate to enable safe BVLOS RPAS flight, as well as to enable integration with conventional aircraft operations. Applicability would include emergency operations in areas of inherently higher density air traffic, such as in proximity to population centres.

Similarly, where a TRA is already in place to assist with the management and coordination of conventional aircraft supporting an emergency event, this will provide an environment in which RPAS BVLOS flights can be initiated with simplified air risk assessment and mitigation.

OBSERVATION 17

Declaration of a Temporary Restricted Area or a Temporary Danger Area is likely to provide advantageous air risk mitigation for RPA in certain circumstances. This measure should be considered, and implemented when appropriate, when RPAS are operating BVLOS in support of fire and emergency management.

9.5.6.6. Visual Observers

One trial participant's approved CONOPS required the deployment of trained Visual Observers (VOB) at strategic locations around the area of operations and along the route between the launch and recovery site and the operating area, as a measure to mitigate air risks. Training requirements for VOBs are modest, however the project determined that while it may be practical to utilise VOBs in the immediate vicinity of an RPA launch and recovery site, it would rarely be practical or safe to deploy VOBs along transit routes or in the vicinity of the area of operations in real-world emergency situations. Clearly a requirement to deploy visual observers for a BVLOS flight could be regarded as somewhat self-defeating in many circumstances. Alternative air risk mitigation measures, such as monitoring radio traffic, regular broadcasts regarding the presence of BVLOS RPAS on appropriate VHF-AM frequencies, monitoring of electronic conspicuity, advisory NOTAMS and liaison with other airspace users should be considered. These types of mitigators were considered adequate for other approved BVLOS trial flights. The respective participant advised that in most circumstances appropriate designation of temporary restricted airspace is also likely to reduce air risks to a level where visual observers would not be required.

OBSERVATION 18

A requirement to deploy visual observers (VOB) for BVLOS RPA operations, other than in the immediate vicinity of take-off and recovery sites, is unlikely to be practical in many fire and emergency management situations. More practical air risk mitigation measures are available.

9.5.6.7. Time-of-day or day-of-week

One trial participant's CONOPS required that BVLOS flight be conducted on weekdays only, outside the hours between 11:00 and 15:00 AEST, although this restriction was not explicit in the respective CASA Instrument of Approval. This restriction reflected the likely higher density of conventional general aviation traffic in the vicinity of the approved area of operations and the associated entry and exit corridors at these times, based on historical data. In-part, density of traffic is greater at these times due to a higher incidence of training flights originating from local flying schools. The published standard Instrument Flight Rules (IFR) routes in the vicinity also influence traffic density.

The project found this restriction curious, as it can reasonably be assumed that other air risk mitigations will normally be effective for the relevant classes of airspace user. General aviation training traffic will usually be electronically conspicuous, will reliably communicate by VHF-AM and will be aware of NOTAMs. The same can be said for flights following published IFR routes in the vicinity. Mitigations can also be strengthened by direct, advance consultation with relevant flight schools.

Clearly a time-of-day or day-of-week restriction is incompatible with fire and emergency operations. Having said that, it is also reasonable to assume, at least outside of major population centres, that should a fire or emergency requiring BVLOS RPAS support occur, other airspace users are likely to avoid the area unless directly associated with incident response. In turn, risks can be further mitigated, if required, by issuing more specific NOTAMs or by designating Temporary Restricted Airspace.

OBSERVATION 19

A requirement to limit BVLOS RPA flights to a specified time-of-day or day-of-the-week is unlikely to be compatible with most fire and emergency management operations. More practical air risk mitigation measures are available.

9.5.6.8. Relevant events

The CASA Instrument of Approval for the trial participant that envisaged operating from a licenced, uncontrolled aerodrome (Ararat aerodrome) precluded RPA operations during a "relevant event". A relevant event is defined in the CASR as the presence of a crewed aircraft operating in a defined zone (known as the "no-fly zone") of a non-controlled aerodrome or helicopter landing site (HLS).

This requirement applies generally to RPA operations at uncontrolled aerodromes in any case. Although a relevant event did not occur during the operational trials, the project did not observe any reason why it would not be practical to conform with the requirement during fire and emergency operations.

9.5.7. Mixed authorisations

Mixed authorisations in this instance refers to the practice of combining flight authorisations that are applicable to adjacent areas of operation in order to facilitate achievement of a flight. For example, an RPA could be flown within visual line of sight from a take-off point, under the RPA Standard Operating Conditions, and then into an adjoining BVLOS approved operational volume. This may enable a flight to occur when conditions in the immediate vicinity of the take off point were not otherwise compatible with a BVLOS flight authorisation, or where an emergency situation required a change of launch or recovery sites.

CASA Instruments of Approval applicable to the trial flights did not specifically preclude or allow for mixed authorisations. It is fair to say that amongst trial participants there were some differing interpretations of how and when mixed authorisations might be practically applied.

The project did not observe any reason why mixed authorisations would be problematic, providing the requirements relevant to each flight segment are observed. Whatever authorisation is applicable to any segment of a flight, the risks will have been appropriately considered and mitigated for that proportion of the flight. The additional flexibility offered by mixed authorisations is highly likely to be a valuable feature of BVLOS RPAS operations in support of fire and emergency response.

