Search and Rescue Challenge

Mission, rules and judging criteria

Version: 1.2

Date: 9 April 2014

IMPORTANT NOTICE TO COMPETITORS

This document is subject to change by the UAV Challenge Outback Rescue organisers. The current rules document will be available from the challenge website, http://www.uavoutbackchallenge.com.au. Registered participants will be notified of any changes.

Flight operations during the Challenge will be governed, in order of priority, by the UAV Challenge Outback Rescue Operations Manual, the UAV Challenge Outback Challenge Search and Rescue Challenge rules (this document) and the UAV Challenge Outback Rescue Airborne Delivery Challenge rules. In the event of an unlikely inconsistency that impacts teams in an uneven way, the judges will take this into consideration.

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Major Revision Record

Changes from V1.1 to V1.2

- Section 2.1.3: added that the emergency package may be autonomously guided
- Section 4: event schedule updated
- Section 5.24: added that an individual can only be a member of one team
- Section 6.2: D2 page limit increased to 21 pages as the compliance statement is now 3 pages
- Appendix A: Compliance statement updated

Changes from V1.0 to V1.1

- Changes to Mission Boundary and other defined waypoints.
- Major changes include, but are not limited to:
    - Section 3.2, add Stall Margin information to Deliverable 2. Added notes.
    - Section 3.3; added note.
    - Section 5.5.1; added note to address RC drop out in manual mode.
    - Section 5.5.1; added requirement for State Machine Diagrams and Transitions for D2.
    - Section 5.5.4, removed reference to RC and clarified that the landing is as declared in Deliverables and approved via scrutineering.
    - Section 5.5.5, removed activation from GCS for consistency.
    - Section 5.5.9, added new section to cover "Lock Up" or Failure of any processor and/or hardware implementing the mission boundary crossing detection. Removed from Section 5.5.6 which now only covers autopilot. Added requirements for total barometric altitude failure.
    - Section 5.22; added not on quality of mobile data service and offsite processing done at own risk.
    - Section 5.24, added to cover cooperation between teams.
    - Section 5.25; added extra notes on Soft GeoFence.
    - Section 6.2, allowed an extra page for design approach and rationale.
    - Section 6.2, where information or detail is requested within these rules and no deliverable is specified then it is to be assumed that it is to be included in Deliverable 2.
    - Section 9.1; added Camera System Testing during Scrutineering.
    - Section 9.2; added to cover manual – autonomous mode transitions.

1 Objective

The goal of the UAV Challenge is to demonstrate the utility of Unmanned Airborne Vehicles (UAVs) for civilian applications. The competitors will be required to develop a UAV that could save lives by quickly and cost effectively delivering medical supplies to critically ill patients in the Australian Outback.

The UAV Challenge Outback Rescue rules have been designed to address safety and maintain an acceptable level of aviation rigour, while attempting to maintain a high level of "fair play", accessibility, and enjoyment. There is an expectation that teams will enter into the UAV Challenge Outback Rescue with a desire to compete within the spirit of the challenge and not to exploit loopholes for an unfair advantage. The organisers and judges reserve the right to take action against any team or individual that conducts themselves in a manner judged contrary to the intent and spirit of the UAV Challenge Outback Rescue.

The UAV Challenge Outback Rescue will provide valuable experience to student and private entrants, in the design, construction and operation of UAVs. This experience will help create a future generation of aerospace professionals - all focused on the fastest growing component of the international aerospace industry.

The event comprises of 2 flying categories. These are the:

- Airborne Delivery Challenge (open to high school students),
- Search and Rescue Challenge (open to all)

2 Search and Rescue Challenge

The Search and Rescue Challenge is open to worldwide entrants – university students, privateers and hobbyists. Companies will be permitted to enter at the discretion of the UAV Challenge Outback Rescue Technical Committee provided they are shown to be participating in the spirit of the competition. Teams will be assessed for their eligibility to enter this category on application.

Employees of organisations who are official sponsors or organising partners of the 2014 UAV Challenge Outback Rescue are permitted to enter the Search and Rescue Challenge BUT will not be eligible to win any of the prize money. Exceptions to this rule may be made for junior or casual employees. Such entrants will be assessed for their eligibility to win the prize money on application. Entrants must declare to the UAV Challenge Outback Rescue Technical Committee any employment relationship with an official sponsor or organising partner before arrival at the UAV Challenge Outback Rescue in Kingaroy.

2.1 The Mission

Outback Joe is lost in the Australian outback and desperately needs assistance. Teams must deploy a UAV to find him and deliver an emergency package via an air-drop.

2.1.1 Finding Outback Joe

The system must be capable of finding Joe in the *Search Area*, located near Kingaroy airport. The aircraft must fly through a defined corridor of approximately 1 nautical mile (nm) in length and 0.2nm in width to the Search Area. The *Mission Boundary,* allocated for the competition, is approximately 2 x 3nm. The rural search area for locating Outback Joe will be 0.5nm within this boundary. If at any time the aircraft flies outside the Mission Boundary for the competition, the aircraft's mission must be terminated automatically by the on-board system(s).

Figure 1 shows a schematic of the Mission Boundary and Search Area. The corresponding GPS coordinates are given in Table 1.

The airspace within the mission boundary will be specially allocated by CASA for the event and teams must not fly below 200ft (excluding take-off and landing at the airport). Teams that wish to fly above 400ft must seek approval from the UAV Challenge Outback Rescue Organising committee. Additionally, teams are limited to a maximum height of 1500ft AGL by the competition organisers. The organisers are to ensure that the airspace application to CASA requests that the airspace boundary described in the applicable NOTAM provides an additional safety zone around the mission boundary so as to provide separation between competition participants and other airspace users.

Figure 1: Mission Boundary (MB) and Search Area (SA).

Table 1: Search and Rescue Waypoint Coordinates.

Boundary Point	**South** **(WGS 84 Degrees:Minutes:Seconds)**	**East** **(WGS 84 Degrees:Minutes:Seconds)**
Mission Boundary		
MB-1	26° 34' 10.4304"	151° 50' 14.5428"
MB-2	26° 34' 11.8416"	151° 50' 21.8580"
MB-3	26° 34' 36.5628"	151° 50' 28.1112"
MB-4	26° 34' 37.1640"	151° 50' 24.1620"
MB-5	26° 34' 52.4178"	151° 50' 27.8249"
MB-6	26° 34' 55.4157"	151° 50' 33.0095"
MB-7	26° 34' 45.0444"	151° 50' 57.5844"
MB-8	26° 35' 24.0336"	151° 51' 03.5062"
MB-9	26° 36' 34.4664"	151° 51' 47.1600"
MB-10	26° 38' 20.2488"	151° 51' 31.8204"
MB-11	26° 38' 41.9006"	151° 50' 50.0068"
MB-12	26° 38' 36.8592"	151° 49' 49.2600"
Search Area		
SA-1	26° 37' 02.8020"	151° 50' 35.4624"
SA-2	26° 37' 09.0156"	151° 51' 20.0628"
SA-3	26° 38' 16.2348"	151° 51' 05.7492"
SA-4	26° 38' 19.7808"	151° 50' 56.8356"
SA-5	26° 38' 14.6148"	151° 50' 21.7896"
Entry / Exit Lanes		
EL-1	26° 36' 25.9632"	151° 50' 43.4004"
EL-2	26° 37' 02.9928"	151° 50' 36.8412"
EL-3	26° 37' 06.1140"	151° 50' 59.2368"
EL-4	26° 36' 29.1312"	151° 51' 05.9256"
Loss of Data Link		
Airfield Home	26° 35' 05.2116"	151° 50' 32.3700"
Comms Hold	26° 36' 25.9632"	151° 50' 43.4004"

The Mission Area is a 3-Dimensional Area with horizontal boundaries as defined in Table 1, and with vertical boundaries being ground level and 3 000 ft AMSL (pressure / barometric altitude referenced to QNH, NOT GPS Altitude).

Note: The 200 feet AGL requirement is an operational constraint and will not be a GeoFence (Flight Termination) boundary as per Section 5.5.5).

All competitors will use the waypoints as named in Table 1, but may add additional waypoints as part of their planning. Note that these waypoints are available in a KMZ (Keyhole Markup Language) file "2014 S&R Waypoints.kmz". Please see UAV Challenge Outback Rescue website for this file. Note: four decimal places have been included for consistency between waypoint definition sources, and that is what is produced automatically from the Master reference. Fewer decimal places may be used in practice.

The target for the search will be a human shaped dummy wearing a high visibility shirt, jeans and an Akubra hat. The dummy will not be moving and will be positioned in a typical resting pose for a tired and lost bush walker visible from the air.

After the search for Outback Joe is complete, the GPS coordinates representing his location must be provided to the judges by the team (in WGS 84 Degrees:Minutes:Seconds format).

An authorised drop: For safety reasons, teams will only be allowed to drop the emergency package if the team's chosen GPS position is within 100m of Outback Joe.

Note: An unauthorised or unintentional drop will not be immediate grounds for disqualification but will not be considered as a valid drop in terms of the Search and Rescue Challenge of the UAV Challenge Outback Rescue.

Teams will be allowed three attempts to provide the correct location of Outback Joe to the Judges. If a team fails to locate Outback Joe on the third attempt the team will be asked to command their aircraft to return to the airport.

2.1.2 Air Traffic Management Requirements

To assist in air traffic management during the search for "Joe" Entry and Exit waypoints have been defined, with search area entry and departure procedure.

The yellow "X"s in Figure 1 mark the four waypoints.

Search Area Entry Procedure:

- Depart Kingaroy Airport
- Track to EL-1
- Track Direct to EL-2
- Entry to Search Area only via EL-2

Search Area Departure Procedure:

- Exit Search Area only via EL-3
- Track Direct to EL-4
- Track to Kingaroy Airport

All waypoints are reporting points. Please advise the Marshall at the GCS when overhead. The Marshall will advise the judges and observers.

Emergency Procedure:

If possible, track to Kingaroy Airport from current location within Search Area via EL-4; otherwise track direct to Kingaroy Airport.

2.1.3 Rescuing Outback Joe

Once Joe has been located, the aircraft must safely deliver a lifesaving drink to him (minimum of 500ml). There are no restrictions on the deployment device, however a competition scrutineer on the range must be able to open the container by hand and measure the quantity of drink delivered. The drink must be an unopened container suitable for human consumption – examples include a bottle of water or soft drink. The emergency package (containing the drink) should be dropped as closely as

possible to Outback Joe without touching him, but the emergency package is allowed to hit Outback Joe.

Only one drop will be allowed per departure from Kingaroy airport. Teams must only drop a single object – no scattering of bottles are allowed!

After the drop, the team will command their aircraft to return to Kingaroy airport for landing.

A team may attempt additional drops within their allotted time. All attempts will be considered as a whole, therefore any failure to comply with the rules and requirements on any given attempt is considered across all of the attempts. Each team will be responsible for weighing the risk versus reward for making addition drops. Each attempt will be scored individually, with the best score being considered (given that all attempts comply with the rules and requirements). The score will not be comprised from the best elements of the various attempts.

The emergency package may include a guidance system to guide its decent, provided this system is autonomous. The emergency package may have no propulsion system and must remain as a single package.

