# Search and Rescue Challenge

# Mission, rules and judging criteria

**Version:** 1.1

**Date:** 19 July 2011

# IMPORTANT NOTICE TO COMPETITORS

**This document is subject to change by the Challenge 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.**

# Table of Contents

# Major Revision Record

Changes from 2010

- There are numerous changes in the rules from last year and all teams are advised to read this document very carefully.
- Major changes include, but are not limited to:
    - Section 2.1.3, Rescuing Outback Joe: Multiple drop attempts allowed with conditions.
    - Section 3.1, Airmanship: Airmanship responsibilities.
    - Section 5.3.1, Radio Equipment Frequencies: dropped the requirement for separate frequencies.
    - Section 5.5.2, Loss of Data Link: Now only one method allowed.
    - Section 5.5.8, 5.5.8 "Lock Up" or Failure of Stability Augmentation System (SAS): new requirement if SAS is used on air vehicle.
    - Section 5.15, Situation Awareness: Now mandatory to provide an NMEA output from the ground station
    - Section 6.2.1, Statement of Originality and Accuracy: teams will now formally declare the originality and accuracy of their work.
    - Section 6.2.2, Compliance Statement: A new requirement for Deliverable 2. Template to be provided in future rule update.
    - Section 6.3, Autonomous Flight Record (Deliverable 3): New deliverable requirement.
    - Section 6.4: Team Interview: teams will now be judged during a team interview and the requirement for an oral presentation has been dropped.

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- Section 5.4, Manual control limitations detailed
- Section 5.5, Clarified that once flight termination has be activated it cannot be overridden
- Section 5.5.1, Separated flight termination criteria into autonomous and manual sections
- Section 5.6, Modified bold text to indicate that flight termination due to loss of GPS and data link is only mandatory in autonomous mode
- Section 5.5.5, Emphasised that activation of flight termination upon crossing the mission boundary must occur in all operating modes
- Section 5.5.6, Added note on autopilot self monitoring
- Section 5.6, Added text emphasising the flight termination criteria

# 1 Objective

The goal of the UAV Outback 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 Challenge 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 Challenge 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 Challenge.

The Challenge 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. Small companies will be permitted to enter at the discretion of the UAV Outback Challenge 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 of the 2011 UAV Challenge are permitted to enter the Search and Rescue Challenge BUT will not be eligible to win any of the prize money.

## 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 (nmi) in length and 0.2nmi in width to the Search Area. The *Mission Boundary,* allocated for the competition, is approximately 2 x 3nmi. The rural search area for

locating Outback Joe will be 0.5nmi 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 onboard 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 takeoff and landing at the airport). Teams that wish to fly above 400ft must seek approval from the UAV Challenge 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.