OBSERVATION 20

The project noted some uncertainty about the general applicability of mixed flight authorisations. The project did not observe any reason why mixed flight authorisations should not apply if required.

RECOMMENDATION 5

CASA and the RPA industry collaborate to arrange for consistent guidance on the applicability of mixed flight authorisations involving BVLOS RPAS operations.

9.5.8. Communications

The operational trials provided a good opportunity to understand considerations around control and payload communications with BVLOS RPAS.

Both RPAS flown in the operational trial used essentially line-of-[radio]-sight mesh (networked) radio as the primary means of communication for control of the RPA and payload and for delivery of payload data. LTE (mobile phone data) provided backup for one operator, the other operator utilised multiple mesh radios on different frequencies.

Some transient terrain shielding of radio signals was observed during trial flights of both RPA. Backup systems and redundancy measures readily coped with these situations.

Prior to flight, trial participants used software to model probable signal strengths and possible terrain shielding, and to determine where additional mesh radio nodes might be needed. Radio performance during actual flights very closely followed predicted performance. Signal strength and integrity of primary and backup communications systems were also remotely monitored during all flights.

All systems automatically prioritised control communications over payload communications. Some degradation of payload communications was observed (lower bandwidth and therefore lower resolution imagery) as distance from the respective radio site increased. Depending on the height of the aerial platform at the time, this degradation generally became significant at around 10km from the radio site. This could be problematic in an emergency management situation. Signal degradation could be at least partially ameliorated by using directional or tracking antennas at ground radio sites, or by positioning additional mesh radios at suitable sites in the vicinity of the operating area. Additional mesh nodes could also potentially be airborne.

This is a topic requiring further investigation and potentially the further development of high-reliability communications systems. While it is possible to place multiple meshed radios around or above an operating area for a pre-planned operation, this may not always be practical in an emergency – particularly where the area, or access to the area, is affected by the emergency event. Almost by definition, this is a likely scenario. Similarly, although very capable bonded modem units are available to optimise LTE integrity by using multiple mobile phone providers, LTE cannot necessarily be completely relied upon as a backup to line-of-sight mesh radio, as it is not unusual for mobile phone networks to be compromised during an emergency event.

The project concluded that although the communications systems tested during the trial posed no immediate safety concerns (in that the RPA will respond appropriately to a communications interruption or failure) and are adequate for pre-planned deployments, it would be desirable for BVLOS RPAS supporting fire and emergency management operations to be equipped with higher-reliability, fully redundant communications systems. Utilising satellite-based communications likely presents some possibilities. Store and forward payload communications may also be helpful.

OBSERVATION 21

Modelling of control and payload communications integrity in software prior to flight is a useful measure to assure safety of BVLOS flight and to ensure that a flight will meet mission objectives.

OBSERVATION 22

For many fire and emergency management support operations, RPAS equipped with high-reliability, redundant control and payload communication systems that do not always depend on ground-based infrastructure in the vicinity of the operating area are likely to offer greater utility.

9.5.9. Vertical obstructions

Vertical obstructions can potentially pose a hazard to RPAS flying BVLOS. Although not within any of the approved areas of operation, wind turbines of heights over 500' AGL were present in the vicinity. The height of a communications tower on Lookout Hill, which was within the FRV planned tasking area, also exceeds 500' AGL. In other areas of Australia, electrical transmission lines, especially across valleys, may pose a hazard. BVLOS RPA pilots will not necessarily have the ability to see obstructions as the RPA approaches them and will rely entirely on procedural and technological solutions. In turn these solutions depend on the obstructions being notified to appropriate authorities, and details being made available on maps and in the databases that are used to assure ground clearance when operating RPAS BVLOS. This reinforces the necessity for RPA operators to ensure that systems and software used to guide RPA BVLOS flight are populated by up-to-date, high-quality data..

Structures that extend beyond 100m (330') AGL must be notified to Airservices Australia, Airservices Australia (ASA). SA maintains appropriate databases and ensures that obstructions are mapped on aeronautical charts. However, there is some anecdotal evidence that construction of some tall structures in Victoria, notably wind farm meteorological monitoring towers, may not have always been reported in a timely manner in the past.

OBSERVATION 23

It is crucial the operators of BVLOS RPA access and use up-to-date vertical obstruction data to guide BVLOS flights. Operators should also not assume that all vertical obstructions will be recorded and should take appropriate precautions.

9.5.10. Electromagnetic interference

During the operational trial a real-time desktop simulation exercise was conducted whereby BVLOS RPAS were tasked with examining and reporting damage to critical communications infrastructure on Lookout Hill (elevation 3,747' AMSL, including communications towers). Lookout Hill is within the FRV originally planned tasking area for the trial.

The premise was that the access road to the site had been blocked by fire-related damage. The RPAS operator was to assume that at least some of the communications facilities on Lookout Hill were still operating, potentially radiating electromagnetic (EM) energy. Trial participants were provided with publicly available information regarding licensed EM radiation from the site.

Trial participants were able to successfully demonstrate operating practices that could be expected to adequately guard against the risk of EM interference to the operation of the RPA and still achieve the mission objectives.