2.2 Time Limit

A time of 90 minutes is allowed for the entire mission. This is broken down as follows:

- Set up and launch: 15 mins
- Flight time (including the landing): 60 mins
- Recovery and pack up: 15 mins

While the aircraft is returning to Kingaroy airport, judging of the drop accuracy will be performed. Multiple attempts are allowed in the time allocated. I.e. a team may command their aircraft to return to the airport. However, severe point penalties will be incurred for having an aircraft flying past the 60 minute time limit.

The setup, launch and recovery periods may be run in parallel to other team operations.

Teams may be ask to "hold" at the end of their set up phase if another team has not yet returned from the range (i.e. only one aircraft will be in the air at one time). Teams must receive approval from the Aerodrome Controller (or relayed via a Judge or Range Marshall) prior to launch. Any delays in authorising the launch due to other airspace users will not be counted as part of the time limit.

Variations in set up and recovery can be made at the judges' discretion. However, the 60 minutes flight time will be strictly enforced.

Teams may be required to hold while they are airborne for operational requirements such as separation management with other airspace users. These holds will not be included in the team's flight time. The judges may make additional time adjustments to ensure fairness, taking into account such matters as establishing and exiting holding patterns. Teams must make endurance data available to the Range Safe Officer and at the time of request the team shall advise any implications of the requested hold or if the circumstances change during the requested hold.

2.3 The aircraft and other Infrastructure

The aircraft must comply with the specifications in Section 5.1. The aircraft used for the mission MUST be the aircraft demonstrated to the scrutineers. Teams are restricted to use one aircraft only for the mission and from this it is clear that only one aircraft can be airborne at any time.

Teams can place infrastructure within the boundary of Kingaroy Airfield without restriction, although it is highly recommended that movement air side is limited as much as practical. Team infrastructure can be located outside the Kingaroy Airfield with the following provisions:

- The infrastructure cannot be of a type that can provide information on the possible location of Outback Joe.
- The setup and removal of the infrastructure is under the same time allowance as detailed in Section 2.2. The people and infrastructure cannot depart until the team is invited to setup and the clock starts. The return of people and infrastructure to the remainder of the team at Kingaroy Airfield must be within the time allocation for setup plus flight time plus recovery and pack up.
- Any person leaving Kingaroy Airfield cannot return until the completion of all attempts at the mission. If a person who has left Kingaroy Airfield returns prior to the competition of the mission, the team will be deemed to have completed the mission and must immediately recover the aircraft to Kingaroy Airfield.
- There is to be no communication between people who leave Kingaroy Airfield and those who remain on Kingaroy Airfield.
- People and infrastructure who leave Kingaroy Airfield must not depart the Mission Boundary area and must respect Private Property (i.e. ask permission before entering a property).
- The source of control for the unmanned aircraft shall be from infrastructure located on Kingaroy Airfield and those sources shall be made known to the judges and scrutineers.

Any breach of these requirements will result in the mission being deemed incomplete and not eligible for any prize money.

Judges reserve the right to alter these requirements under circumstances, taking into account whether any advantage or gain was received.

Competitors are required to declare details of people and equipment that is to be located off Kingaroy Airfield in Deliverable 2. The UAV Challenge Outback Rescue Technical Committee will liaise with the teams upon notification as required, and provide approval or otherwise as part of Deliverable 3 assessment.

2.4 Adverse Weather

Postponement of the competition due to adverse weather conditions will be at the judges' discretion. Flying will be delayed if:

- the 10 minute average wind speed exceeds 15kts at the airport, or
- it is raining or it is considered likely that rain will occur within the mission time allocation.

Two adverse weather days have been built into the schedule (Table 2).

If in the unlikely event that it is impossible to have all teams fly in the competition during the event days (including the adverse weather day) due to adverse weather, the competition will be declared Cancelled and no prizes awarded. The organisers will do all in their power to have all teams compete.

In addition to the competition rules, it is up to the teams to decide if they are safe and capable of performing the mission given the prevailing conditions.

2.5 Additional Deliverables

In addition to the points awarded for the mission, entrants will also be graded on a technical report and video (Deliverable 2 - Section 6.2). The report must outline a team's design, methodology for package deployment (including a deployment risk assessment) and operational and safety procedures. A Team Interview must also be undertaken at the competition (Section 6.4).

2.6 The Reward

The winning team will receive $50,000 if the mission is completed **and the competition is completed** (i.e. all teams that pass scrutineering have an opportunity to fly the mission). The definition of a "completed mission" can be found in Section 5.12.

In the case of a tie on points, a count back system will be implemented as follows:

1. Team that did not hit Outback Joe with the emergency package.
2. Team with the fewest number of missions flown wins.
3. Team with the fewest number of drop requests (location of Outback Joe) wins.
4. Team with the shortest mission time wins (measured from start of the 1 hour mark until the landing of the aircraft at the airport).
5. If there is still a tie, joint winners will be declared and the prize money will be equally split among the winning teams.

3 Challenge Safety

Safety is a priority for the UAV Challenge Outback Rescue, and the rules and regulations contained in this document have been put in place with safety in mind. The safety mechanisms that have been put in place include: ensuring compliance with CASR101; air vehicle safety inspections and structural verification; UAV controller override capability; flight termination mode; and a proven history of safe flight operations.

Entrants based in Australia are reminded that during their research and development phase, all test flying must comply with the relevant CASA regulations. **Participants must ensure they contact their local CASA regional office to ensure that they are in compliance.**

Teams based outside Australia should contact their national aviation regulator to ensure that they comply with local regulations when testing for the Challenge.

The rules outlined in Section 5 will be strictly enforced in order to manage the risk associated with holding the UAV Challenge Outback Rescue. Either the UAV Challenge Outback Rescue Technical or the UAV Challenge Outback Rescue Organising Committees may disqualify any entry that they deem to pose an unreasonable safety hazard to people, infrastructure, and other airspace users.

Additionally, a *Mission Termination* device must be used by all entrants in the Search and Rescue Challenge. This device provides another layer of safety for the general public in the surrounding area to the Challenge and prevents the aircraft from flying beyond the Mission Boundary. Refer to Section 5.5 for full details.

Aircraft are not to intentionally overfly any building within the Mission Boundary. Besides being standard aviation practice, this will limit risk exposure to an unintentional emergency package drops and engine failure.

3.1 Airmanship

Airmanship is a term widely used in the aviation industry. One of the better definitions can be found at http://www.auf.asn.au/students/airmanship.html, and it states:

> *Good airmanship is that indefinable something, perhaps just a state of mind, that separates the superior airman/airwoman from the average. It is not particularly a measure of skill or technique, nor is it just common sense. Rather, it is a measure of a person's awareness of the aircraft and its flight environment, and of her/his own capabilities and behavioural characteristics, combined with good judgement, wise decision-making, attention to detail and a high sense of self-discipline.*
>
> *Airmanship is the cornerstone of pilot competency. Competency has been defined as the combination of knowledge, skills and attitude required to perform a task well or to operate an aircraft safely — in all foreseeable situations.*

The expectation of the UAV Challenge Outback Rescue is that all teams exercise good airmanship. It is each team's responsibility to conduct their operations in a manner that they feel comfortable. If at any stage a team feels uncomfortable with the tempo of the operation, number of people in and around a given area, the weather conditions, readiness of their UAS, etc., they are invited to make their concerns known to officials and make appropriate requests. These requests will be assessed for compliance with the rules and the requirements, as well as the safe and efficient conduct of the event as a whole. While a decision not to proceed due to concerns is a difficult one to make, it is one that is often required in the aviation industry and is applauded as an example of good airmanship.

3.2 Aeronautics

All documents and operations in the UAV Challenge Outback Rescue will comply with:

- General 2.1.1 "Units of Measure", and
- General 2.1.3.1 "Geodetic Reference Datum"

As found in the Aeronautical Information Publication (AIP) Australia which is published by the Aeronautical Information Service (AIS), Airservices Australia. (http://www.airservicesaustralia.com/aip/current/aip/general.pdf)

The tolerance for overflight of the waypoints listed in this document is ±50 metres.

Aircraft fly on airspeed, not ground speed which is what GPS provides. Ground Speed may be reported, however the Technical Committee will be looking for an understanding as to how teams will maintain a suitable speed margin above stall. This should be included in Deliverable 2.

Note: As the risk of stall increases (by not being aware of airspeed and/or managing the stall margin) so too does the risk to people and property on the ground. While there is not a requirement to determine and document a flight envelope for the UAV Challenge Outback Rescue, sound aeronautics and airmanship requires an understanding of the limitations (boundaries of capability) of the Unmanned Aircraft System (UAS). Another area to consider is an understanding of wind limits and control power of the UAS. Many small unmanned aircraft are tested in light wind conditions and then flown in higher winds beyond the aircrafts ability to maintain control and/or navigation, again increasing risk.

While the UAV Challenge Outback Rescue will move towards the adoption of the International Civil Aviation Organisation (ICAO) and Civil Aviation Safety Authority (CASA) standard UAS acronyms, many now superseded acronyms will continue to be used due to branding (i.e., UAV Challenge) or to avoid confusion and maintain continuity with previous rule releases.

3.2.1 Definition and Levels of Autonomy

3.2.1.1 Definition

There is currently no widely accepted definition of autonomy and levels for unmanned aircraft. In the context of the UAV Challenge Outback Rescue there are two types of autonomous operations:

3.2.1.2 Type 1 Autonomy – Remotely Piloted Aircraft Systems (RPAS)

Type 1 Autonomy is the level of autonomy implemented by "waypoint following" autopilots, where the remote pilot does not directly control the aircraft control surfaces (such as aileron, elevator, rudder, elevons, etc.). The progress of the unmanned aircraft is continuously monitored by the remote pilot and the remote pilot can alter the waypoint positions, sequencing of waypoints, and command altitude and speed changes.

3.2.1.3 Type 2 Autonomy – Function Activation without Remote Pilot Intervention

Type 2 Autonomy is where specific functionality on a remote aircraft is activated by the sensing of specific conditions and without intervention from the remote pilot.

3.2.1.4 Autonomy authorised in the Search and Rescue Challenge

Type 1 Autonomy shall be implemented by the unmanned aircraft as part of the Search and Rescue Challenge, and MUST be activated before the unmanned aircraft departs Kingaroy Aerodrome for the search area. The unmanned aircraft must be able to revert to typical remote control (RC) flight control. Many teams will use RC control for take-off and landing.

Type 2 Autonomy shall be implemented for the following functions:

- Loss of Data Link
- Loss of GPS
- Loss of Data Link AND Loss of GPS
- Mission Boundary Crossing – GeoFence (hard GeoFence)
- "Lock Up" or Failure of Autopilot
- "Lock Up" or Failure of any processor and/or hardware implementing the mission boundary crossing detection
- "Lock Up" or Failure of GCS
- "Lock Up" or Failure of Stability Augmentation System (SAS)
- Flight Termination
- Soft GeoFence

3.3 Altimetry

All altitudes will be given as Above Mean Sea Level (AMSL) or Above Ground Level (AGL). If the reference is not stated it will be assumed as AMSL.

AMSL altitudes will be measured and reported as pressure altitudes as per aviation standards and will use QNH. QNH will be provided by the Technical Committee based on standard aeronautical references. Autopilots may use GPS altitude for altitude reference, but the remote pilot shall know and report the aircrafts pressure altitude. The vertical boundary for the UAV Challenge Outback Rescue is a pressure altitude AMSL.