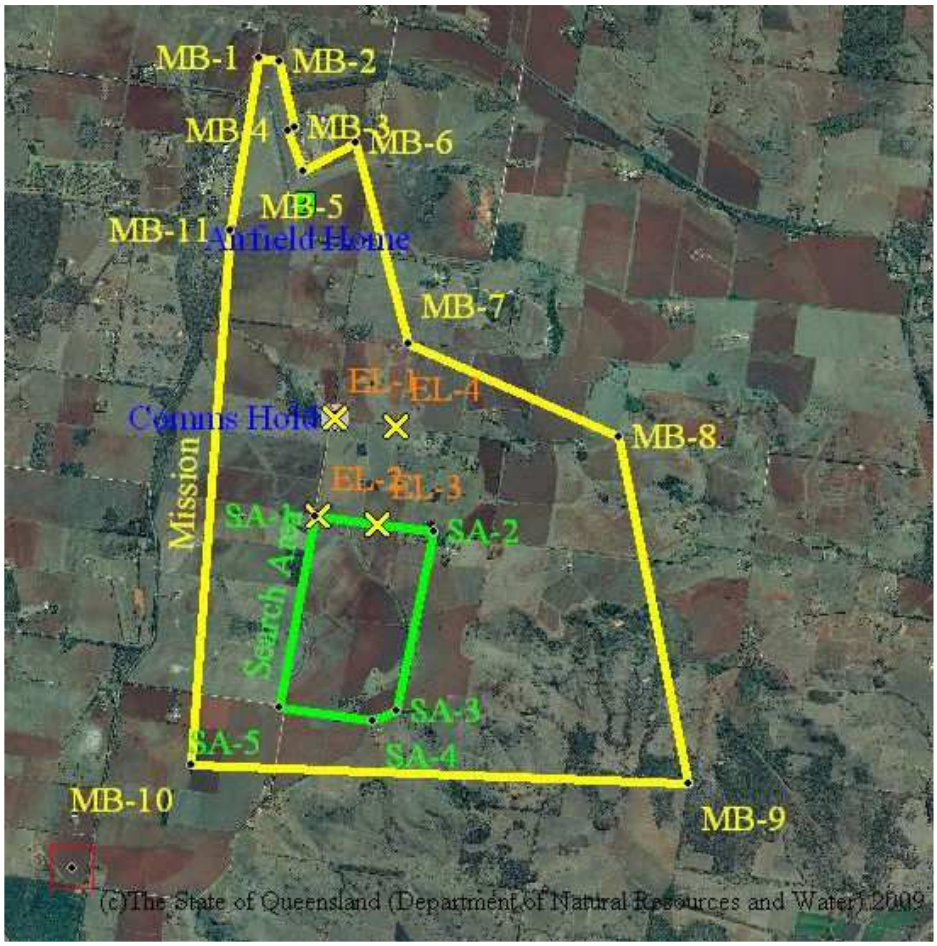


**Figure 1**: Mission Boundary (MB) and Search Area (SA).

**Table 1:** Search and Rescue boundary coordinates.

| **Boundary Point** | **South** **(WGS 84 Degrees:Minutes:Seconds)** | **East** **(WGS 84 Degrees:Minutes:Seconds)** |
|---|---|---|
| *Mission Boundary* | | |
| MB-1 | 26°34' 10.4" | 151°50' 14.5" |
| MB-2 | 26°34' 11.8" | 151°50' 21.9" |
| MB-3 | 26°34' 36.6" | 151°50' 28.1" |
| MB-4 | 26°34' 38.3" | 151°50' 25.2" |
| MB-5 | 26°34' 53.4" | 151°50' 31.0" |
| MB-6 | 26°34' 42.5" | 151°50' 50.9" |
| MB-7 | 26°35' 58.2" | 151°51' 10.4" |
| MB-8 | 26°36' 33.2" | 151°52' 29.1" |
| MB-9 | 26°38' 43.7" | 151°52' 55.4" |
| MB-10 | 26°38' 36.9" | 151°49' 49.3" |
| MB-11 | 26°35' 15.4" | 151°50' 03.9" |
| *Search Area* | | |
| SA-1 | 26°37' 02.8" | 151°50' 35.5" |
| SA-2 | 26°37' 09.0" | 151°51' 20.1" |
| SA-3 | 26°38' 16.2" | 151°51' 05.7" |
| SA-4 | 26°38' 19.8" | 151°50' 56.8" |
| SA-5 | 26°38' 14.6" | 151°50' 21.8" |
| *Entry / Exit Lanes* | | |
| EL-1 | 26°36' 26.0" | 151°50' 43.4" |
| EL-2 | 26°37' 03.0" | 151°50' 36.8" |
| EL-3 | 26°37' 06.1" | 151°50' 59.2" |
| EL-4 | 26°36' 29.1" | 151°51' 05.9" |
| *Loss of Data Link* | | |
| Airfield Home | 26°35' 05.2" | 151°50' 32.4" |
| Comms Hold | 26°36' 26.0" | 151°50' 43.4" |

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 2011OpenS&RLayout.kmz. Please see Challenge website for this file.

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.