OBSERVATION 24

Operators of BVLOS RPAS do need to consider risks of electromagnetic interference to the operation of their RPA and take appropriate precautions. Operational risk mitigation procedures are available and are likely to allow for completion of fire and emergency tasks in most circumstances.

Part of the communications infrastructure at Lookout Hill in 2010
Image: Google Maps

For many fire and emergency management operations, RPAS equipped with high-reliability, redundant communication systems that do not depend on local ground infrastructure are likely to offer greater utility.

Image: FRV

10.

Electronic conspicuity

The electronic conspicuity (EC) demonstration conducted alongside trial operations focused principally on Automatic Dependent Surveillance – Broadcast (ADS-B) technology, where aircraft are equipped with a device that broadcasts the GNSS[26] derived position of that aircraft, and other data, multiple times per second. These transmissions are then received and processed by airborne or ground ADS-B In receivers that are within receiving range of the transponder.

ADS-B Out devices fitted to aircraft, including RPA, must be of a type approved by CASA. Each ADS-B Out device must be assigned a unique, internationally standard code, referred to as a HEX code and in-turn registered to a specific aircraft. HEX codes are allocated by CASA on request. In some cases, HEX codes may be allocated for a specific operation or a defined period. The project team did find this latter aspect somewhat curious, as it does not encourage broad adoption of EC technology.

ADS-B Out devices fitted to aircraft can be incorporated with the aircraft's radar transponder (which imposes information on ATC radar returns) or can be a standalone unit. To achieve full ADS-B functionality, aircraft transponders must operate in a mode known as extended squitter (ES) which broadcasts comprehensive aircraft position information and other associated data[27].

Aircraft-based ADS-B In devices (ADS-B receivers), which can be either portable or permanently installed, can usually display the position of other aircraft equipped with ADS-B Out on an in-aircraft situational awareness display or as part of a more sophisticated Traffic Collision Avoidance System (TCAS). When suitable connectivity is available, some in-aircraft ADS-B receivers also forward the position data received from other aircraft to other users.

Ground-based ADS-B receivers can be purchased off-the-shelf or assembled at low cost[28]. There is an existing wide network of ground-based ADS-B receivers around the world, with many operated by volunteer enthusiasts. Suitably provisioned ADS-B receivers on the ground can display the position data received from ADS-B Out equipped aircraft in real time, but more often directly send the data, via the internet, to an ADS-B integrator. The ADS-B integrator pools data from multiple receivers and adds data from other sources (such as aircraft type, flight plan etc.) and makes this aggregated data available to users. Many integrators will also display ADS-B aircraft positions on a publicly accessible map. Readers may be familiar with popular ADS-B data integrators such as FlightAware, FlightRadar24 and ADSB Exchange, for example.

Mapping and data integration systems or Common Operating Picture (COP) systems that are used by fire and emergency agencies (or may be used in the future) can also interface with ADS-B data integrators to acquire, process, display and store relevant aircraft position data.

It is worth noting that many general aviation aircraft in Australia are equipped with a Mode-S transponder that does not broadcast the full GPS position of the aircraft but does provide altitude information. In many cases ADS-B receivers can still detect the presence of these aircraft and if the ADS-B Mode S broadcasts are received by multiple receivers the geographic position of the aircraft can still be accurately determined.

Many ADS-B receivers, ground or airborne, can be programmed to provide aural or visual alerts regarding the presence or proximity of ADS-B Out equipped aircraft.

Where it is not practical for an RPA to carry an approved ADS-B Out device there is potential to feed equivalent position data from the RPAS Ground Control Station (GCS) to ADS-B data integrators, such that the RPA can still appear on connected maps and displays as if it were equipped with ADS-B Out. This approach is referred to as virtual ADS-B in this report. Although it comes with the limitation that an ADS-B position of the RPA is not transmitted directly to nearby aircraft, standardised adoption of virtual ADS-B Out can still generate significant situational awareness and coordination benefits.

It is also worth noting that all conventional aircraft utilised for firefighting in Australia are equipped with an additional tracking system, referred to as AFAMS[29], that employs satellite communication and forwards aircraft position data to a specialist data integrator[30] at least once very ninety seconds. This means that position data for firefighting aircraft is available even where there are insufficient ADS-B receivers in a locality. While the potential latencies in this system mean that it is not ideal for active aircraft separation, it is a high-reliability system and well suited to providing overall situational awareness for pilots of RPAS and conventional aircraft alike and for management and co-ordination of aerial assets; as well as providing a reliable backup for other systems. It would be relatively straightforward for BVLOS RPAS supporting emergency response activities to participate in the AFAMS system.

(26) Global Navigation Satellite System, which includes GPS.