Note: Altitude is a significant safety issue, to ensure safe separation with other airspace users UAS operators need to compare like-with-like and all other aircraft use a pressure altitude referenced to QNH (for operations below 10 000 ft).

3.4 Type of Rules and Regulations for UAV Challenge Outback Rescue

These rules and regulations address different elements of the UAV Challenge Outback Rescue and will have different compliance requirements. These different elements are:

1. Safety of people, property, and other airspace users during the event – MANDATORY full compliance.
2. Regulatory compliance – MANDATORY full compliance.
3. Efficient and fair conduct of the event – Limited PARTIAL compliance.
4. Competition requirements designed to grade participants – compliance as assessed during the event.

4 Schedule

Table 2 below sets forth the overall competition schedule:

Table 2. 2014 UAV Challenge Outback Rescue schedule

Activity	Date
Registration *Registration details will be on the UAV Challenge Outback Rescue website.*	Closes on 3rd July 2013 at 5pm AEST
Deliverable 1: Flight Safety Review (short Technical Report) *A short technical report (Section 6.1) on the UAV design concept and proposed safety methodology must be provided.*	At the latest: 7th August 2013 at 5pm AEST
Deliverable 2: Flight Readiness Review (Technical Report and Video) *A technical report (Section 6.2) must be provided. The underlying objective of this report is to convince the organising committee that the team has developed a reliable and safe UAV system, along with the appropriate operating procedures.* *A Video must also be supplied that includes a flight demonstration of the dropping mechanism that will deliver the payload.*	At the latest: 23rd April 2014 at 5pm AEST
Deliverable 3: Autonomous Flight Record *Documentary evidence (Section 6.3) must be provided that details a minimum of five (5) hours of autonomous flight.* *This deliverable may include an equivalency case when the five hours has been accumulated across different systems.*	At the latest: 6th August 2014 at 5pm AEST
Final "Go/No-Go" Announcement of Teams *Final approval to participate in the 2014 UAV Challenge Outback Rescue given to teams. The final approval to participate will be based on several aspects of the technical report, predominantly the demonstrated ability to operate within the competition safety standards.*	13th August 2014
CASA Application Update *The Technical Committee are to submit an update to CASA advising them of the names of the participants for inclusion in the airspace approvals for the UAV Challenge Outback Rescue.*	20th August 2014
Team Insurance Deadline *Teams must provide documentation illustrating their insurance coverage. More details of insurance requirements and options will be posted on the UAV Challenge Outback Rescue website. Teams that have not submitted this documentation by this date may be disqualified from the competition.*	27th August 2014

Activity	Date
Search and Rescue Challenge *Orientation, Safety Briefing and Inspections, Team Interview and Flight Demonstrations*	23rd September 2014
Search and Rescue Challenge *Flight Scrutineering*	24th September 2014
Search and Rescue Challenge *Competition Flights*	25th September 2014
Adverse Weather Day *One adverse weather day is allocated in case judges decide wind, rain or other adverse conditions interfere with the running of the competition. Note that the 22nd September 2014 is when the Airborne Delivery Challenge will be run.*	26th September 2014

4.1 Optional Early Delivery of Documentation

The organisers understand that some teams would like to receive a "Go" or "No Go" decision earlier than detailed above. The assessment process for Deliverable 1 and 2 documents prevents any early notifications and as such early delivery can be made but will not impact the processing and notification schedule. For Deliverable 3, being a compliance milestone, can be submitted earlier than detailed above and the Technical Committee will endeavour to assess them as soon as possible and send notification. However, multiple attempts at achieving the "Go" decision will not be allowed, unless additional information or clarification is formally requested by the Technical Committee.

5 Additional Rules

5.1 Aircraft Requirements and Limitations

Aircraft entered will be subject to the following requirements and limitations:

1. Must not be a commercial off-the-shelf complete system (i.e., aircraft with all avionics already integrated);
2. Must be capable of *autonomous* flight;
3. Must be free flying;
4. Maximum gross weight (MTOW) must be less than 100 kg (rotary) or 150kg (fixed wing) as per CASR101;
5. Must have continuous radio communication with the *UAV Controller*; and
6. Platform and on-board systems can be commercial off the shelf or custom made.

5.2 Piloting Proficiency

UAV Safety Pilot(s) will be required to demonstrate their proficiency of UAV systems and manual piloting skills at the competition before they are allowed to fly a mission. See Section 9 for details of the practical flight proficiency test.

Experience of the organisers has shown that good piloting skills are required in order to develop, test and tune autonomous aircraft. It is very unlikely that a team will make a serious attempt on the UAV Challenge Outback Rescue without a good pilot.

If a team enters an aircraft with automatic take-off and landing and hence does not require any pilot and complies with Section 5.4 that team may elect not to demonstrate pilot proficiency. If pilot proficiency is not demonstrated or otherwise accepted by the Head Scrutineer then no manual control of the aircraft will be authorised other than steering commands while in an altitude hold mode. For emergencies a suitable manual controller (i.e. RC transmitter) must be made available to a person nominated by the Head Scrutineer, along with an adequate briefing on how to activate the compulsory manual override.

5.3 Safety Inspections

All aircraft and ground-based equipment will undergo rigorous safety evaluations leading up to the UAV Challenge Outback Rescue. Physical inspections will occur during the orientation, practice days and competition days. These inspections must be passed before the aircraft will be permitted to fly. All decisions by the organising committee in relation to airworthiness are final.

Safety inspections will include (but not be limited to) the following:

- Structural verification of the aircraft to ensure structural integrity including,
    - Components adequately secured and fasteners tightened
    - Propeller structure and attachment integrity
    - Inspection of all electronic wiring
    - Controls move as expected
    - Payload general integrity
- UAV Controller override;
- Radio spectrum frequency compliance;
- Radio range checks with motor off and on;
- Flight termination system tested;
- Aircraft will be weighed to ensure they fall within the weight restrictions;
- Video evidence and flight logs of flight tests demonstrating safe operations;
- Proficiency of team members with respects to operation of UAV software & equipment, communications and procedures.
- Flight demonstration.

All teams, aircraft, and equipment shall be subject to ground and flight scrutineering to ensure safety, proficiency, and compliance. Section 9 contains more information on the Ground and Flight Scrutineering, but is not exhaustive in detailing the contents and requirements of scrutineering.

5.3.1 Radio Equipment Frequencies

Teams are permitted to use any combination of frequencies as long as they comply with ACMA regulations (See Section 8 for more details).

Radio Equipment and frequencies shall be declared in Deliverable 2.

The "Kingaroy Triangle": Please note that organisers did see interference in the 36MHz band during the 2010 event and it appeared that some external source (not UAV Challenge Outback Rescue related) was causing this issue.

5.3.2 Radio Licences

Teams must present any radio licences that they may have obtained and need to use during the UAV Challenge Outback Rescue to the scrutineers during scrutineering. CASA staff at the UAV Challenge Outback Rescue event may also ask to see these licences. Any licenses required shall be detailed in Deliverable 2.

5.4 UAV Controller Override

For safety reasons, all systems shall include a capability where the aircraft can be changed from autonomous flight to a manually flown radio mode when operating in normal visual/control range of the safety pilot. The limit of manual control under normal conditions is the boundary of the Aerodrome. Flight in the mission area should be autonomous, except when conducting a recovery due to GPS loss (section 5.5.4) with approval from judges and/or range safety personnel.

If a team enters an aircraft with automatic take-off and landing and hence does not require any pilot then a Safety Case must be made in Deliverables 1 and 2 to show how the aircraft would terminate and behave in the event of a failure within the normal area of safety pilot control (i.e. close to the launch point within the airfield boundary). This Safety Case must include some data from an actual demonstration of such a near-range flight termination.

5.5 In Flight Failures and Emergencies

It is the intention to keep aircraft that are capable of flight in the air as long as they maintain the required level of acceptable safety. As soon as the acceptable level of safety cannot be assured, flight termination must be activated.

Once flight termination has been activated it is not allowed to be overridden by any means. This includes all modes, Autonomous and Manual.

Deliverable 1 shall indicate proposed methods of compliance to Section 5.5 and its sub-sections.

Deliverable 2 shall detail compliance to Section 5.5 and its sub-sections, including which methods have been implemented where there is a number of methods available.

5.5.1 Criteria for Flight Termination

The following events must result in immediate activation of the flight termination when in Autonomous mode(s) (as specified within these rules):

- The aircraft crossing the Mission Boundary – the GeoFence (as defined in Table 1 and includes vertical boundaries);
- Failure or "lock up" of the autopilot;
- Failure or "lock up" of any processor and/or hardware implementing the mission boundary crossing detection;

- Loss of GPS position AND Loss of Command (Data) Link;
- If the aircraft is deemed to be out of control by the judges and/or range safety personnel;
- As requested by the judges and/or range safety personnel.

The following events must result in immediate activation of flight termination when in manual mode(s)

- The aircraft crossing the Mission Boundary – the GeoFence (as defined in Table 1 and includes vertical boundaries);
- Failure or "lock up" of any processor and/or hardware implementing the mission boundary crossing detection;
- Loss of Command (Data) link used to facilitate the flight controls (includes RC receiver(s)) – Note that an RC fail could either trigger Flight Termination or a transition to Autonomous flight. Details of this transition shall be included in Deliverable D2.
- Loss of Stability Augmentation System (SAS) required for UAV flight stability;
- If the aircraft is deemed to be out of control or leaving the aerodrome by judges and/or range safety personnel;
- As requested by the judges/and or range safety personnel.

Deliverable 2 shall contain State Machine Diagrams and Transitions detailing the Flight Termination requirements.

Note: The aircraft may implement 'de-bouncing' of the RC receiver signal, so that signal loss from the RC transmitter for a period of up to 1.5 seconds is not regarded as being a failure of the RC receiver during manual flight. Loss of positive signal from the RC receiver for more than 1.5 seconds during manual flight must trigger flight termination.

The flight termination mode is detailed at Section 5.6.

These criteria must be met for both autonomous and manual flight modes.

The method of compliance to Section 5.5 and its sub-sections shall be detailed in Deliverables 1 and 2, with increased fidelity in accordance with the maturity of the design. Scrutineering will check compliance prior to attempting the challenge.

Missions must be IMMEDIATELY terminated by the teams upon request of the Range Safety Officer. This will be done through the ground station interface. As a last resort teams will be asked to switch off all transmitters, thus dropping data link and initiating Flight Termination.

5.5.2 Loss of Data Link

All teams must implement a method to establish the status (existence) of a command and control data link between the GCS and the UAV. This status must be updated at a rate of at least 1 Hz and if the data link is lost a data link flight mode must be entered.

Teams must implement a system that behaves as follows:

- This flight mode must be activated if the data link is lost for 10 seconds or greater.