A simulated heat signature will be located next to the dummy. The heat lamp used will be a Videotec IR50WFL11:

http://www.videotec.com/dep/IR_EN_0945.pdf

This lamp will be facing directly upward and run continuously during the Search and Rescue Challenge competition hours.

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.

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 life saving 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) must be dropped as closely as possible to Outback Joe, without touching him.

**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.

## 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 set up, 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).

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

## 2.3 The aircraft and other Infrastructure

The aircraft must comply with the specifications in Section 5.1. Teams are restricted to use one aircraft only for the mission. All other team-supplied infrastructure must be located at the launch position at the airfield.

The aircraft used for the mission MUST be the aircraft demonstrated to the scrutineers.

## 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 25kts at the airport, or
- it is raining.

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 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 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 with the fewest number of missions flown wins.
2. Team with the fewest number of drop requests (location of Outback Joe) wins.
3. Team with the shortest mission time wins (measured from start of the 1 hour mark until the landing of the aircraft at the airport).
4. 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 Outback Challenge, 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 reduce the risk associated with holding the UAV Outback Challenge. The organising committee may disqualify any entry that they deem to pose an unreasonable safety hazard to people and infrastructure.

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.

## 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 Outback Challenge 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 Type of Rules and Regulations for UAV Outback Challenge

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

1. Safety of people and property during the event – MANDITORY full compliance.
2. Regulatory compliance – MANDITORY 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**. 2011 UAV Outback Challenge schedule

| Activity | Date |
|---|---|
| **Registration**<br>*Registration details will be on the UAV Challenge website.* | closes on 27 July 2011 at 5pm AEST |
| **Deliverable 1: Flight Safety Review (short Technical Report)**<br>*A short technical report (Section 6.1) on the UAV design concept and proposed safety methodology must be provided.* | At the latest: 27 July 2011 at 5pm AEST |
| **Deliverable 2: Flight Readiness Review (Technical Report and Video)**<br>*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.*<br>*A Video must also be supplied that includes a flight demonstration of the dropping mechanism that will deliver the payload.* | At the latest: 4 April 2012 at 5pm AEST |
| **Deliverable 3: Autonomous Flight Record**<br>*Documentary evidence (Section 6.3) must be provided that details a minimum of five (5) hours of autonomous flight.*<br>*This deliverable may include an equivalency case when the five hours has been accumulated across different systems.* | At the latest: 15 Aug 2012 at 5pm AEST |
| **Final "Go/No-Go" Announcement of Teams**<br>*Final approval to participate in the 2011 UAV Outback Challenge 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.* | 22 Aug 2012 |
| **CASA Application Update**<br>*The Organising committee are to submit an update to CASA advising them of the names of the participants for inclusion in the airspace approvals for the Outback challenge.* | 31 Aug 2012 |
| **Team Insurance Deadline**<br>*Teams must provide documentation illustrating their insurance coverage. More details of insurance requirements and options will be posted on the UAV Challenge website.* | 7 Sep 2012 |

| Activity | Date |
|---|---|
| *Teams that have not submitted this documentation by this date may be disqualified from the competition.* | |
| **Search and Rescue Challenge**<br>*Orientation, Safety Briefing and Inspections, Team Interview and Flight Demonstrations* | 1 Oct 2012 |
| **Search and Rescue Challenge**<br>*Competition day and Awards* | 2 Oct 2012 |
| **Adverse Weather Day**<br>*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 3 Oct 2012 is when the Airborne Delivery Challenge will be run and flying opportunities on this day will be limited.* | 4 Oct 2012 |

### *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. Teams are therefore allowed to submit their Deliverable 1 and 2 documents as early as possible. The Technical Committee will endeavour to assess them as soon as possible. However, multiple attempts at achieving the "Go" decision will not be allowed.

# 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 (ie: 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 onboard systems can be commercial off the shelf or custom made.

## 5.2 Piloting Proficiency

UAV Controller must be MAAA gold-wing standard or **equivalent**. The onus of proof is on the UAV Controller and he/she will be asked to demonstrate their proficiency at the competition before they are allowed to fly a mission if they cannot produce documentary evidence of gold-wings proficiency. **Please see Section 9 for details of the proficiency test for non-gold-wings pilots**.

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 Challenge without a good pilot.

## 5.3 Safety Inspections

All aircraft and ground-based equipment will undergo rigorous safety evaluations leading up to the Challenge. 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; and
- Flight demonstration.

### 5.3.1 Radio Equipment Frequencies (major change from 2010)

In 2010, the rules stated that the frequencies for video, radio control and auto-pilot command transmitters-receiver sets shall not be the same spectrum. This rule has been dropped from 2011 and teams will be allowed to use any combination of frequencies as long as they comply with ACMA regulations (See Section 8 for more details).

Please also note that **video frequencies** of 900MHz, 1.2GHz and 1.3GHz are illegal for use in Australia. That is, you may not transmit **video signals** over these frequencies.

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 Challenge 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 Challenge to the scrutineers during scrutineering. CASA staff at the Challenge event may also ask to see these licences.

## 5.4 UAV Controller Override

For safety reasons, all systems must 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 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 a 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 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**.

### 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);
- Failure or "lock up" of the autopilot;
- 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);
- Loss of Command (Data) link used to facilitate the flight controls (includes RC receiver(s));
- 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.

The flight termination mode is detailed at Section 5.6.

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

It is expected that the method of compliance to Section 5.5 will 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 (change from 2010)

From 2011 there will be only one method of handling loss of data link (there were two methods allowed in 2010).

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.
- 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 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.
    - 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 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 onboard 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:
        - Activate flight termination (Section 5.6).
        - Onboard dead reckoning navigation direct to "Airfield Home". Once RC control has been established, recover the aircraft to the airfield. Range safety personnel will monitor mission boundary compliance and direct flight termination if required.
        - Flight recovery to "Airfield Home" using onboard video. Once RC control has been established, recover the aircraft to the airfield. Range safety personnel will monitor mission boundary compliance and direct flight termination if required.
- If the GPS recovers, the mission maybe 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 challenge. 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

From 2011, GeoFencing is mandatory. All teams must implement automatic (on-board) detection of mission boundary crossing.

If at any stage the aircraft breaches the Mission Boundary as defined in Table 1 the aircraft must enter the flight termination mode (Section 5.6). This activation may be initiated from either the GCS or onboard. 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.

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 onboard) 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

### 5.5.6 “Lock Up” or Failure of Autopilot

All teams must implement a method of monitoring the status of the autopilot and any external processor 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 the autopilot or any external processor implementing the mission boundary crossing detection 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.

## 5.6 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 onboard the aircraft and be a completely independent device from all other onboard 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 onboard 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.

### 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 Flight Demonstration

Before attempting the challenge mission, all teams must demonstrate their aircraft in flight to the Scrutineers. A predefined circuit (Figure 2 and Table 3) must be flown in piloted mode and autonomous mode to demonstrate the competency of the aircraft and the UAV Controller (pilot). The details of the failsafes will be provided on the scrutineering documents sent to the successful teams shortly after Deliverable 1 Go/No-go announcements.

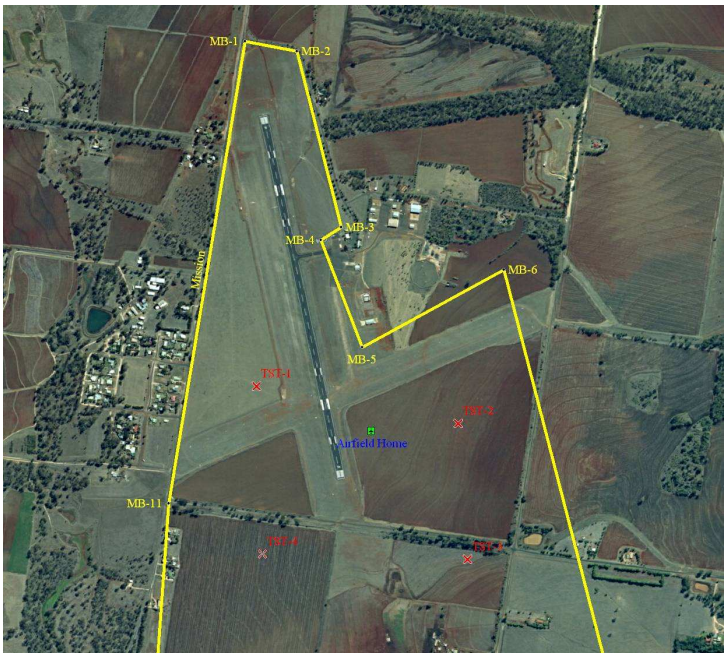


**Figure 2:** The scrutineering course (red marks).

**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' 10.4" | 151°50' 14.5" |
| MB-2 | 26°34' 11.8" | 151°50' 21.9" |
| MB-3 | 26°34' 36.6" | 151°50' 28.1" |
| MB-4 | 26°34' 38.3" | 151°50' 25.2" |
| MB-5 | 26°34' 53.4" | 151°50' 31.0" |
| MB-6 | 26°34' 42.5" | 151°50' 50.9" |
| MB-7 | 26°35' 58.2" | 151°51' 10.4" |
| MB-8 | 26°36' 33.2" | 151°52' 29.1" |
| MB-9 | 26°38' 43.7" | 151°52' 55.4" |
| MB-10 | 26°38' 36.9" | 151°49' 49.3" |
| MB-11 | 26°35' 15.4" | 151°50' 03.9" |
| *Scrutineering Course* | | |
| TST-1 | 26°34' 58.9" | 151°50' 16.2" |
| TST-2 | 26°35' 04.1" | 151°50' 44.5" |
| TST-3 | 26°35' 23.2" | 151°50' 45.9" |
| TST-4 | 26°35' 22.4" | 151°50' 17.0" |

| *Loss of Data Link* | | |
|---|---|---|
| Airfield Home | 26°35' 05.2" | 151°50' 32.4" |

Note that these waypoints are available in a KMZ (Keyhole Markup Language) file 2011S&RScrintineeringCourse.kmz. Please see Challenge website for this file.

As part of the scrutineering the Search and Rescue entrants will be required to take off, track TST-1, TST-2, TST-3, TST-4, 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.

Pilots, please refer to Section 9 for non-gold wings equivalence-testing procedure(s), which is in addition to the flight demonstration test described above.

## 5.8 Take-off and Landing

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

## 5.9 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 2011 UAV Outback Challenge documentary and promotional materials.

## 5.10 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 Outback Challenge 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.

## 5.11 Definition of "Completed Mission"

A Search and Rescue Challenge mission 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. The emergency package does not touch Outback Joe.
5. At least 500mL of water is recovered by the scrutineers on the course.
6. 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 emergency package does not touch Outback Joe.
4. The aircraft returns to the airport and lands safely.

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

## 5.12 Loss of UAV Controller

In the case that a team's designated UAV Controller (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 pilot (Section 5.2) to take their place.

## 5.13 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 Challenge.

## 5.14 Access to Video Stream from UAV

The UAV Challenge 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.

## 5.15 Situational Awareness Requirement (Change from 2010)

Each team must provide either:

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

**and**

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

## 5.16 Li-Po Battery Management

The UAV Challenge 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.

## 5.17 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.

## 5.18 Spectrum Management

Spectrum compliance is an issue that the organisers of the UAV Challenge 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 Challenge, but the following information can be used as a pre-event guide to how it will operate.

### 5.18.1 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.

### 5.18.2 "Tinker Time"

Starting in 2011 a period of time known as "Tinker Time" will be introduced. This 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 suitable safety procedure to prevent injury to engine starts, etc.

# 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): no points - go/no-go decision
- 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 Outback Challenge 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.

There are no points awarded for this deliverable. Instead 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 2011 UAV Challenge.

## 6.2 Technical Report and Video (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 15 pages:

1. Tile page (1 page)
2. Table of Contents (1 page)
3. Statement of Originality and Accuracy – see Section 6.2.1 (1 page)

4. Executive Summary (1 page)
5. Introduction (1 page)
6. Design Approach and Rationale (2 pages)
7. 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)
8. Flight Test Results and Discussion (2 pages)
9. Conclusions (1 page)

No appendices are allowed.

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 (12 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.

**Note to Teams: CASA will be given copies of Deliverable 2 as part of the compliance information for the Challenge 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 (new from 2011)

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**.

### 6.2.2 Compliance Statement (New from 2011)

From 2011, each team will be required to submit a Compliance Statement addressing the competition rules and requirements. A template will be added to the rules in a later release. 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 prior to submission of Deliverable 2.

## 6.3 Autonomous Flight Record (Deliverable 3) (New from 2011)

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

### 6.3.1 Requirements for Deliverable 3

The rules and requirements detailed in this section are mandatory.

From 2011, 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 UAS Outback Challenge 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 Outback Challenge, 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 Outback Challenge 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 Outback Challenge.

The evidence may be provided in the form of copies of flight log books, sample GPS-telemetry, videos and web-enabled interviews with the team. Each team is to detail how they will provide the required evidence as part of their Deliverable 2 submission.

While this deliverable is primarily a Go/No-Go point, the UAV Outback 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.

### 6.3.2 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 (change from 2010)

During the 2010 event, teams were asked to give an Oral Presentation. This requirement has been dropped from 2011 and instead teams will be judged during an interview session in the team tent held next to the team aircraft.

During their interview session 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, 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)<br><br>If you hit Outback Joe – NO POINTS |
| EITHER Manual detection of "Joe" during the mission time | 10 |
| 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 with the fewest number of missions flown wins.
2. Team with the fewest number of drop requests (location of Outback Joe) wins.
3. Team with the shortest mission time wins (measured from start of the 1 hour mark until the landing of the aircraft at the airport).
4. 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 Organising Committee for the UAV Outback Challenge.

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 Challenge*

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 there of, 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 (eg. Digital modulation, Frequency hoping).
- 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 take very seriously.**

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

**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 8.5 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 Flight Testing for Non-Gold-Wings Pilots

Pilots that do not have MAAA gold-wings rating must demonstrate the following during a practical flight test to the scrutineers.

1. Use of the RC-transmitter 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), takeoff and entry into the circuit, trimming (if required) of the aircraft in flight.
3. Simulated landing (i.e. go-around), landing circuit, dead-stick (loss of throttle) landing (*see Note a*.), and actual landing.
4. Box-shaped circuits (*see Note b*.) at a given altitude (no altitude variation), both directions, pronounced 90 degree corners with each transact of the box, parallel to the opposing side of the box.
5. Figure 8 shape circuits (from left to right, and right to left) both inward and outward directions of travel (*see Note c*.). The transition between each half of the 8 should be with level wings for at least 2 seconds, radius of the turn should be greater than 50 metres, and of similar radial length to the previous half of the 8, again no loss in altitude.
6. The ability to navigate the aircraft in a given air-shed boundary, (with winds that may be up to 20-25knts), accounting for downwind, cross-wind, and head wind speed variations (*See Note d*.).
7. Practiced knowledge of airmanship (this includes communication on the flight line, communication to the GCS & team members and communication to the relevant safety officials).

Notes:

a. Dead-stick landing, whilst not always able to make it back to the runway, Pilot's need 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. Level flight after turns needs to be demonstrated.
c. Inward figure of 8 is where after the first half of the figure of 8, the plane is heading directly toward the pilot, an outward figure of 8 is where after the first half of the 8, the plane heading directly away from the pilot.
d. Be aware, if your plane crosses the mission boundary, FTS should be activated under all circumstances.

# 10 Disclaimer

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