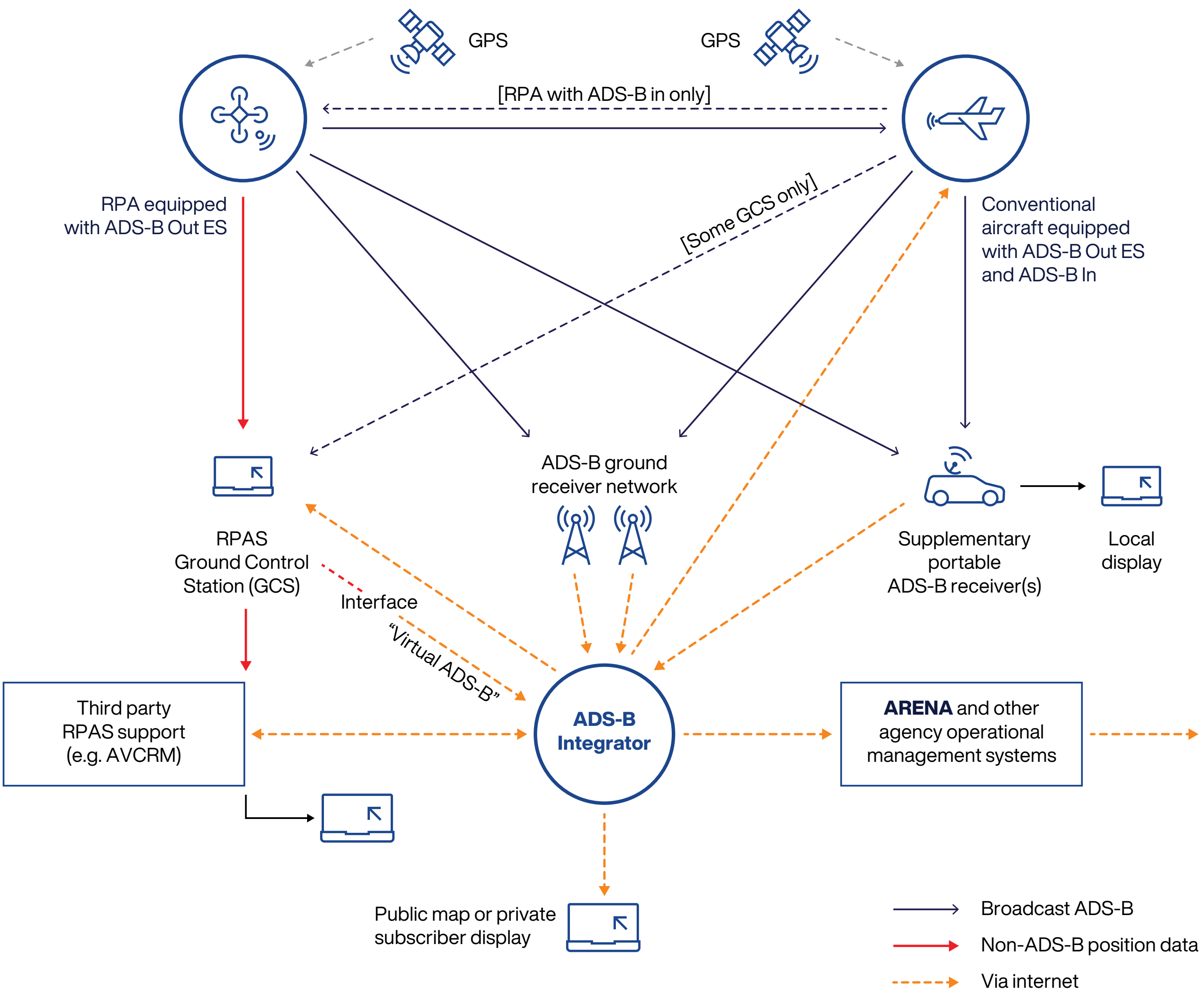
(27) For a more comprehensive outline of capabilities of in-aircraft transponders and ADS-B devices refer to CASA Advisory Circular AC 91-23 v2.0 ADS-B for enhancing situational awareness 2024.

(28) A self-contained receiver with a high-performance antenna could be assembled from components costing less than 300 AUD in July 2025.

(29) https://www.nafc.org.au/wp-content/uploads/2020/11/NAFC-Standard-OPS-014-Tracking-Event-Reporting-and-Messaging-v2020.1.pdf, accessed 18 August 2025.

(30) https://www.tracplus.com/.

SIMPLIFIED REPRESENTATION OF POSSIBLE ADS-B POSITION DATA PATHWAYS



The project considered demonstrating other forms of EC, such as FLARM or TABS (low powered ADS-B) but concluded that as 1090Mhz mainstream ADS-B has already been widely adopted by conventional aviation in Australia and other countries, and as there is an existing and growing network of ground receivers, this technology is most likely to provide the backbone of any reasonably universal air traffic awareness and co-ordination system. ADS-B is also likely to be used in future automated see-and-avoid systems for RPAS. The project did, however, take the opportunity to briefly examine the possibilities offered by Electronic Flight Bag (EFB) providers where a tablet or similar device operating in an aircraft sends the GPS position of the tablet (and therefore the aircraft) to the EFB provider in near real time. This relies on suitable air-ground connectivity, which is usually provided by LTE data through the mobile phone system. In turn, the position data is processed by the EFB provider and made available to registered users on a map. In the future, third-party RPAS support providers, such as AVCRM, who monitor their clients RPA operations in real-time, may also be able to forward equivalent data.

The area of western Victoria where the BVLOS trial flights were conducted is not well served by ground-based ADS-B receivers. To facilitate the EC demonstration, FRV positioned several low-cost, portable, self-contained ADS-B receivers, referred to as field receivers, in the vicinity of BVLOS areas of operation. These receivers were locally monitored in real time on a mobile device connected to the field receiver via conventional Wi-Fi, displaying information on ADS-B Out equipped air traffic within the receiving range. The field receivers also fed the received ADS-B data via the internet to several data integrators for display on publicly available websites using either LTE (4G mobile phone data network) or commercially available, portable, satellite broadband units.