- This flight mode, once activated, must return the aircraft directly to the waypoint "Comms Hold" (Figure 1, Table 1) (no time limit for transit, but it must be direct to the waypoint) and enter a loiter centred on that waypoint.
    - After a maximum of 2 minutes of loitering, if the data link has not been re-established, the aircraft must be programmed to return directly to waypoint "Airfield Home" (Figure 1, Table 1), where the RC link may be re-established for a manual recovery. There is no time limit for the transit, but it must be direct to the waypoint. *(Note: The Range Safety Officer must be informed that the aircraft is making its way back to Kingaroy to ensure appropriate notification is given to other airspace users. This information may come from observers, officials, or team members and is not a requirement on the competing team.)*
    - On arriving at "Airfield Home", the aircraft must enter a loiter centred on that waypoint. If after 2 minutes, RC contact has not been re-established, an autopilot initiated and controlled flight termination mode must be activated. A controlled flight termination mode may be (but not limited to) an autonomous landing or entering the flight termination mode (Section 5.6).
- This flight mode must be able to be activated from the ground by the UAV Controller at the command of the judges or range safety personnel.
- If the data link is regained prior to the conclusion of 2 minutes (maximum) of loiter at "Comms Hold" the mission maybe continued, otherwise any subsequent regain of data link still requires return to the competition airfield and land.
- Each team is allowed a maximum of two loss of data link failures. The third (or additional) loss of data link failure, the Loss of Data Link mode must be entered and the mission terminated with a return to the competition airfield and landing or flight termination (Section 5.6).

If there is a loss of GPS while experiencing a loss of data link whilst in Autonomous mode(s), the flight termination (Section 5.6) must be activated immediately. This behaviour must be documented in the D2 document.

If there is a mission boundary crossing whilst experiencing a loss of data link, the flight termination (Section 5.6) must be activated immediately. This behaviour must be documented in the D2 document.

5.5.3 Engine Failure

Procedure to be followed must be declared by the team in Deliverable 2.

5.5.4 Loss of GPS

All teams must implement a method to monitor the status of the GPS on-board the aircraft, without intervention from the ground. All teams must implement a GPS failure mode. Teams must implement a system that behaves as follows:

- This flight mode must be activated immediately if the GPS position is unavailable or if the GPS receiver reports loss of signal or satellite lock.
- This flight mode, once activated, must enter a loiter at the current location and advise judges and/or range safety personnel of the GPS failure.
    - After 30 seconds the following options are available (only one needs

to be implemented and should be declared in Deliverable 2):

- Activate flight termination (Section 5.6).
- On-board dead reckoning navigation direct to "Airfield Home". Range safety personnel will monitor mission boundary compliance and direct flight termination if required. The aircraft is to be landed at the airfield as declared in Deliverables and approved via scrutineering.
- Flight recovery to "Airfield Home" using on board video. As this is an abnormal event the requirement for "no manual control once the aircraft has left the airfield" is waived as per Section 5.4. Range safety personnel will monitor mission boundary compliance and direct flight termination if required. The aircraft is to be landed at the airfield as declared in Deliverables and approved via scrutineering.

- If the GPS recovers, the mission may be continued. If there is a second (or additional) GPS failure, the GPS failure mode must be entered and the mission terminated with a return to the competition airfield and landing or flight termination (Section 5.6).

Teams must advise of the implemented option prior to attempting the UAV Challenge Outback Rescue. Addition scrutineering may be required dependant on option implemented.

If there is a loss of data link while in GPS failure mode, the flight termination (Section 5.6) will be activated immediately. This behaviour must be documented in the D2 document.

5.5.5 Mission Boundary Crossing - GeoFence

GeoFencing is mandatory. All teams must implement automatic (on-board) detection of mission boundary crossing.

If at any stage the aircraft breaches the horizontal Mission Boundary as defined in Table 1 or the vertical boundaries as defined in Section 2.1.1 the aircraft must enter the flight termination mode (Section 5.6). This activation must be initiated on-board. The position of the aircraft will be monitored via the Situation Awareness requirement (Section 5.16) and range safety personnel. Judges or range safety personnel may also request flight termination.

Note: The term "Mission Boundary" includes both horizontal and vertical boundaries.

Note: The lower vertical boundary for this requirement is ground level and NOT 200 feet AGL (which is an operational limit detailed in Section 2.1.1).

Aircraft MUST AUTOMATICALLY activate flight termination settings on crossing the mission boundary in all operating modes (no ground interaction can be involved). The autopilot is allowed to detect the mission boundary crossing and activate the flight termination device, or the boundary crossing can be detected external (but on-board) to the autopilot with activation of the flight termination device, or incorporated into the flight termination device. Deliverables 1 and 2 should address the implementation. The mission boundary activation will be checked at the event by scrutineers by the physical moving of the aircraft across the mission boundary.

Autopilots capable of self-monitoring and activating failsafe termination states upon lockup or failure are also acceptable devices for implementing failsafe states. Note that self-capability of an Autopilot does not replace the additional failsafe device required by Section 5.6

It is recommended but not mandatory that teams implement a "soft GeoFence" inside the mission boundary, set up that when crossed the aircraft commences a manoeuvre that will reduce the possibility of a mission boundary crossing and the subsequent mandatory activation of the "hard GeoFence". The mission boundary GeoFence requirement described in this section is non-negotiable regardless of the "soft GeoFence" implementation, and will be subject to scrutineering. Refer to Section 5.25 for further details of the "soft GeoFence".

5.5.6 "Lock Up" or Failure of autopilot

All teams must implement a method of monitoring the status of the autopilot. The status will be updated at a rate of at least 1 Hz. On detecting a "lock up" or failure of the autopilot the aircraft will enter the flight termination mode (Section 5.6). Deliverable 2 should address the implementation.

5.5.7 "Lock Up" or Failure of GCS

All teams must implement a method of monitoring the status of the GCS. On detecting a "lock up" or failure of the GCS the aircraft must enter the implemented Loss of Data Link mode and procedure. It is acceptable that the monitoring be by the GCS operator and that the mechanism to place the aircraft in the implemented Loss of Data Link mode is to power off the data link transceiver(s) or other appropriate means of "failing" the data link.

5.5.8 "Lock Up" or Failure of Stability Augmentation System (SAS)

If the air vehicle requires any form of Stability Augmentation System (SAS) to allow safe manual piloting AND that system was active during the Section 5.2 Piloting Proficiency assessment, then teams must implement a method of monitoring the status of the SAS. On detecting a "lock up" or failure of the SAS AND if Section 5.4 UAS Control Override is required, then the flight termination (Section 5.6) must be activated immediately.

If the SAS was inactive during the Section 5.2 Piloting Proficiency assessment then Section 5.4 UAS Control Override will be allowed if the SAS is active OR if the SAS can be isolated in the case of a "lock up" or failure. If the SAS cannot be isolated in the case of a "lock up" or failure then the conditions stated for using SAS during Section 5.2 Piloting Proficiency assessment apply.

5.5.9 "Lock Up" or Failure of any processor and/or hardware implementing the mission boundary crossing detection

All teams must implement a method of monitoring the status of any processor and/or hardware implementing the mission boundary crossing detection. The status will be updated at a rate of at least 1 Hz. On detecting a "lock up" or failure of any processor and/or hardware implementing the mission boundary crossing detection

the aircraft will enter the flight termination mode (Section 5.6). Deliverable 2 should address the implementation.

A failure that results in the total loss of barometric altitude does not require activation of flight termination if the following requirements are met:

- The failure is annunciated at the Ground Control Station (GCS) (i.e., the remote pilot is made aware of the failure, or can detect the failure in less than one minute).
- The judges and/or range safety personnel are advised of the failure.
- The aircraft either autonomously or via manual command switches to an alternate source of altitude, which may not be barometric altitude.
- The aircraft either autonomously or via manual command maintains an altitude that is well below the upper altitude boundary (i.e., 1000 ft below the upper altitude boundary, which will be approximately 500 ft AGL.).
- Activation of flight termination on request of the judges and/or range safety personnel.

Teams may submit as part of Deliverable 2 an alternate means of maintaining airspace altitude requirements in the case of a total loss of barometric altitude. The calculation of an equivalent barometric altitude may be acceptable. These will be considered as part of the Safety Case consideration. Teams will be advised if their proposal is not acceptable and will be given an opportunity to update their design and Deliverable 2.

5.6 Flight Termination

All teams must implement a flight termination mode. Teams must design and construct this device with the following conditions:

- Preliminary design details must be provided in the Flight Safety Review Technical Report (Deliverable 1).
- The device must be on-board the aircraft and be a completely independent device from all other on-board systems (separate power supply, processor, etc.).
- The device must be able to command the servos to the servo positions as listed below, OVERRIDING any other on-board system.
- The device must be able to be activated from the ground by the UAV Controller at the command of the judges or Range Safety Officer.

All points above must be demonstrated to the scrutineers prior to the mission flight.

The flight termination servo positions for fixed-wing aircraft are:

- Throttle closed;
- Full up elevator;
- Full right rudder;
- Full down on the right aileron;
- Full up on the left aileron; and
- Full flaps down (if applicable).

The flight termination servo positions for rotary-wing aircraft is to simply close the throttle.

In the case of lighter than air aircraft, strategies should be included that note how the aircraft can be brought to ground in the case of failure, noting maximum crosswinds and the estimated maximum distances that the vehicle could exceed the Mission Boundary.

Flight termination must activate in all instances (and control modes – Autonomous and Manual) when the flight termination criteria have been met, regardless of the previous or current state conditions of the UAS e.g. If a loss of comms state is activated, and then the mission boundary is breached, the flight termination must take place immediate upon crossing the boundary as per the flight termination criteria.

5.6.1 Alternate Flight Termination Systems

Teams may choose to implement an alternate flight termination strategy to that proposed in Section 5.6.

It should be noted that any alternative systems will only be considered if it can be demonstrated that the system proposed will operate to the same or increased level of safety as the flight termination system specified by the organisers.

Teams who wish to use an alternate flight termination strategy must demonstrate (with actual figures from real testing) the maximum distance their air vehicle could reach outside the mission boundary, if the flight termination system was activated at the boundary, and the air vehicle was travelling at maximum velocity and maximum altitude. Crosswinds should also be considered and specified. An example of such a system maybe that of a parachute-based recovery system. If a parachute system was proposed, the organisers must see data showing the performance of the system in winds of up to 20 knots.

In the event a Commercial off the Shelf Flight Termination System is used, teams must also provide manufacturer evidence supporting the proposal at Deliverable 2.

The minimum data that the Technical Committee is looking for is:

- Test data to quantify the rate of descent after termination activated.
- Analysis of the impact of wind (using rate of descent data) to gauge maximum drift distance (maximum distance beyond mission boundary).
- Details on how the system is triggered and activated.

It is acceptable that the data be gathered on a proxy aircraft of similar size and weight.

5.6.2 Pyrotechnic Mechanisms for Parachute Deployment

If a team chooses to use pyrotechnic mechanism for deployment of a parachute for a flight termination system then additional safety mechanisms must be implemented.

Safe/Arm System
A safe/Arm system shall be implemented for any pyrotechnic mechanisms. This shall consist of a minimum of a safe/arm plugs whereby the when the system is 'safe' the pyrotechnic ignition system shall be:

1. Physically disconnected from the initiating electronics

2. Electrically shorted to reduce the chance of accidental firing due to electromagnetic interference

Additionally:

1. The safe plug shall be coloured GREEN
2. The arm plug shall be coloured RED
3. The safe/arm plug shall be clearly visible, accessible and replaceable from the exterior of the aircraft without the need to remove hatches covers etc.
4. The safe/arm plug system should allow external testing of continuity of initiating devices (such as electric matches) to determine if the system has been activated.