One RPA flown in the operational trial was equipped with a CASA approved ADS-B Out device.

One of the BVLOS RPAS flown in trial flights was not fitted with an ADS-B Out device but was equipped with an onboard ADS-B receiver which forwarded the data received from ADS-B Out equipped aircraft in the vicinity via the normal RPAS control and communication link to a display at the GCS.

During trial flights of the RPA equipped with ADS-B Out, a conventional light helicopter was flown in the general vicinity. The light helicopter was equipped with ADS-B Out and ADS-B In. Electronic conspicuity equipment was used for demonstration purposes only and was not used to aid aircraft separation during flights. Separation was achieved procedurally, and the helicopter remained outside the approved RPA area of operations and at least 5 km distant from the RPA.

The helicopter was equipped with a transponder normally capable of providing ADS-B Out in Mode ES however a technical issue limited transmissions to Mode S (altitude only) during demonstration flights. The helicopter also had a traffic situational awareness display in view of the pilot and co-pilot positions to present ADS-B In data. A further technical issue prevented display of received ADS-B data on the in-aircraft unit.

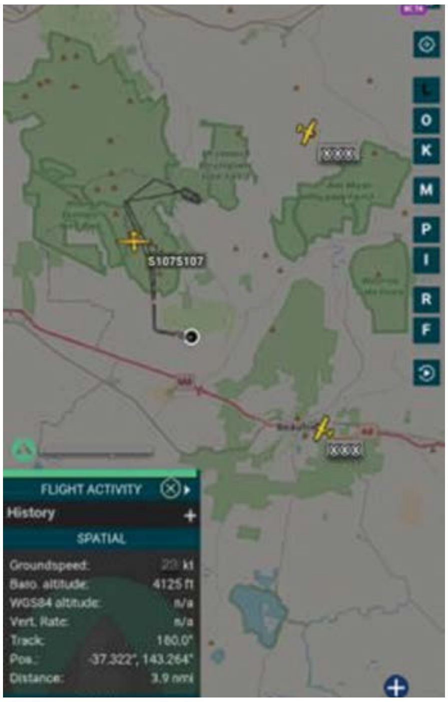
The helicopter also carried a portable EFB – a GPS equipped tablet device connected to a commercial EFB provider via LTE (4G mobile phone). LTE connectivity was available for the duration of all helicopter flights. The EFB tablet reliably forwarded GPS position data to the EFB provider.

Air and ground-based users who subscribed to the respective EFB service were able to view the position of the EFB tablet (and therefore the aircraft) in near real-time.

All trial participants also monitored ADS-B data at their GCS using publicly available ADS-B integrator websites as well as local standalone (not connected to the internet) portable ADS-B receivers with inbuilt displays.

It was observed that all RPA operators were careful to account for potential discrepancies in altitude data sourced from GPS devices and ADS-B transponders, which in-effect use different datums.

The field ADS-B receivers were placed at locations in the general vicinity of RPA launch and recovery sites, outside the approved area of operations. This was intended to mirror a typical emergency management situation, where it is likely to be impractical to place portable equipment within an area directly affected by the emergency. In one field receiver location, LTE coverage was not available at ground level, however the commercial satellite broadband internet service functioned well.



Screengrab from mobile device displaying ADS-B data integrator website, showing relative positions of BVLOS RPA and other low-level traffic (ADS-B data received by FRV portable field receivers and forwarded to integrator) – Image: adsbexchange.com digitally altered by FRV for privacy reasons

Low cost, portable, self-contained ADS-B field receiver – Image: FRV

The field receivers proved effective in reliably receiving ADS-B data from the RPA equipped with ADS-B Out and from other airspace users. In turn this data was forwarded to several ADS-B integrators and was visible via their publicly available websites in near-real-time. Importantly, it was able to be confirmed by analysing data pathways that (other than for air traffic flying at very high altitudes, whose position data was received by other networked receivers at considerable distances from the general area of trial flights) the data would not have been available if the field receivers had not been established.

ADS-B position data was received from the ADS-B Out equipped RPA by the field receivers at distances of up to 12 km with the RPA at 4,000' AMSL and the field receivers at around 1,000' AMSL. Longer distances may have been possible but were not tested. Occasional, transient terrain shielding was observed when the RPA was flown at lower altitudes.

Mode S data was also received from the light helicopter by the field receivers. Insufficient total receivers were available to "triangulate" the actual position of the helicopter, however the data indicated the presence of the aircraft and its altitude. When integrated with other data, the registration and aircraft type were also readily available.

The RPAS that was equipped only with an ADS-B In receiver also reliably received ADS-B transmissions from aircraft in the vicinity. This data was available to the remote pilot in real time at the GCS.

It is worth noting that portable or supplementary ADS-B receivers, servicing the general area of a fire or emergency incident could also be airborne in a conventional aircraft or RPAS. This has previously been demonstrated in Australia[31]. This aircraft could be a BVLOS RPAS carrying out other primary tasks (as was demonstrated during the trial) or could be dedicated to supplementing the ADS-B receiver network and other communications. In a similar vein, it would not be difficult for fire and emergency agencies to permanently supplement the existing ground-based ADS-B receiver network, especially in regional areas where coverage is often lacking. Low-cost, networked receivers could easily be installed at rural fire stations or state emergency service depots, many of which have existing internet connections and antenna mounts. This would potentially benefit all aviation operations at fire or emergency incidents.

During the demonstration it was observed that the EFB on-board the light helicopter displayed GPS position data of the aircraft itself, integrated with ADS-B positions of other aircraft including the ADS-B Out equipped RPA. This ADS-B data (received via the local field receivers) is forwarded to the EFB provider by an ADS-B integrator. As such, traffic awareness information was available in the helicopter even though its ADS-B receiver traffic display was inoperative.

The trial did not have the opportunity to demonstrate virtual ADS-B Out, where an RPA GCS forwards "ADS-B like" position data of an RPA to an ADS-B integrator, EFB provider, RPA support provider or agency common operating picture system. It was noted that all GCS employed in the trial had suitable data available at an accessible interface.

Due to the unserviceability of the light helicopter's in-aircraft traffic display, the trial also did not have the opportunity to examine the ergonomics or efficacy of actively using displayed information or visual or aural alerts to assist with deconfliction. Ideally this aspect would be the subject of further trials and demonstrations.

It is important to recognise some current key limitations and considerations around using EC data. These include:

- currently, ADS-B Out is not mandated for many types of air traffic[32]
- there is a limited range of approved ADS-B Out devices suitable for RPA
- the existing ground ADS-B receiver network can be sparse in some regional locations
- many general aviation and recreational aircraft in Australia are not fitted with ADS-B In receivers or cockpit displays. However relatively low-cost portable units are available
- where situational awareness displays or common operating pictures depend on forwarded ADS-B or EFB data, connectivity may be an issue. Connectivity, especially via LTE, may be limited in some regional locations or may be affected by the emergency incident itself. One potential advantage of ADS-B technology, however, is that aircraft-to-aircraft data does not depend on external communications systems
- sharing of ADS-B data by some ADS-B integrators is affected by commercial considerations. For example, ADS-B position data received by some networked ground-based receivers is not available to all data integrators
- sharing of EFB data by some EFB providers and third-party RPA support providers is also affected by commercial considerations.

(31) Fire Air Traffic Management (FATM) trials during 2024 and 2025 coordinated by FireTech Connect.

(32) At the time of writing, the Australian Government was conducting public consultation regarding extending mandated use of ADS-B. The consultation material includes links to more detailed explanations of ADS-B and options to expand the use of ADS-B in Australian airspace: https://www.infrastructure.gov.au/have-your-say/automatic-dependent-surveillance-broadcast-ads-b-mandate accessed 28 September 2025.

What could be perceived as relatively slow adoption of contemporary ADS-B technology by Australian airspace users is somewhat concerning. An internationally standard technology that can reduce air risks and improve safety of operations is reasonably available and accessible. However, the potential of the technology is limited unless it is more fully embraced by airspace users.

Some of the limitations on sharing and making available Electronic Conspicuity data resulting from commercial considerations are also concerning. Ideally, technology and data that may be important to the safety of flight operations should be open and readily available.

Overall, it was concluded that ADS-B position data from RPA and other airspace users can provide valuable situational awareness for pilots of conventional aircraft and RPA. It was considered that wider use of EC, and ADS-B in particular, has potential to significantly enhance the safety of all RPA operations. It was also clear that use of the technology has the potential to enable safe integration of RPA, whether BVLOS or not, with conventional aircraft.

FINDING 5

Broad adoption of ADS-B technology has potential to significantly enhance the safety of BVLOS and non-BVLOS RPA operations.

FINDING 6

ADS-B technology has potential to help enable airspace integration of BVLOS and non-BVLOS RPA and conventional aircraft.

RECOMMENDATION 6

CASA, Airservices Australia, the RPAS industry and the fire and emergency sector continue to facilitate and promote broader adoption of ADS-B technology by airspace users in Australia, and to remove barriers to adoption of ADS-B technology.

RECOMMENDATION 7

Relevant aviation industry associations work with ADS-B integrators and other providers of aircraft position data (such as Electronic Flight Bag providers and third-party RPAS support providers) to remove commercial barriers to exchange of safety-related data.

RECOMMENDATION 8

The RPA industry in Australia work with ADS-B data integrators and other providers of aircraft position data to develop technical standards for Virtual ADS-B (position data from RPA Ground Control Stations) such that it can be easily integrated with ADS-B data.

RECOMMENDATION 9

Fire and emergency agencies conducting RPA operations; and RPA operators, consider deploying portable ADS-B receivers with traffic displays (or airborne receivers where appropriate) alongside all RPAS operations as standard operating practice. Where possible, portable ADS-B receivers should also feed received ADS-B data to appropriate data integrators.

RECOMMENDATION 10

Fire and emergency agencies conducting RPA BVLOS operations consider requiring the RPA to be equipped, where practicable, with an ADS-B receiver that forwards received data to the Ground Control Station and to ADSB integrators.

RECOMMENDATION 11

Fire and emergency agencies conducting RPA BVLOS operations consider requiring the RPA to be equipped, where practicable, with an ADS-B Out device.