No objects shall be dropped from the Aircraft as a consequence of the activation of the Flight Termination System.

The pyrotechnic devices used must conform to all relevant legislation and a team member must hold any licenses required as a consequence of manufacturing transporting and using the pyrotechnic system.

Only commercial propellants and initiating devices are to be used in the system.

Teams using pyrotechnics shall provide an operations and safety manual for their pyrotechnic system as an appendix to Deliverable 2.

5.7 Flights after an In Flight Failure, Emergency, Unintentional or Uncommanded Event

If an aircraft recovers to an area outside of the competition airfield perimeter or outside the mission boundary it will not be allowed to make further flights in the Search and Rescue Challenge of the UAV Challenge Outback Rescue.

If the aircraft is recovered to within the competition airfield perimeter and inside the mission boundary, it will be examined by the UAV Challenge Outback Rescue scrutineering team. This activity will be undertaken in allocated mission time. A decision will be made by the CASA Designated Coordinator, in consultation with the UAV Challenge Outback Rescue Head Scrutineer and the UAV Challenge Outback Rescue Technical Committee, as to whether the aircraft can be repaired and further flights attempted. Any repairs will need to be scrutineered before flight. The UAV Challenge Outback Rescue Technical Committee may decide to adjust the remaining mission time to account for delays in bringing the necessary people together for the reviews.

5.8 Flight Demonstration

Before attempting the challenge mission, all teams must demonstrate their aircraft in flight to the Scrutineers. A designated flight testing area shown in Figure 2 and Table 3, is allocated for the teams to demonstrate the competency of the UAV safety pilot and compliance of the UAS. Mission boundary failsafe activation will be demonstrated either via a portable GPS simulator (provided by the OBC) or walking the aircraft across the fence line near the spectator area.

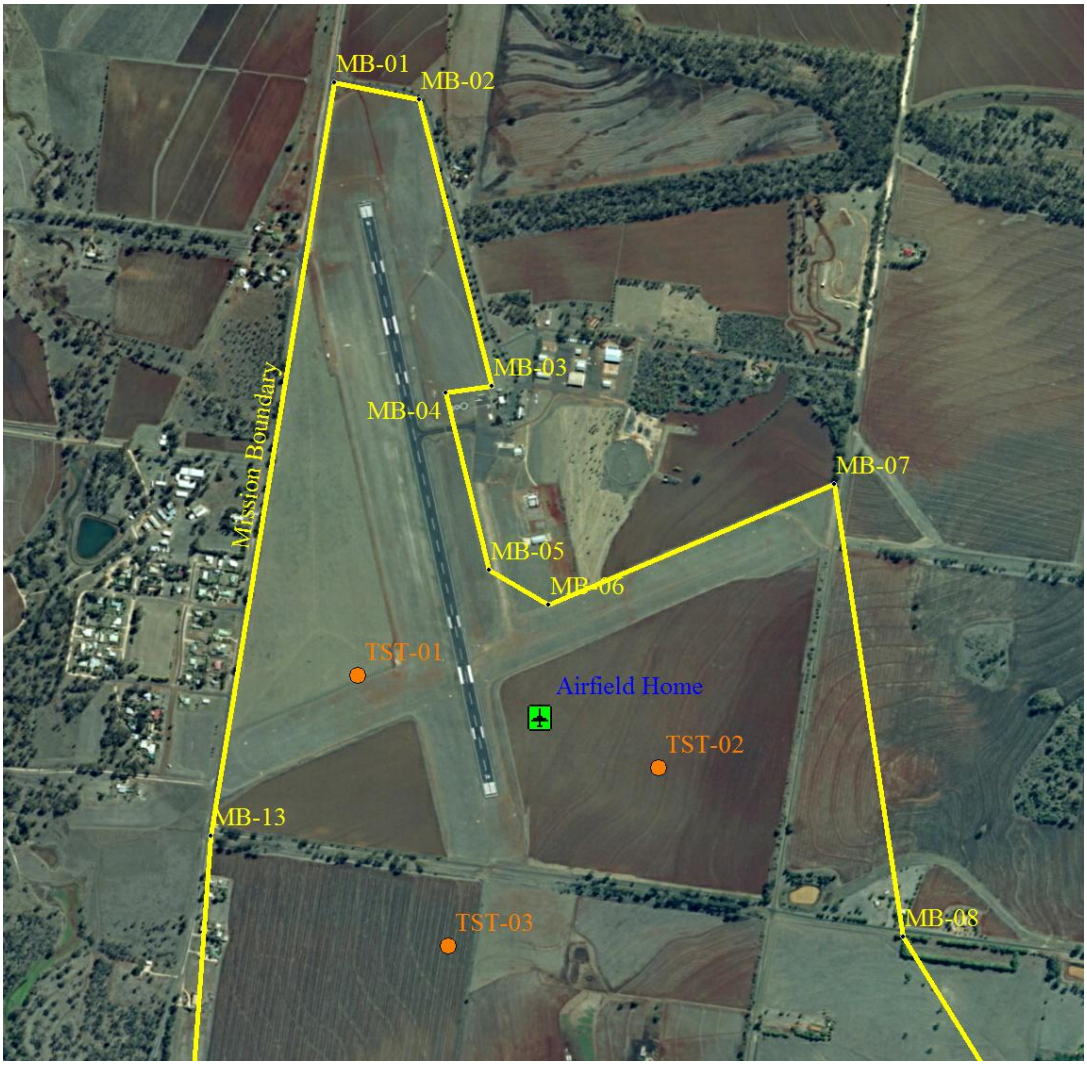

Figure 2: The scrutineering course.

Table 3: Search and Rescue boundary and Scrutineering Course coordinates.

Boundary Point	**South** **(WGS 84 Degrees:Minutes:Seconds)**	**East** **(WGS 84 Degrees:Minutes:Seconds)**
Mission Boundary		
MB-1	26° 34' 10.4304"	151° 50' 14.5428"
MB-2	26° 34' 11.8416"	151° 50' 21.8580"
MB-3	26° 34' 36.5628"	151° 50' 28.1112"
MB-4	26° 34' 37.1640"	151° 50' 24.1620"
MB-5	26° 34' 52.4178"	151° 50' 27.8249"
MB-6	26° 34' 55.4157"	151° 50' 33.0095"
MB-7	26° 34' 45.0444"	151° 50' 57.5844"
MB-8	26° 35' 24.0336"	151° 51' 03.5062"
MB-9	26° 36' 34.4664"	151° 51' 47.1600"
MB-10	26° 38' 20.2488"	151° 51' 31.8204"
MB-11	26° 38' 41.9006"	151° 50' 50.0068"
MB-12	26° 38' 36.8592"	151° 49' 49.2600"
Scrutineering Course		
TST-1	26° 35' 1.5433"	151° 50' 16.5754"
TST-2	26° 35' 9.4625"	151° 50' 42.4943"
TST-3	26° 35' 24.8209"	151° 50' 24.3346"
Loss of Data Link		
Airfield Home	26° 35' 5.2116"	151° 50' 32.3700"

Note that these waypoints are available in a KMZ (Keyhole Mark-up Language) file "2014 S&R Waypoints.kmz". Please see Challenge website for this file.

As part of the scrutineering the Search and Rescue entrants of the UAV Challenge Outback Rescue will be required to take off, track TST-1, TST-2, TST-3, TST-1… Until requested to land. All emergency and failure requirements of the Challenge must be met, with the exception that for Loss of Data Link the procedure will be track direct to "Airfield Home" and orbit for either a landing or regain of Data Link.

Please refer to Section 9 for details of the practical flight proficiency test.

5.9 Take-off and Landing

Teams will have access to grass and the sealed runway at Kingaroy.

5.10 Team Sponsors

Teams must advise the organising committee of their sponsors and the terms of the sponsorship. Full disclosure of sponsors and funding sources must be provided as part of the D2 technical report. Sponsors should be aware that footage of a team's aircraft and team members could form part of the official 2014 UAV Challenge Outback Rescue documentary and promotional materials.

5.11 Liability and Insurance

It will be mandatory for all teams to implement their own insurance, including Public Liability insurance for both flight testing and competition flights. The organising committee are required to sight a Certificate of Currency from each team.

Information on insurance required and insurance that can be purchased through the organisers of the competition will be available on the UAV Challenge Outback Rescue official website.

Teams will have to prove that they have insurance cover BEFORE the organising committee will allow the team at fly at the competition.

5.12 Definition of "Completed Mission"

A Search and Rescue Challenge mission of the UAV Challenge Outback Rescue is considered complete if:

1. The aircraft does not cross the mission boundary.
2. The flight beyond the competition airfield perimeter must be autonomous.
3. The emergency package comes to rest within 100m of Outback Joe.
4. At least 500mL of water is recovered by the scrutineers on the course.
5. The aircraft returns to the airport and lands safely.

For the case where multiple missions are performed within the allotted time: one of the missions MUST comply fully with the Definition of a "Complete Mission" detailed above. Each other mission must comply with the following:

1. The aircraft does not cross the mission boundary.
2. The flight beyond the competition airfield perimeter must be autonomous.
3. The aircraft returns to the airport and lands safely.

All missions must be completed within the Section 2.2 Time Limit.

5.13 Loss of Team Members

In the case that a team's designated UAV GCS Controller or safety pilot is unable to fly the aircraft on the competition or scrutineering day for any reason (such as sickness, etc.), then the judges have the discretion to allow another suitably qualified and competition eligible person (Pilots refer to Section 5.2) to take their place. Other team members who perform roles which are part of the normal flight operations (such as bungee launch assistance) will also need to demonstrate proficiency in that role before being allowed to perform the covering role.

5.14 Sharing of Equipment between Teams

Teams may not share airframes.

Teams may share avionics, piece parts and ancillary equipment. If a part is swapped between teams, the aircraft must be re-scrutineered. Records should be kept of items that are exchanged, from both the perspective of the donor and the recipient, including serial numbers (where they exist), make, model, etc.

Sharing of equipment is not possible if two teams run consecutively due to timing issues.

The sharing provision exists to assist teams that may suffer equipment damage while travelling or at the UAV Challenge Outback Rescue.

5.15 Access to Video Stream from UAV

The UAV Challenge Outback Rescue Organisers request that teams that have a live video stream at the ground station from their aircraft provide access to view this stream to the judges.

5.16 Situational Awareness

Each team shall provide:

- a ground station that includes a graphical display of waypoints and aircraft current location

And:

- an NMEA 0183 serial output with GPRMC and GPGGA sentences for aircraft current location

5.17 Li-Po Battery Management

The UAV Challenge Outback Rescue Organisers request that teams think about the risk of Li-Po battery initiated fires out on the course as a result of aircraft impact with the ground. For example, a team may install extra foam cushioning around batteries to minimise risk of puncturing.

5.18 Competition Timing

The order of flying on the competition day will be determined by drawing team names out of a hat. In the event of a team finishing their mission before the end of their time slot (due to exceptional performance or due to an unforseen termination of the mission), the organisers will offer an earlier start to the next scheduled team

to begin their mission. However, a team will be given 15 minutes notice of this (in time to prepare off the field). Hence, this will only occur if a team finishes more than 15 minutes ahead of their normal end time.

5.19 Spectrum Management

Spectrum compliance is an issue that the organisers of the UAV Challenge Outback Rescue take very seriously. It is the responsibility of each team to ensure their UAV operations are compliant with the ACMA regulations and further information to assist competitors in this is included in section 8.

Spectrum management rules are in place to provide each team with a fair and equal opportunity to compete. The general principal is that when teams are being assessed, such as during static scrutineering, flight scrutineering and competition flights all transmitting equipment must be switched off.

Specific details of spectrum management will be provided at the UAV Challenge Outback Rescue, but the following information can be used as a pre-event guide to how it will operate.

5.19.1 The RF Football

At times when the switching on of transmitting equipment is controlled, only the team in possession of the Radio Frequency (RF) Football are permitted to switch on transmitting equipment. Teams without the RF football are not permitted to switch on transmitters or aircraft (as many aircraft may contain video transmitters), and violations of this rule will be treated harshly.

5.19.2 "Tinker Time"

Tinker time will have no RF Management rules or requirements applied so that teams can work on their systems. No flights will be conducted during this time, and all teams are warned that inadvertent activation of their systems is possible due to the transmissions of others. Each team is to apply a suitable safety procedure to prevent injury due to engine starts, etc.

During "Tinker Time" internal combustion engines must not be started without prior approval from the Scrutineers. Before approval will be given teams will be required to demonstrate how this can be done safely given the non-exclusive RF environment.

During "Tinker Time" electric powered aircraft must have their propellers or rotor blades and fly bars removed before the energy source for their motors is connected. If teams wish to operate their motors with propellers etc. attached prior approval from the Scrutineers must be obtained. Before approval will be given teams will be required to demonstrate how this can be done safely given the non-exclusive RF environment.

5.20 Measuring Payload Drop Accuracy

The distance the payload drop comes to rest from Outback Joe will be measured using a 50 metre fibreglass tape measure, measured in two stages if the payload is over 50 metres from Joe. Measurements will be rounded to the nearest metre, which will be equivalent to a precision of 0.5 points (see section 6.5 for full details of mission performance scoring).

5.21 Smoking, Drugs and Alcohol policy

The UAV Challenge Outback Rescue is a non-smoking event. Event staff, teams or visitors who wish to smoke must leave the area of the UAV Challenge Outback Rescue event if they wish to smoke.

The UAV Challenge Outback Rescue is a drug free event. Alcohol must not be consumed at the aerodrome or by event participants within the CASA NOTAMed area during the competition times (typically from first light until 6pm).

Competitors are advised not to consume alcohol within 6 hours prior to performing their duties or activities relating to the UAV Challenge Outback Rescue. Anyone reporting for competition showing evidence of being under the influence of drugs or alcohol will not be authorised to continue their activities.

5.22 Offsite Data Processing

Teams are allowed to utilise offsite processing of image and Meta data gathered by the aircraft. Any abuse of this section, such as obtaining Outback Joe's location from offsite information other than previously described will be an immediate disqualification.

Teams should note that mobile data coverage in general cannot be guaranteed, and is quite variable in rural Australia. Teams planning to utilise offsite data processing do so at their own risk and no allowance will be made for no or poor quality data service.

5.23 Search Strategy

Teams will be required to submit their search strategy as a part of Deliverable 2, and this can be formally updated to the UAV Challenge Outback Rescue Technical Committee up to the end of the day's activities at the event airfield on the day prior to the first mission flight of the Search and Rescue Challenge of the UAV Challenge Outback Rescue. Any departure from the submitted search strategy will be examined by the Judges as an indication of external information on Outback Joe's position being obtained. If the Judges find that the team has received and made use of information on Outback Joe's position other than by means allowed by the UAV Challenge Outback Rescue that team will be immediately disqualified.

5.24 Cooperation between Teams

Teams are allowed and encouraged to share experiences, data, and lessons learnt as part of the UAV Challenge Outback Rescue. The cooperation may be to all teams, or a sub-group of teams. It is expected that individual teams will develop their own unique implementation, solutions and documentation. It is recognised that some hardware and software (code and algorithms) may be replicated and it would be viewed as a courtesy to acknowledge the source.

Compliance with Section 6.2.1 is still required as "shared", "common", "joint", "re-used", or "copied" documentation will not be accepted. The Technical Committee is required to assess each team for safety and proficiency in order to authorise flight and the Deliverables are a significant component of that assessment. The Deliverables shall demonstrate the teams understanding of their system. Any doubt

as to compliance or system understanding in any Deliverables with large sections of copied, common, or similar work or wording will be awarded a "NO GO" result.

Given that the UAV Challenge Outback Rescue is a competition there is no obligation for a team to cooperate with other teams. If a team chooses to cooperate with other teams then by default that teams forgoes any ability to make claims on overall placing and prizes awarded even if their contribution plays a significant role in another team's success. Teams shall compete individually and independently in the UAV Challenge Outback Rescue regardless of the level of cooperation. Teams are not allowed to enter arrangements to share claims on overall placement or prizes.

"Industrial Espionage" or theft of ideas, hardware (design or physical), or software (code or algorithm) (i.e., where a team has elected not to cooperate with other teams, or has only cooperated on specific items) will not be tolerated.

Teams adjudicated to have broken specific or the spirit of this Section and its restrictions will be asked to show cause as to why they should not be disqualified, and subsequently disqualified if the show cause was not deemed satisfactory.

An individual may only be a member of 1 team at any time. They may change teams up until the beginning of the Kingaroy event, but they will have no claim on overall placing and prizes awarded to any prior teams.

5.25 "Soft GeoFence"

As per Section 5.5.5 it is recommended but not mandatory that teams implement a "soft GeoFence" inside the mission boundary, set up that when crossed the aircraft commences a manoeuvre that will reduce the possibility of a mission boundary crossing and the subsequent mandatory activation of the "hard GeoFence".

The UAV Challenge Outback Rescue Technical Committee does not intend detailing implementation or performance requirements for the "soft GeoFence", leaving it entirely to the individual teams to consider. The intention for inclusion is to explore a means of reducing the potential activations of the "hard GeoFence" and to keep aircraft in the air as long as they are safe to do so.

The following notes are offered for consideration:

- It is accepted that the autonomy may already be trying as hard as it can to follow the tracks defined in the mission and they may not be any options to "try harder" to avoid the "hard GeoFence".
- The activation of the "soft GeoFence" may trigger the use of more aggressive or different control laws.
- The activation of the "soft GeoFence" may alert the remote pilot that incorrect waypoints have been entered or generated allowing changes to be made and thus avoiding the "hard GeoFence".
- In manual mode, the activation of the "soft GeoFence" may alert the remote pilot as to proximity of the "hard GeoFence" prompting a suitable manoeuvre.
- In manual mode, the activation of the "soft GeoFence" may switch the aircraft to autonomous mode to follow a flight path that avoids the "hard GeoFence". This design will need to be declared in Deliverable 2.

6 Judging

A team of at least three judges will determine compliance with all rules. Judges will be professional staff from within the UAV industry. Official times and measurements will be determined by the judges.

The judges will evaluate each of the five elements listed below, three of which form the total Team score. The five elements are as follows:

- Technical Report (Deliverable 1): max 5 points and go/no-go
- Technical Report and video (Deliverable 2): max 15 points and go/no-go decision
- Flight Record (Deliverable 3): no points - go/no-go decision
- Team Interview: max 15 points
- Mission Performance: max 130 points

Each element is a prerequisite before progressing onto the next. All decisions by the Competition Judges are final.

6.1 Short Technical Report (Deliverable 1)

Each Team is required to electronically submit a Short Technical Report (max 6 pages) in PDF format that describes the proposed system design and safety considerations. The UAV Challenge Outback Rescue organisers want to know how a team will minimise risk and operate as safely as possible.

The technical report must address the following:

1. Overall design of the UAV system
2. Risk Assessment

Risk Management Approach that must include an outline of how the team is addressing the Flight Termination requirements, loss of data link, loss of GPS and loss of engine power. The Risk Management Approach for these areas will be further refined in subsequent deliverables.

Deliverable 1 should demonstrate understanding and compliance to the UAV Challenge Outback Rescue Search and Rescue Challenge rules, and should refer to the rules where applicable. A "cut and paste" of the relevant section will not be considered as having understood and complied with that section. Ensure that compliance is clearly stated and if non-compliant a clear justification statement is required. While a detailed description of the platform is interesting, it should not be at the expense of ensuring that the Technical Committee can assess compliance and safety.

The report will be assessed as follows:

Short Technical Report and Video (total of 5 Points)	
Scoring Components	**Max Points**
Overall Document	2
Risk Assessment	2
Quality of writing	1
Late submissions	MINUS 2 points per day
Over page limit (6 pages)	MINUS 2 points per page

In previous years Deliverable 1 was not scored, and the general standard of the documents was poor. From the 2014 competition Deliverable 1 will be scored to help highlight the importance of producing a document that is effective at communicating the key points about the design and risk assessment to the judges.

This is a go/no-go checkpoint. If the organisers are not convinced that the team is complying with the rules the decision will be "no-go" and the team will be informed that they can no longer take part in the 2014 UAV Challenge Outback Rescue. The UAV Challenge Outback Rescue Challenge Technical Committee reserves the right to allow a team to progress if they believe the technical and safety requirements have been met and that there are exceptional or mitigating circumstances.

6.2 Technical Report and Video (Deliverable 2)

Deliverable 2 is the main Technical Deliverable and is to include as much detail as required to assess safety and compliance, within the page limit. If these rules have requested information or detail and have not specified a specific deliverable then it is to be assumed that it should be included in Deliverable 2.

Each Team is required to electronically submit a Technical Report in PDF format and a flight demonstration video via an on-line video sharing service such as YouTube.

The technical report must use the following headings and be no longer than 21 pages:

1. Title page (1 page)
2. Table of Contents (1 page)
3. Statement of Originality and Accuracy – see Section 6.2.1 (1 page)
4. Compliance Statement – see Section 6.2.2 (3 pages)
5. Executive Summary (1 page)
6. Introduction (1 page)
7. Design Approach and Rationale, including aeronautical requirements and state machine diagrams and transitions (4 pages)
8. Risk Management Approach (5 pages) **including**
    a. how the team is addressing Spectrum Management issues
    b. Details of how the team is addressing the Flight Termination requirements, loss of data link, loss of GPS, lock-up or failure of autopilot and lock-up or failure of GCS, as well as loss of engine power.
    c. the team's Li-Po battery management (if these use them)
    d. the team's risk assessment for unintentional and intentional emergency package drop and energy reduction strategies for the emergency package
9. Flight Test Results and Discussion (2 pages)
10. Search Strategy (1 page)
11. Conclusions (1 page)

No appendices are allowed other than those describing pyrotechnics as specified in section 5.6.2.

Deliverable 2 should demonstrate understanding and compliance to the UAV Challenge Outback Rescue Search and Rescue Challenge rules, and should refer to the rules where applicable. A "cut and paste" of the relevant section will not be

considered as having understood and complied with that section. Ensure that compliance is clearly stated and if non-compliant a clear justification statement is required.