OBSERVATION 25

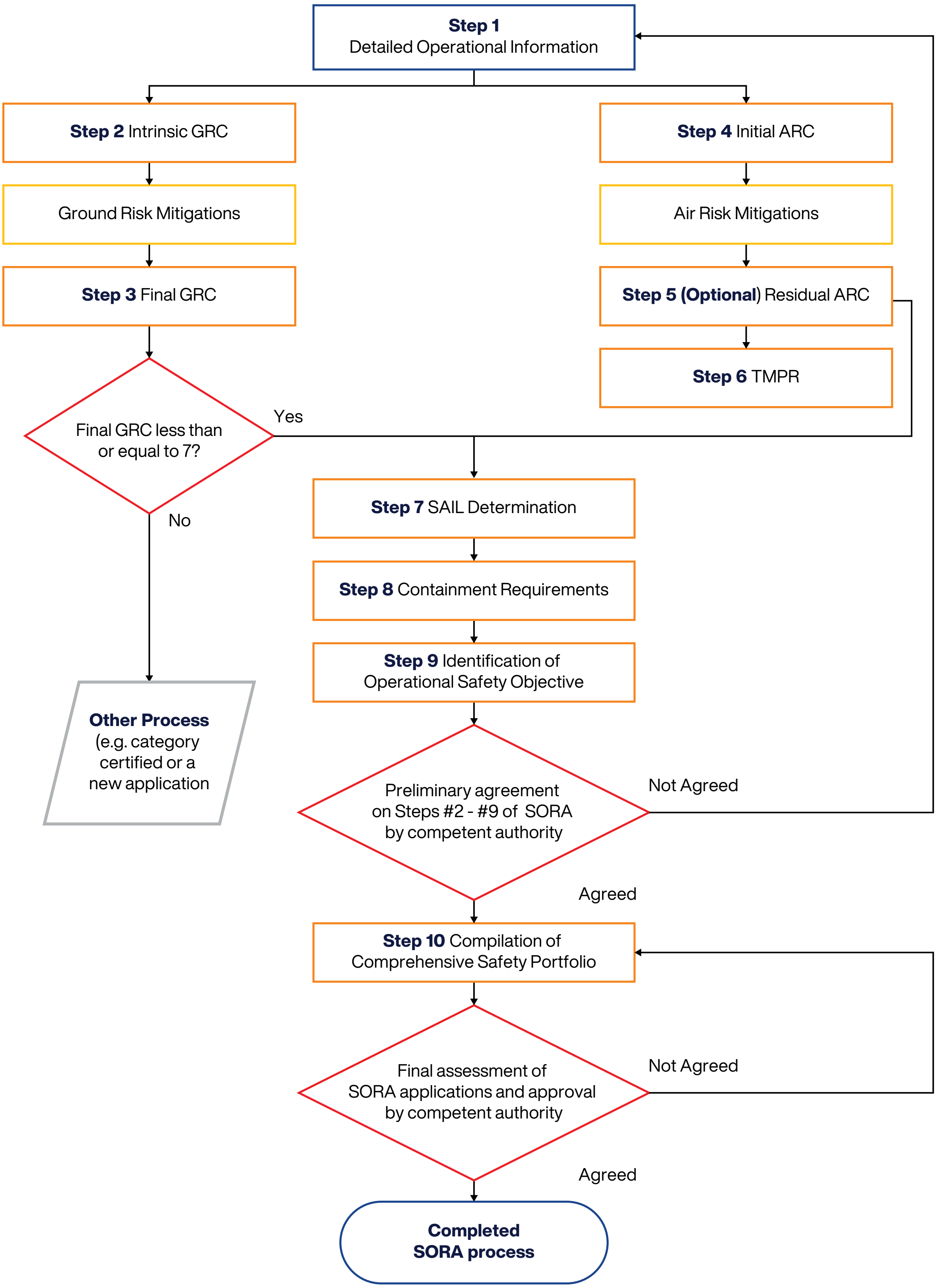
Fire and emergency agencies could consider establishing low-cost networked ADS-B receivers at a range of fixed sites such as rural fire stations and forward received data to appropriate ADS-B data integrators. Priority should be given to complementing existing coverage.

OBSERVATION 26

Automatic see-and-avoid technology onboard BVLOS RPAS operating at fire and emergency events would likely further reduce air risks and address some concerns of other airspace users. Ideally, the RPAS industry would continue to develop and test this functionality.

Appendix 1

SORA METHODOLOGY FLOWCHART



Flowchart reproduced from JARUS SORA Main Body 2.5 AR-DEL-SRM-SORA-MB-2.5 13 May 2024

ARC: Air Risk Class
GRC: Ground Risk Class
SAIL: Specific Assurance Integrity Level
TMPR: Tactical Mitigations Performance Requirements

Appendix 2

Technical Specifications for BVLOS RPAS Trial Expression of Interest

(Some background and introductory information included on the original document has been omitted or paraphrased for brevity).

1. GENERAL

Participants will be required to:

i. obtain the necessary advance regulatory approvals; and to then
ii. mobilise and operate RPAS BVLOS to acquire and transmit imagery and/or data in a range of simulated bushfire scenarios.

2. SITUATION

i. Target areas will generally be in the elevation range of 1000 to 3500 feet AMSL.
ii. Target areas will generally be in areas of relatively low population density.
iii. General locations of the target areas will be available to trial participants in advance, in order to facilitate obtaining required approvals and to allow participants to arrange suitable logistics. Specific detailed tasking within the trial target area will only be made available to participants in a timeframe that reflects actual bushfire operations.
iv. All target areas will be located in areas of Class G airspace to a minimum of 8000 feet AMSL. (Note: this is not intended to require that the RPAS is necessarily operated in Class G Airspace). Participants may propose operation in other classes of airspace, provided that the required approvals can be obtained).
v. In general, participants will be expected to make their RPAS services available for flights on a total of two to three days within in a designated seven-day period.

3. RPAS OPERATOR

	MANDATORY	PREFERRED
General	Must have appropriate approvals and certification by time of trial.	Has organisational experience with BVLOS.
Certification	Can demonstrate that they will hold an appropriate ReOC (or equivalent approval or exemption) by 28 March 2025.	Holds an appropriate Australian ReOC at the time the EOI is submitted.
Approvals	Can demonstrate that they will hold the BVLOS approvals required for trial flights with the proposed platform(s) by 28 March 2025.	Currently holds, or has previously held, some form of BVLOS approval.
Personnel	Can demonstrate that they will have appropriate RePL holders with required approvals by 28 March 2025.	Personnel currently hold appropriate licensing for BVLOS operations in Australia.

4. RPAS PLATFORM (AIRCRAFT)

	MANDATORY	PREFERRED
Configuration	Open (e.g. may be fixed wing, powered lift, multi-rotor or other configuration).	N/A
Maximum take-off weight (MTOW)	Open	MTOW is less than or equal to 150kg.
Endurance	Minimum 30 minutes on target area, plus transit to/from launch/recovery.	Minimum 120 minutes on target area, plus transit to/from launch/recovery.
Range	Ability to operate (maintain continuous control and data communications) at a minimum range of 15 km from the launch/recovery site(s).	Ability to operate (maintain continuous control and data communications) at a minimum range of 40 km from the launch/recovery site(s).
Ceiling	Open	Open
Powerplant	Open	Open
Environmental conditions	Able to operate in 0 degrees Celsius to +45 degrees Celsius (surface temperature). Able to launch, fly and recover in prevailing winds of 25 knots or greater.	Able to launch and recover at night or in conditions of low visibility.
Launch/recovery site(s)	Open	Ability to operate from un-prepared areas with small footprint.
Tracking	Position of platform (latitude/longitude and altitude) able to be accurately tracked in real time, with tracking data available at mission support post. Maximum time between position reports in flight: 15 seconds.	Tracking data is available in standard format at API or similar for incorporation into other systems. Maximum time between position reports in flight: 1 second.
Platform event data	N/A	Platform reports TAS, GS, heading, remaining endurance and other aircraft parameters in near real time to mission support post. Platform event data available in standard format at API or similar for incorporation into other systems.
Conspicuity	Equipped with effective visibility enhancements (e.g. flashing high brightness lights).	Electronically conspicuous to other crewed aircraft (e.g. through ADSB-out or similar).
Detect and avoid technology	N/A	Employs tactical detect and avoid technology.

5. PAYLOAD AND PAYLOAD TELEMETRY

	MANDATORY	PREFERRED
Sensor, telemetry and format	ISR payload that provides real-time georeferenced video, still or mosaic imagery, or equivalent derived data (e.g. a “shape file” or AI derived file), of emergency event. ISR imagery and/or data is available at mission support post in real time, or near real time, in a standard file or stream format. ISR imagery and/or data is available in near-real-time in a standard digital format that can be incorporated in typical end-user GIS systems. ISR imagery and/or data is recorded and can be played back as required.	ISR payload provides high definition, georeferenced visible and infrared imagery of emergency event with embedded metadata. ISR payload provides a range of Field of View (FoV) options, without changing height of platform. FoV can be varied remotely, from mission support post. Imagery and data files/streams are available in near-real-time to approved end-users at a secure API or via a secure VPN on the Internet. Imagery and data files/streams are recorded to a secure data storage solution that is accessible to approved end-users via the internet.
Other payloads	N/A	Optional

6. MISSION SUPPORT FACILITY

	MANDATORY	PREFERRED
Mission support post	A self-contained ground facility for monitoring and controlling operation of RPAS provided by participant. Facility has a high bandwidth connection to internet. Facility is mobile or portable or demountable (unless operator uses an established facility at a separate location).	Facility provides image post- processing capabilities to generate standard format GIS layers for integration with other GIS generated information products.

Appendix 3

ADDITIONAL REFERENCES

Although not all are directly referenced in this report, the following provided useful context and background:

Airservices Australia (2025). *Remotely Piloted Aircraft Systems (RPAS) in controlled airspace*
Webpage published by Airservices Australia, accessed 10 September 2025

Civil Aviation Safety Authority (2025). *ADS-B for enhancing situational awareness Advisory Circular AC 91-23 v2.0*
File ref: D24/511328 July 2025

Civil Aviation Safety Authority (2025). *RPA Flight Authorisation V6.1 Form*
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