The report and video will be assessed as follows:

Technical Report and Video (total of 15 Points)	
Scoring Components	**Max Points**
Executive Summary	1
Design approach and rationale	2
Risk Management Approach	4
Flight test results and discussion	2
Quality of writing	2
Overall style/presentation	2
Overall quality of video	2
Late submissions	MINUS 5 points per day
Over page limit (21 pages)	MINUS 2 points per page

The video must show:

- the Team's aircraft dropping the package and clearly show the aircraft after the package has been dropped so that the judges can determine how stable the aircraft is post-drop., and
- The Team's pre-flight set up and checks along with footage of a take-off and landing.

Note that the movie MUST show the actual plane that is intended to be used in the competition.

This is a go/no-go checkpoint. If the organisers are not convinced that the team is complying with the rules the decision will be "no-go" and the team will be informed that they can no longer take part in the 2014 UAV Challenge. The UAV Challenge Outback Rescue Technical Committee reserves the right to allow a team to progress if they believe the technical and safety requirements have been met and that there are exceptional or mitigating circumstances.

Note to Teams: CASA will be given copies of Deliverable 2 as part of the compliance information for the UAV Challenge Outback Rescue event. CASA reserves the right to check teams at the competition to ensure that their aircraft are as described by the Deliverable 2 and that teams are performing the safety procedures they outline in Deliverable 2 correctly.

6.2.1 Statement of Originality and Accuracy

All Deliverable 2 documents should include a statement of originality and accuracy. This should be on a page by itself after the table of contents and should contain the following words:

> *We declare that this report is entirely the work of the team members listed below, and has not previously been submitted by us, or others for this challenge or any other similar event.*

We have acknowledged external material with appropriate references, quotes or notes to indicate its source.

We declare that this report is an accurate record of activities carried out by us in preparing for this specific challenge. The events, data and other material contained within this report actually occurred and have been fully detailed.

Please then list the names of **ALL team members**.

Teams that have previously competed may submit materials that are still applicable, valid, and current from previous deliverables. This material shall be identified and acknowledged as being applicable, valid, and current.

6.2.2 Compliance Statement

Each team is required to submit a Compliance Statement addressing the competition rules and requirements as part of their Deliverable 2. The aim of the Compliance Statement is to provide a checklist like template to each team to ensure that essential rules and requirements have been addressed and documented in Deliverable 2 prior to submission. The Compliance Statement is shown at Appendix A and a word document version can be found on the Challenge website.

6.3 Autonomous Flight Record (Deliverable 3)

These rules and requirements have been divided into two sections. Those listed in Section 6.3.1 and 6.3.2 are mandatory, Section 6.3.3 is provided as guidance only. All activities undertaken in Section 6.3 must comply with CASA and other appropriate regulations.

Overview of Deliverable 3

The rules and requirements detailed in this section are mandatory.

All teams must provide documentary evidence of five hours of autonomous flight. The five hours do not include the time taken to tune the autopilot. Over the history of the UAV Challenge Outback Rescue it has become clear that the probability of a successful mission is related to the team's level of experience in autonomous operations and sufficient autonomous flight time to tune the autopilot and understand the systems. It is preferable that all five hours is accumulated on the total system that will be operated during the UAV Challenge Outback Rescue, however consideration will be given due to incidents during preparation. An equivalence case will be required to demonstrate that the accumulated experience is relevant. Where equivalence is claimed, a minimum of one hour of autonomous flight on the system to be used at the UAV Challenge Outback Rescue must be documented.

The five hours must have at least one flight with a duration in excess of 30 minutes.

If components, systems or airframes are replaced by identical components, systems or airframes equivalence will be automatic and only a functional checkout will be required. The one hour requirement is waived; a functional test flight is a requirement.

If the airframe or system has significant changes, it is expected that evidence be provided related to the airframe and system to be operated during the UAV Challenge Outback Rescue.

While this deliverable is primarily a Go/No-Go point, the UAV Challenge Outback Rescue Technical Committee reserves the right to allow a team to progress if they believe the technical and safety requirements have been met and that there are exceptional or mitigating circumstances.

6.3.1 Deliverable 3 Requirements

The following evidence of autonomous flight must be provided for Deliverable 3:

- A digital copy of the flight log book
- A GPS telemetry log of a single flight in excess of 30 minutes duration
- A video of not more than 5 minutes runtime showing the aircraft during autonomous flight and the operational ground station
- 10 or more static images showing the ground station, aircraft and team members during flight operations from a number of flights.

As part of Deliverable 3 teams must provide the following information for each RF transmitter in their aircraft or ground station:

- Transmission frequency
- Transmitter power
- Transmitter antenna gain
- Calculated Effective Isotropic Radiated Power (EIRP)
- Any radio spectrum licences the team has obtained and needs to use during the challenge

Deliverable 3 must provide the following details regarding the aircraft and its flight performance:

- Maximum airspeed (i.e. at full throttle)
- Cruise airspeed (i.e. most fuel efficient)
- Endurance at maximum airspeed
- Endurance at cruise airspeed
- Maximum take-off weight
- Competition take-off weight
- Wingspan
- Airframe length
- Identifying marks (if any)
- Aircraft plan form and configuration (e.g. High wing double boom tail pusher or low wing cruciform tail tractor).

This information can be updated on arrival at Kingaroy.

6.3.2 Guidance Material for Deliverable 3

This section is provided as guidance and is not mandatory. Evidence of following this guidance would be viewed favourably.

Each team should aim to obtain at least ten hours of autonomous flight time (not including autopilot tuning flights), with at least one flight of one hour duration. It would be expected that multiple flights be undertaken in excess of 30 minutes.

Each team should conduct testing of their command and control (C2), payload and RC override data links, including loss of data link actions.

Flights should be conducted in a range of wind conditions.

6.4 Team Interview

Teams will be interviewed by the judges during the event to assess their approach to safety and the features of their system during their interview session, which will be held in the team tent next to the team aircraft, teams can be expected to answers questions from the Judges relating to:

- their approach to safety,
- system design,
- what they have learned from the process, and
- Unique or innovative features and safety approaches.

The answers to the Judges' questions will be assessed as follows:

Team Interview Questions (total of 15 Points)	
Scoring Components	**Max Points**
Safety Approach	5
System Design	3
Learnings from the development process	3
Unique or innovative features	4

6.5 Mission Performance (Flying)

For the Search and Rescue Challenge of the UAV Challenge Outback Rescue, the mission performance will be assessed as follows:

Mission Performance (total of 130 Points)	
Scoring Components	**Max Points**
Pre-flight checks, team communication and organisation, and demonstration of good judgement (airmanship)	10
Autonomous take-off (yes/no)	10
Landing (safety, controllability and condition of UAV)	10
Autonomous Landing (yes/no)	10
Accuracy of payload drop (measured from where it rests)	Points = 0.5x(100-d), where d is distance in m from Outback Joe (max points 50, min 0)
EITHER Manual detection of "Joe" during the mission time	10

Mission Performance (total of 130 Points)	
Scoring Components	**Max Points**
OR Autonomous "Joe" detection during the mission time.	20
Dropping of emergency supply package (an authorised drop – Section 2.1.1)	20
Time penalty	Minus 2 point for each minute over the hour
Fly outside the Mission Boundary	Disqualified

7 Awarding of Prizes

A team will only be awarded the first place prize if they successfully complete the defined mission in the time allocated. If more than one team successfully completes the mission, the team with the highest overall points will be awarded the first place prize.

In the case of a tie on points, a count back system will be implemented as follows:

1. Team that did not hit Outback Joe with the emergency package.
2. Team with the fewest number of missions flown wins.
3. Team with the fewest number of drop requests (location of Outback Joe) wins.
4. Team with the shortest mission time wins (measured from start of the 1 hour mark until the landing of the aircraft at the airport).
5. If there is still a tie, joint winners will be declared and the prize money will be equally split among the winning teams.

8 Guidelines for Spectrum Compliance

The following information has been summarised from the official ACMA website (refer below) and correspondence with the Authority, on behalf of the UAV Challenge Outback Rescue Organising Committee for the UAV Challenge Outback Rescue.

Please note that the following information should only be considered as GUIDELINES designed to assist competitors in understanding the issue of spectrum compliance. Each team should ensure they understand and comply with all relevant spectrum regulations prior to their Deliverable 2 submission.

8.1 The ACMA, Spectral Planning and Licensing

The Australian Communications and Media Authority (ACMA) are the Australian federal regulatory body responsible for radio-communications compliance and manage the access to the radiofrequency spectrum within Australia.

As an independent Statutory Authority to the Commonwealth of Australia, the ACMA manages the spectrum in accordance with the Radiocommunications Act 1992, as outlined by the Ministry of Communications, Information Technology and the Arts.

While the ACMA encourages competitiveness and self-regulation of the RF spectrum, spectral planning provides the overall Statutory framework for the allocation and administration of radiofrequency transmissions for different types of services, as granted under the Act. This is done to maximise the efficient use of the spectral resource and minimise interference of adjacent channels.

The Australian Radiofrequency Spectrum Plan (ARSF) is the latest spectrum plan used in Australia and is based upon the outcomes of the International Telecommunication Union (ITU) World Radiocommunication Conferences. As Australia is an obligatory member of the ITU, the ARSF must be drafted so that it takes into account the spectral allocations moved by the ITU.

The ARSF is used in conjunction with frequency and administrative band plans to structure the available RF spectrum for use within Australia.

In order to utilise the RF spectrum, a relevant licence must be obtained from the ACMA for anyone who makes use of a transmitter, as implied under the Act. The licensing of operators using RF devices falls under several different categories:

- Apparatus Licence – based on the type of service provided by the communication link.
- Spectrum Licence – based on the area the communication link is routed.
- Class Licence.

Both Apparatus and Spectrum Licences are issued on an individual basis and there are subsequent Licence fees incurred, as well as the need for direct consultation with the ACMA by the licensee over the terms and conditions of the Licence.

Class Licences cover designated parts of the spectrum set aside for shared access by the general populous. Users of devices under a Class Licence conform to a common set of conditions applicable to all users and do not need to register or pay the ACMA for the Licence.

Under the current regulatory framework, there are no "un-licensed" bands for RF communication purposes.

All radiofrequency bands are subject to frequency and power restrictions, as defined within the applicable Licence category. This includes Class Licences.

8.2 Class Licensing and the UAV Challenge Outback Rescue

Class Licences are a common choice of Licence given the ease of their use and the wide range of readily-available communication devices that fall within the operational conditions of the various Licences.

Class Licences vary according to the type of services provisioned under the Licences, the bandwidth of frequencies each Licence is defined over and the maximum allowable transmitted power over that bandwidth.

As such, not all Class Licences are applicable for UAV operations from legal, technical and safety perspectives.

The Technical Committee has deemed the following Class Licences, or parts thereof, applicable to the UAV Challenge for competitors to use in their link budget designs:

- Radiocommunications (Low Interference Potential Devices) Class Licence 2000
- Radiocommunications (Radio-Controlled Models) Class Licence 2002

8.3 Guidelines for Using Class Licences

Competitors are entitled to use the aforementioned Class Licences for their radio links, on the provision that they act in accordance with the conditions defined under the Licence.

In general, this requires competitors to conform to:

- The class of transmitter specified by the Licence (e.g. Digital modulation, Frequency hopping).
- The maximum radiated power for that frequency band. This is usually expressed in Effective Isotropic Radiated Power (EIRP).

If competitors fail to meet the conditions specified by the Class Licence, they are no longer deemed to be acting in accordance with it. Unless competitors gain another type of Licence from the ACMA to do so, it is classified under the Act as an illegal activity.

The ACMA has stated to the Technical Committee that devices used under the Radio communications (Low Interference Potential Devices) Class Licence 2000 must be low interference. They are within their right, should circumstantial evidence be provided, to turn off any transmitter causing potential interference and prevent further usage of the offending device.

8.4 ISM Frequencies

Several of the Industrial, Scientific and Medical (ISM) bands fall under the Radio communications (Low Interference Potential Devices) Class Licence 2000 and devices used for radio communication purposes across these frequency bands are subject to the provisions outlined by the Class Licence.

It should be noted that the frequency range for the 900MHz ISM band for Region 3 (Australia) is different to other parts of the world and competitors should take this into consideration when designing their system.

Furthermore, the ACMA warns that radio communication services operating over ISM frequencies cannot be afforded protection from interference caused by non-radio communication ISM applications. As such, the suitability of using ISM bands for radio applications should be assessed by competitors (refer NOTE § 3 of the LIPD Class Licence).

8.5 Final Note to Competitors on Spectrum Compliance

Spectrum compliance is an issue that the organisers of the UAV Challenge Outback Rescue take very seriously.

It is the responsibility of each team to ensure their UAV operations are spectrum compliant for the UAV Challenge Outback Rescue.

Details of frequency management at Kingaroy will be provided during competitor orientation and safety briefing.

Failure to comply with any of the rules in Section 8 may result in team disqualification or other appropriate penalties (at the judges' discretion).

For more information regarding spectrum planning, licensing and frequency allocation, please refer to the ACMA website available at:

www.acma.gov.au

9 Ground and Flight Scrutineering for Search and Rescue Challenge Teams in the UAV Challenge Outback Rescue

Flight scrutineering will involve all team members directly involved with the flight operations of the aircraft. The GCS operator will be assessed on their ability to competently perform their role, which includes hardware setup and ground control software usage. Communication between team members will also be observed. The safety pilot will also be required to demonstrate competency to pilot the aircraft when in manual control (as outlined below).

1. Use of the RC-transmitter or like device (where applicable) without having to look at the transmitter for function, correct start-up procedures for both electronics and mechanical aspects of the UAS/aircraft.
2. Taxi (if required), take off via conventional, hand launch, bungee or catapult, entry into the circuit, and trimming (if required) of the aircraft in flight.
3. Simulate an aborted landing (i.e. go-around), clearly demonstrated landing circuit, dead-stick (loss of throttle) landing (*see Note a*.), and actual landing.
4. Circuits (*see Note b*.) at a constant given altitude (no altitude variation), in both directions.
5. Procedure turns - one approach from the left and the other approach from the right. The radius for each turn in the procedure turn should be of equal length.

6. The ability to navigate the aircraft in a given air-shed boundary in a controlled manner, (with winds that may be up to 20-25knts), accounting for downwind, cross-wind, and head wind speed variations (*See Note c*.).
7. Practiced knowledge of airmanship (this includes crew resource management, communication on and off the flight line, communication with the GCS controller, other team members and relevant officials).

Notes:

a. Dead-stick landing, whilst not always able to make it back to the runway, the pilot needs to demonstrate situational awareness and safety when making the choice of where to land the aircraft. Recognise the dangers of dead-stick landings at low airspeed, low altitude and make the appropriate choices to ensure safety is of paramount importance when doing this procedure.
b. Circuits need to be of sizes ~200m x 400m, but no smaller than 100m x 200m. Wings level, and maintain straight and level flight after each turn to be demonstrated.

c. Be aware, if your plane crosses the mission boundary, FTS will be activate under all flight modes.

d. During the manual scrutineering flight the pilot may optionally use audible feedback from the ground station to provide situational awareness information on the aircraft, including proximity to the geo-fence, altitude and speed. It is suggested that teams take advantage of this capability to reduce the chance of a geo-fence breach during the scrutineering flight.

9.1 Camera System Testing during Scrutineering

During the scrutineering flight a high visibility object (possibly Outback Joe, if schedule allows) will be placed on the ground in the area of the scrutineering circuit, such that the aircraft will pass over that object during the circuit. This is to provide a final opportunity for the teams ground station operators to test their camera and ground station systems for correct operation. Teams must ensure that the pilot in charge of the aircraft is not distracted by any use the team wishes to take of this opportunity.

The operation of the teams' camera system is not part of the scrutineering test, and a failure of the camera system will not result in the team being penalised, nor will it result in the team being given any additional testing time during scrutineering.

This opportunity must not interfere with the scrutineering process, and if it does there is a risk of failing the scrutineering requirements. This will be at the Chief Scrutineers discretion.

9.2 Transitioning between Manual and Autonomous Modes

During ground scrutineering testing (prior to any flight scrutineering) of the aircraft teams will be required to demonstrate a successful transition between Manual and Autonomous Modes. The test will involve the following steps:

1. With the motor disabled, place the aircraft into autonomous mode while the RC transmitter is connected.

2. While the aircraft is in autonomous mode the RC transmitter is to be switched off (or the aircraft is out of range) (or placed in a configuration not controlling the aircraft). The aircraft shall remain in autonomous mode without entering flight termination.

3. While the aircraft is in autonomous mode and the RC transmitter is initially switched off (or the aircraft is out of range) (or placed in a configuration not controlling the aircraft), the transmitter is then switched on (and aircraft is in range). The aircraft shall enter manual mode with control via RC.

4. While the aircraft is in manual mode and the RC transmitter is initially switched on (and aircraft is in range), the transmitter is then switched off (or the aircraft is out of range) (or placed in a configuration not controlling the aircraft). The aircraft shall enter flight termination.

5. While the aircraft is in manual mode, RC Transmitter is switched off (or the aircraft is out of range) (or placed in a configuration not controlling the aircraft), and the aircraft has entered flight termination. The RC transmitter is switched on (and aircraft is in range) the aircraft shall remain in flight termination.

10 Disclaimer

This document is subject to change by the UAV Challenge Outback Rescue organisers. The current rules document will be available from the challenge website. Registered participants will be notified of any changes.

Appendix A: Compliance Statement

Team Name:

We declare that this report and the entry that it describes complies with the rules of the 2014 UAV Challenge, and that we enter with the intention of competing in the spirit of the challenge. Specifically we declare that our entry is compliant with the following topics and provide reference to within our Deliverable 2 document were our method of compliance is described:

Rules Reference	Topic	Compliance	Deliverable 2 Reference
Mandatory / Essential *(Note: Non-compliance in this section will result in a No-Go finding unless there are significant and/or extenuating circumstances. Please read the rules in detail with a view to safety and specific requirements.)*			
2.3	The aircraft and other Infrastructure	□ Compliant □ Compliant – Off Airfield Names and Equipment □ Non-Compliant	
3.2	Aeronautics	□ Compliant - Airspeed □ Compliant – Stall Margin Details □ Non-Compliant	
3.3	Altimetry	□ Compliant □ Non-Compliant	
5.1	Aircraft Requirements and Limitations: All.	□ Compliant □ Non-Compliant	
5.3.1, 5.3.2, 5.19, 8	Radio Equipment Frequencies: ACMA Compliance and Licensing.	□ Compliant □ Non-Compliant	
5.4	UAV Controller Override: Compliance to override requirement or Safety Case provided.	□ Compliant - *Override* □ Compliant - *Safety Case* □ Non-Compliant	
5.5	In Flight Failures and Emergencies: All. (Once activated it cannot be overridden – all modes.)	□ Compliant □ Non-Compliant	
5.5.1	Criteria for Flight Termination: All (State Machine Diagrams and Transitions Provided)	□ Compliant □ Non-Compliant	
5.5.2	Loss of Data Link: All	□ Compliant □ Non-Compliant	
5.5.3	Engine Failure: Procedure provided in Deliverable 2.	□ Compliant □ Non-Compliant	
5.5.4	Loss of GPS: All and nomination of the implemented option for recovery.	□ Compliant – *Flight Termination* □ Compliant – *Dead Reckon* □ Compliant - *Video* □ Non-Compliant	
5.5.2, 5.5.4	Loss of Data Link and loss of GPS: All.	□ Compliant □ Non-Compliant	

Rules Reference	Topic	Compliance	Deliverable 2 Reference
5.5.5	Mission Boundary Crossing – GeoFence: All. (Horizontal and Vertical)	□ Compliant □ Non-Compliant	
5.5.2, 5.5.5	Loss of Data Link **and** Mission Boundary Crossing – GeoFence: All.	□ Compliant □ Non-Compliant	
5.5.6	"Lock Up" or Failure of Autopilot: All.	□ Compliant □ Non-Compliant	
5.5.7	"Lock Up" or Failure of GCS: All.	□ Compliant □ Non-Compliant	
5.5.8	"Lock Up" or Failure of Stability Augmentation System (SAS): All.	□ Compliant □ Non-Compliant □ Not Applicable	
5.5.9	"Lock Up" or Failure of Mission Boundary Crossing detection: All	□ Compliant □ Non-Compliant	
5.6	Flight Termination: All and nomination of the implemented option	□ Compliant - *5.6 Implemented* □ Compliant - *5.6.1 Implemented* □ Compliant - *5.6.2 Pyrotechnics* □ Non-Compliant	
5.6.1	Commercial off the shelf Flight Termination System used: manufacturer evidence provided	□ Compliant □ Non-Compliant □ Not Applicable	
5.10	Team Sponsors: All.	□ Compliant □ Non-Compliant	
5.16	Situational Awareness: Graphical display of waypoints and aircraft location.	□ Compliant □ Non-Compliant	
5.16	Situational Awareness: NMEA 0183 Output.	□ Compliant □ Non-Compliant	
5.23	Search Strategy	□ Compliant □ Non-Compliant	
5.24	Cooperation between Teams	□ Compliant □ Non-Compliant	
6.2.1	Statement of Originality and Accuracy: All.	□ Compliant □ Non-Compliant	
6.2.2	Compliance Statement: All.	□ Compliant □ Non-Compliant	
6.3.1	Overview of Deliverable 3.	□ Compliant – Deliverable 3 Submission □ Non-Compliant □ Not Applicable – Deliverable 2 Submission	
6.3.1	Deliverable 3 Requirements.	□ Compliant – Deliverable 3 Submission □ Non-Compliant □ Not Applicable – Deliverable 2 Submission	
Highly Desirable			
5.15	Access to Video Stream from UAV	□ Compliant □ Non-Compliant	

Rules Reference	Topic	Compliance	Deliverable 2 Reference
5.17	Li-Po Battery Management	□ Compliant □ Non-Compliant	
5.22	Offsite Data Processing	□ Compliant □ Non-Compliant □ Not Applicable	
5.25	"Soft GeoFence"	□ Compliant □ Non-Compliant □ Not Applicable	
6.2	Deliverable 2: Max 21 pages.	□ Compliant □ Non-Compliant	

Additional Information:

Date:
Signed by a team representative, on behalf of all team members:
Printed Name: