

UAV Challenge Outback Rescue 2008



**Airborne delivery challenge
and search and rescue challenge**

**Mission, rules and regulations,
judging and scoring criteria**

Version: 5.1

Date: 14 May 2008

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Major Revision Record

Revision Number	Description of Changes	Date Released
5.1	<p><u>Section 2.2:</u></p> <ol style="list-style-type: none"> 1. <u>Clarified Eligibility criteria for Small Companies and Staff</u> of partner and sponsor organisations; 2. <u>Clarified GPS data formats as WGS 84 Degrees:Minutes:Seconds;</u> 3. <u>Inserted "Only 3 attempts to provide the location of Outback Joe will be allowed. If a Team fails to locate Outback Joe on the third attempt the team must finish the mission immediately and no more points will be awarded. Points will also be deducted from the teams score as per the points section (refer Section 6.2).";</u> <p><u>Section 5.4.3:</u> Clarified criteria for employing a COTS Flight Termination System;</p> <p><u>Section 6.2.2:</u> Table 4 amended to include penalty for failing to locate Outback Joe in the Search and Rescue category.</p>	
5.0	<p><u>Section 2.1:</u></p> <ol style="list-style-type: none"> 1. Airborne delivery Challenge now open to all Australian High Schools 2. Figure 1 updated to reflect the new course layout and location of the <i>mission manager</i>. 'Flying Zone' and 'No Fly Zone' explicitly identified 3. Deleted "<i>The mission manager must be located in the mission manager's zone throughout the mission. The mission manager's zone will be located 10m from the centre of the flight line and on the starboard side of the aircraft. It is also located adjacent to the beginning of the</i> 	

	<p><i>50m course at the 0m marker."</i></p> <ol style="list-style-type: none">4. Clarified that the mission manager will <i>"NOT be able to see the target zone during the competition and will NOT be able to communicate with the UAV controller during the drop sequence."</i>5. Clarified that there are now limitations on the location of the UAV controller: <i>"The UAV controller is to remain in the pilots station at all times during the competition except when preparing the aircraft for take off and recovering the aircraft after landing."</i> <p><u>Section 2.2: Prize amount amended to \$50,000</u></p> <p><u>Section 3:</u></p> <ol style="list-style-type: none">1. All deliverable dates amended for 2008 schedule;2. Clarified that under Deliverable 2, video evidence of flights is now <i>"required"</i> <p><u>Section 5.5.1:</u> Added <i>"Airborne Delivery Teams must be capable of executing takeoff and landing from a roughly mown grass runway. Search and Rescue teams will have access to the sealed runways.."</i></p> <p><u>Section 5.7:</u></p> <ol style="list-style-type: none">1. Deleted <i>"Education Queensland high schools will be covered under their own policy so teams do not have to personally organise insurance. All other schools must ensure their teams have the appropriate insurance."</i>2. Replaced 'Education Queensland High school' with 'High school' <p><u>Section 6.1.4:</u> Added <i>"The video shall NOT contain any copyright media or where copyright media has been included evidence of the approval to use such media <u>must</u> be provided. Each team entering the Documentary Challenge is required to submit 2 version of their video. One original copy and a second copy containing no backing audio."</i></p>	
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4.0	<p><u>Section 8:</u> Updated definition of "2008 UAV Outback Challenge Organising Committee"</p> <p><u>Section 2.2:</u> Added section "Points to Note":</p> <ol style="list-style-type: none"> 1. <i>Teams may only drop ONE bottle of fluid to Outback Joe. Teams that drop multiple bottles of liquid will be immediately disqualified</i> 2. <i>For safety, teams should only carry enough fuel for the mission (plus necessary reserves)</i> <p><u>Section 2.2:</u> Added:</p> <ol style="list-style-type: none"> 1. <i>Updated the Proposed Map for the Search and Rescue Challenge</i> 2. <i>Added the GPS Waypoints that define the Proposed Map for the Search and Rescue Challenge</i> <p><u>Section 6.1:</u> Added additional information regarding what is required to list in the budget: <i>"The budget must list the cost of all hardware used by teams to complete the mission. This cost is the estimated off-the-shelf cost (as if you had to purchase everything in the system from scratch). It does not include software costs. All items must be included – even if they have not been purchased specifically for the competition, and all donations must be included also. The items that you must include is everything in the system to complete the mission – air vehicle, avionics, fuel, batteries, ground station components, etc."</i></p> <p>References to altitude have all been changed to <i>"height above ground"</i></p> <p><u>Section 5.5.1:</u> Clarified height above ground conditions for the search and rescue challenge</p> <p><u>Section 3:</u> Clarified what is expected to be included as part of the video evidence deliverable:</p> <p><i>"Video evidence must include a flight demonstration of the dropping mechanism that will deliver the</i></p>	22 nd 2007 May
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3.3	<p><i>payload. The video must include an actual 'drop' of the payload."</i></p> <p><u>Section 2.1:</u> <i>"The mission manager's area will be enclosed with a barricade around the edges and covered from the top for safety. The mission manager will be able to see out of the area."</i></p> <p><u>Section 2.1:</u> Added information about wet weather:</p> <p><i>"In the event of a complete wet weather day, the flights will be cancelled and a winner determined by points from the teams technical reports, oral presentations and video evidence."</i></p> <p><u>Section 2.1:</u> <i>"Teams must adhere to the flight circuit procedures that will be given to teams at the competition."</i></p> <p><u>Section 3:</u> Added the insurance deadline date to the schedule. PLEASE READ THIS SECTION – teams can be disqualified for not submitting by the due date</p> <p><u>Section 5.4.3:</u> Added a supplementary note concerning submitting a proposal for an alternative flight termination system.</p> <p>The following lists all changes up to this revision from the original rules document released:</p> <p><u>Section 2.1:</u> Figure 1 altered to show hurdles are not transparent</p> <p><u>Section 2.1:</u> Added paragraph after paragraph 8: <i>"Note that the mission manager cannot see through the hurdles as shown in Figure 1."</i></p> <p><u>Section 2.2:</u> Added paragraph after paragraph 6: <i>"The SAR Challenge target heat signature simulator is a Videotec IR50WFL11: http://www.videotec.com/upl/pdf/i/IR_EN.pdf</i></p> <p><i>This lamp will be facing directly upward and run continuously during the SAR Challenge competition hours."</i></p> <p><u>Section 2.2:</u> Subsection – "Rescue Outback Joel". Paragraph 1: changed reference to</p>	1 st May 2007
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	<p>500ml of water to <i>"a minimum of 500ml of fluid"</i>. The fluid must be an unopened vessel suitable for human consumption – examples include a bottle of water, Coke, etc purchased from a shop.</p> <p><u>Section 2.1:</u> The airborne delivery challenge UAVs must not go above 200ft.</p> <p><u>Section 2.2:</u> Paragraph 4: The search and rescue challenge UAVs must not go below 200ft (except for takeoff and landing at the airport) nor above 400ft without CASA approval. Additionally, teams are limited to a maximum height of 1500ft by the competition organisers.</p>	
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1 Objective

The goal of the 2008 UAV Outback Challenge is to demonstrate the utility of *Unmanned Aerial 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 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.

2 Mission

The competition comprises of 3 categories. These are the:

- Airborne Delivery Challenge;
- Search and Rescue Challenge; and
- Team Documentary.

2.1 Airborne Delivery Challenge

This category is open only to Australian high school students.

The Mission

A spherical package (golf ball) will be provided to each team for delivery on the day of the competition. The sphere will be 43mm in diameter and will weigh approximately 50 grams. The sphere will represent an emergency package that could be delivered to someone lost in the outback.

Each team must develop an airborne delivery system that can drop the package into a target zone. The target zone will comprise of a sandpit with dimensions of 1m wide, 2m down-range (in the direction the UAV is flying) and 5cm in height (refer to **Figure 1** below).

The UAV will be remotely controlled by a human operator, known as the *UAV controller*. Before the drop, the UAV must fly down a straight course of 50m, starting over the 0m marker. On the test day, two hurdles with a height of 4m, and a width of 3 m, will be placed on each side of the target zone. The target zone will appear between the hurdles as shown in **Figure 1** below.

Teams must fly their UAV such that it passes over the hurdles, but must not fly higher than 200 feet (well within *CASR101* guidelines).

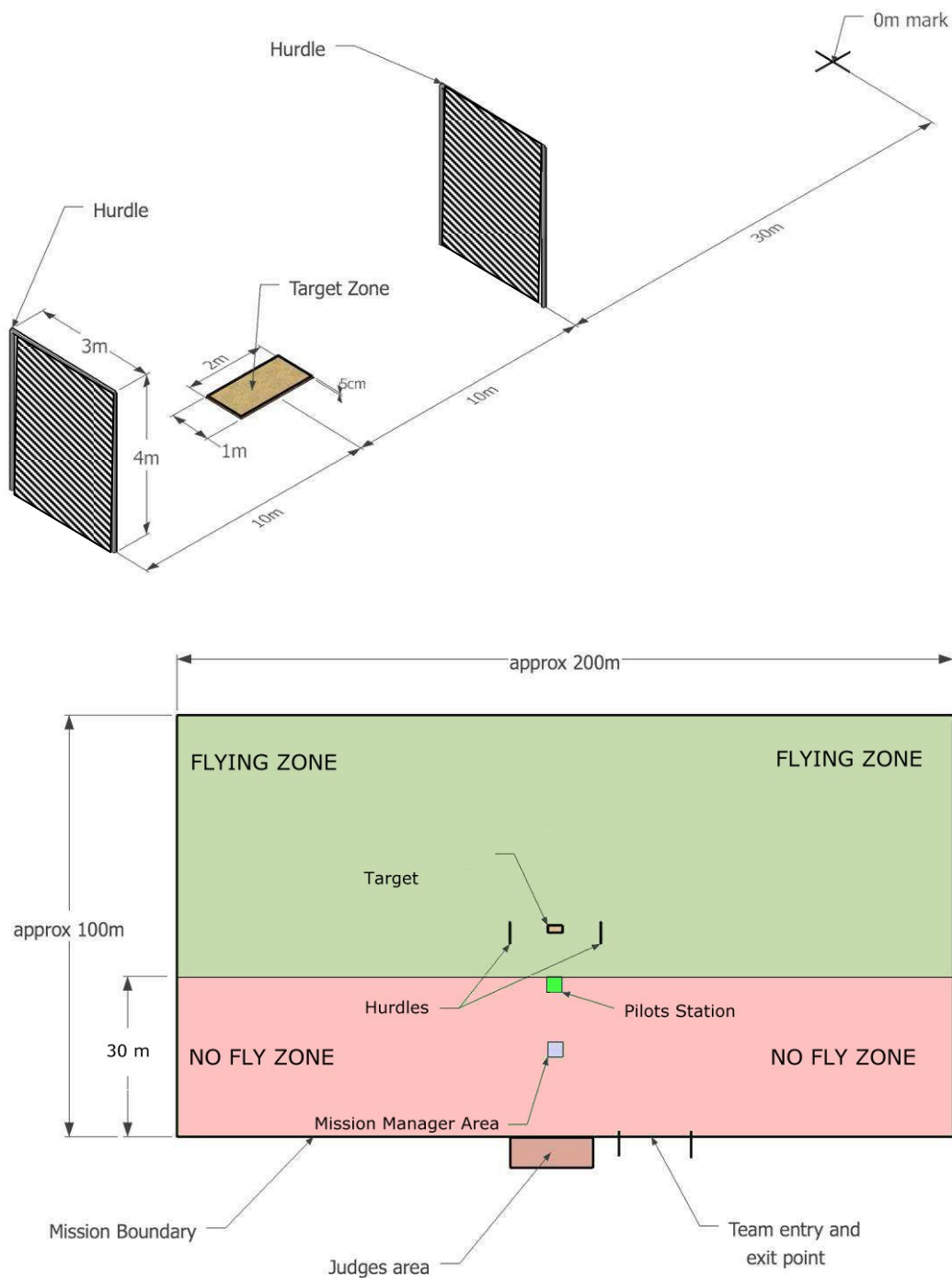


Figure 1. Airborne Delivery Challenge Schematic

The delivery of the payload will be controlled by a human operator, known as the *mission manager*. The mission manager's zone will be marked on the test day and will be a 2m x 2m square. The mission manager and associated equipment must be located within this square at all times during the mission.

The mission manager's area will be enclosed with a barricade around the edges and covered from the top for safety. The mission manager will NOT be able to see the target zone during the competition and will NOT be able to communicate with the UAV controller during the drop sequence.

The *mission manager* must control the delivery mechanism independently of the *UAV controller* who is flying the aircraft.

The UAV controller is to remain in the pilots station at all times during the competition except when preparing the aircraft for take off and recovering the aircraft after landing.

Note that the mission manager cannot see through the hurdles as shown in **Figure 1**.

The objective is for the *mission manager* to deploy the spherical package such that its first point of contact is in the centre of the target zone.

The air vehicle must comply with the specifications in Section 5.3.1. Whilst flying between the hurdles, the air vehicle must maintain an average minimum forward velocity of 3m/s. This will be verified by the judges.

At all times during the mission the UAV must not fly at a height above ground of greater than 200ft.

Points will be awarded based on the time required to complete the mission and the proximity to the centre of the target zone (refer Section 6.1 for full details). A maximum of three drops will be allowed. For each drop attempted, a maximum of three passes will be allowed (a pass may occur where the package is not dropped). The two best results will be averaged and used for judging.

A total allowable time of 30 minutes will be provided for each team. This includes all time for setup, launch, the mission, landing, recovery/pack-up and measuring of each dropped spherical package for judging.

The judges will indicate when the timer starts and teams can then enter the mission area. The timer will be stopped once all team members leave the mission area with all equipment. The mission manager will indicate that the mission is complete by exiting the mission manager's zone.

Teams must adhere to the flight circuit procedures that will be given to teams at the competition.

Postponement of the competitions due to adverse weather conditions will be at the judges' discretion. In the event of a complete wet weather day, the flights will be cancelled and a winner determined by points from the teams technical reports, oral presentations and video evidence.

Additional Deliverables

In addition to the points awarded for the mission, entrants will also be graded on a technical report. This report will outline their design, methodology for package deployment and operational and safety procedures. An oral presentation of the technical report information will also be graded.

All deliverables and points allocation are outlined in Section 6.

The Reward

The winning school in this category will receive a prize of \$10,000. In the event of a tie on points the prize will be equally shared by all parties.

2.2 Search and Rescue Challenge

This category is open to worldwide entrants – university students, privateers or hobbyists. Small companies will be permitted to enter at the discretion of the 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 and the Technical Committee reserves the right to re-assess Team Eligibility at Deliverable 1.

Staff of partner and sponsor organisations are permitted to enter a modified version of the Search and Rescue category which will be known as the *Professional Challenge*. This category will follow the same rules as the Search and Rescue Challenge, however competitors will compete only against other *Professional Challenge* competitors and will not be eligible to win any prize money.

The Mission

Outback Joe is lost in the Australian outback and desperately needs assistance. Teams must deploy an air vehicle that is used to find Outback Joe and to deliver an emergency package once he has been located.

Where's Outback Joe!

The system must be capable of searching an area near *Kingaroy* airport. The air vehicle must fly through a defined corridor of approximately 1nm 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 air vehicle goes outside the mission boundary for the competition, the air vehicle's mission will be terminated by the *Range Safety Officer (RSO)* (refer Section 5.5.2). The GPS coordinates

representing the 4 corners of the search area and the mission boundary coordinates will be provided in the lead up to the competition¹.

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 CASA for the event. Additionally, teams are limited to a maximum height of 1500ft by the competition organisers.

Figure 2 below shows a schematic of the mission boundary and search area.



Figure 2. Search and Rescue Challenge Schematic

¹ At least 1 day prior to the event

Table 1: Search and Rescue Waypoints

MISSION AREA BOUNDARIES (WGS 84 Degrees:Minutes:Seconds)	SEARCH AREA BOUNDARIES (WGS 84 Degrees:Minutes:Seconds)
Mission Boundary - Point 1 (MB – 1) 26°34'39.21"S 151°50'12.79"E	Search Area - Point 1 (SA – 1) 26°36'57.00"S 151°50'35.00"E
Mission Boundary - Point 2 (MB – 2) 26°34'38.31"S 151°50'25.24"E	Search Area - Point 2 (SA – 2) 26°37'2.76"S 151°51'59.19"E
Mission Boundary - Point 3 (MB – 3) 26°34'53.44"S 151°50'31.02"E	Search Area - Point 3 (SA – 3) 26°38'12.81"S 151°52'15.83"E
Mission Boundary - Point 4 (MB – 4) 26°34'42.55"S 151°50'50.89"E	Search Area - Point 4 (SA – 4) 26°38'7.48"S 151°50'28.24"E
Mission Boundary - Point 5 (MB – 5) 26°35'58.16"S 151°51'10.39"E	
Mission Boundary - Point 6 (MB – 6) 26°36'33.16"S 151°52'29.07"E	
Mission Boundary - Point 7 (MB – 7) 26°38'43.72"S 151°52'55.39"E	
Mission Boundary - Point 8 (MB – 8) 26°38'36.86"S 151°49'49.26"E	

The target for the search will be a human dummy wearing light khaki clothes and an Akubra hat. There will be a simulated heat signature for the dummy. 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.

The SAR Challenge target heat signature simulator is a Videotec IR50WFL11:

http://www.videotec.com/upl/pdf/i/IR_EN.pdf

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

After the search for Outback Joe is complete, the GPS coordinates representing his location must be provided to the judges (in WGS 84 Degrees:Minutes:Seconds format). The judges must confirm the location is within range of Outback Joe before a drop is allowed². Failure to do this will result in immediate disqualification.

² For safety reasons, teams will only be allowed to drop the emergency package if the team's chosen GPS position is within a certain range from Outback Joe

Only 3 attempts to provide the location of Outback Joe will be allowed. If a Team fails to locate Outback Joe on the third attempt the team must finish the mission immediately and no more points will be awarded. Points will also be deducted from the teams score as per the points section (refer Section 6.2).

Rescue Outback Joe!

Once Joe has been located, the air vehicle must deliver a minimum of 500ml of fluid safely to him. There are no restrictions on the deployment device, however the judges must be able to open a container (possibly containing the vessel of fluid) by hand and measure the quantity of fluid delivered to Outback Joe (simulating the drinking of the lifesaving fluid). The fluid must be an unopened vessel suitable for human consumption – examples include a bottle of water or Coke purchased from a shop.

The emergency package (containing the fluid) must be dropped as closely as possible to Outback Joe, without touching him. The UAV will then return to the Kingaroy airport for landing.

A time of 1 hour is allowed for the mission. This includes all time for setup, launch, the mission, landing, recovery/pack-up and measuring the location of the dropped emergency package for judging. While the air vehicle is returning to Kingaroy airport, judging of the drop accuracy will be performed. Multiple attempts are allowed in the time allocated. Severe point penalties will be incurred for going over the 1 hour time limit as per Section 6.1.

The air vehicle must comply with the specifications in Section 5.3.2. Teams are restricted to use one air vehicle only for the 60 minute mission.

Points will be awarded based on the time required to complete the mission, the level of autonomy and the proximity of the emergency package to Outback Joe (as per the Section 6.1).

Points to Note

1. Teams may only drop ONE bottle of fluid to Outback Joe. Teams that drop multiple bottles of liquid will be immediately disqualified
2. For safety, teams should only carry enough fuel for the mission (plus necessary reserves)

Additional Deliverables

In addition to points awarded for the mission, entrants will be required to submit a technical report which outlines their design, methodology for package deployment and their operational and safety procedures. An oral presentation of the technical report information is also required. Judges will grade these deliverables.

Demonstrating a safe level of operations is mandatory for all teams. This will be assessed by the judges before any flights are permitted at Kingaroy. This will include video evidence and flight log records of previous flights.

The Reward

Winners in this category will receive \$50,000 cash if the mission is completed.

2.3 Team Documentary

In order to record the events during and building up to the 2008 UAV Outback Challenge, the organisers will offer a prize to the film maker/s that creates the best documentary (not exceeding 15 minutes).

The Challenge

The documentary should show the full story of a team preparing for the Challenge. Teams will submit their documentary to the challenge organising committee at the commencement of the competition. Refer Section 6.1.4 for details regarding the Official 2008 UAV Outback Challenge Documentary.

In addition to the Team Documentary Challenge, an official 2008 ARCAA Challenge documentary will be produced.

It must be noted that the Challenge organising committee will have exclusive rights to develop the official documentary. This documentary may include footage submitted from each entrant in this category. By submitting to the Documentary challenge, all teams grant ARCAA permission to use any submitted material for commercial, promotional or any other use.

It is not compulsory for teams to enter the documentary competition component of the UAV Outback challenge. All teams must however produce video evidence of flights as part of the submission process as outlined in Section 5.4.1.

The Reward

There are 2 prizes in this category – one for each challenge. Winners in the Airborne Delivery Documentary category will win \$2000 and the winners in the Search and Rescue Documentary category will win \$8000.

3 Schedule

Table 2 below sets forth the overall competition schedule:

Table 2. 2008 UAV Outback Challenge schedule

Activity	Date
Nominations Close	7 May 2008

Activity	Date
<i>Nominations must be made by close of business, and through the competition website.</i>	
<p>Participant Notification of eligibility</p> <p><i>The organising committee will evaluate the nominations and will make final decisions as the eligibility of each entrant. This notification will be made via email to the team project leader.</i></p>	14 May 2008
<p>Deliverable 1: Report on UAV Design Concept and Proposed Safety Methodology</p> <p><i>A short report must be delivered to the organising committee for assessment to continue in the competition.</i></p>	2 Jun 2008
<p>Feedback on Deliverable 1</p> <p><i>Teams will receive feed back on their submissions as to their eligibility for the competition (eg. are safety standards met by design and operations concept).</i></p>	9 Jun 2008
<p>Team Insurance Deadline</p> <p><i>Teams must provide the documentation as outlined in the ARCAA UAV Outback Challenge Insurance Overview for Participants: http://www.arcaa.aero/insurance.pdf before their application to participate in the Challenge becomes unconditionally accepted. Teams must submit this information NO LATER than 29th Aug 2008. Teams that have not submitted this documentation by this date may be disqualified from the competition.</i></p>	29 Aug 2008
<p>Deliverable 2: Demonstration of Flight Readiness</p> <p><i>A technical report that outlines the final design, along with test results 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. It is required that video evidence of flights along with copies of the aircraft flight log will be components of this deliverable.</i></p> <p><i>Video evidence must include a flight demonstration of the dropping mechanism that will deliver the payload. The video must include an actual 'drop' of the payload.</i></p>	29 Aug 2008
<p>CASA Applications Due</p> <p><i>All participating teams must apply for their relevant approvals. Participants in both challenges must apply for permission to operate on or near an aerodrome. Participants in the Search and Rescue Challenge must also apply for a UAV area approval. The appropriate information is available on the CASA website. Applications should be sent to the organising committee for forwarding to CASA. Note there will be a \$75 fee associated with the issue of the approval.</i></p>	29 Aug 2008

Activity	Date
Go-No Go Announcement of Teams <i>Final approval to participate in the 2008 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.</i>	5 Sep 2008
Airborne Delivery Challenge <i>Orientation, Safety Briefing and Inspections, Oral and Documentary Video Presentation</i>	22 Sep 2008
Airborne Delivery Challenge <i>Competition day and Awards BBQ</i>	23 Sep 2008
Search and Rescue Challenge <i>Orientation, Safety Briefing and Inspections, Oral and Documentary Video Presentation and Practice Day</i>	23 Sep 2008
Search and Rescue Challenge <i>Competition Day and Awards Banquet</i>	24 Sep 2008
Adverse Weather Day <i>An adverse weather day is allocated in case judges decide wind, rain or other adverse conditions interfere with the running of the competition.</i>	25 Sep 2008

4 Challenge Safety

Safety is a priority for the 2008 UAV Outback Challenge, and the rules and regulations (refer Section 5) contained in the 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 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.**

The rules outlined in Section 5 will be strictly enforced in order to reduce the risk associated with holding the 2008 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 category. This device provides another layer of safety for the general public in the surrounding area to the Challenge and prevents the air vehicle from flying well beyond the *mission boundary*. Refer to Section 5.5.2 for full details.

5 Rules and Regulations

5.1 Entry Nomination

Entry *nominations* must be submitted in English to the *2008 UAV Outback Challenge Organising Committee* by 7 May 2008. Nomination forms can be found on the UAV Outback Challenge website: <http://www.uavoutbackchallenge.com>. The completed forms can be submitted electronically on the website.

When registering, teams should nominate the Challenge category that they wish to compete in. The organising committee will review all nominations, and reserves the right to refuse entry into a proposed category if it feels the team is not qualified for that category (based on team experience, platform capabilities, etc).

All decisions regarding nomination categories are final. Teams must state on the nomination form the individual or organisation to whom prize cheques should be made payable and disclose the estimated budget for the entrant.

5.2 Team Composition

All teams must provide a list of team member names to the organising committee. Each Team must designate a team leader on their nomination form. The team leader will be responsible for all official communication with the organising committee, and will speak on behalf of the team during the competition.

5.3 UAV Requirements and Limitations

5.3.1 Airborne Delivery Challenge

UAV entries will be subject to the following requirements and limitations:

- Must use an electric propulsion system;
- Must be free flying;
- Have no entangling encumbrances such as tethers;
- Takeoff gross weight must be less than 15 kg;
- Must have continuous radio communication with the *UAV Controller*; and
- Platform and onboard systems can be commercial off the shelf or custom made.

5.3.2 Search and Rescue Challenge

UAV entries will be subject to the following requirements and limitations:

- Must not be a commercial off-the-shelf UAV complete system (ie: UAV with all avionics already integrated);
- Must be capable of *autonomous* flight;
- Must be free flying;
- Maximum gross weight (MTOW) must be less than 100 kg (rotary) or 150kg (fixed wing) as per CASR101;
- Must have continuous radio communication with the *UAV Controller*; and
- Platform and onboard systems can be commercial off the shelf or custom made.

5.4 Entry Qualification Requirements

5.4.1 Safety Inspections

All UAVs 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 UAV 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 UAV 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 range checks with motor off and on;
- Flight termination system tested;
- UAVs 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.

Specific details on these safety tests will be provided to teams closer to the event date.

5.4.2 UAV Controller Override

For safety reasons, all UAVs must provide an override capability where the UAV can be changed from autonomous flight to a manually flown radio mode.

5.4.3 Flight Termination Mode

All Search and Rescue Challenge category 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 Safety Methodology document for the organising committee to provide feedback on (Due 2 June 2008);
- the device must be onboard the UAV 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; and
- the device must receive a heart-beat like signal from the onboard computers/communications link every 5 seconds, so that the flight termination mode is initiated if the heart beat signal is not received.
- must be able to be activated from the ground by the UAV controller at the command of the judges.

All points above must be demonstrated to the judges prior to every flight conducted at Kingaroy.

The flight termination servo positions for fixed-wing UAVs 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 UAVs is to simply close the throttle.

Supplementary Note:

Teams may, submit a detailed proposal with Deliverable 2 to the organisers for variation of the flight termination device in their air vehicle that differs to the system specified above. 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. Also note, that teams who wish to use an alternative flight termination strategy must demonstrate (with actual figures) 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. 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.

In the case of lighter than air vehicles, strategies should be included that note how the air vehicle 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.

5.4.4 Flight Demonstration

Before attempting the Challenge, all teams must demonstrate their UAVs in flight to the Judges. A circuit must be flown in piloted mode and autonomous mode (if applicable) to demonstrate the competency of the UAV and the UAV controller. The details of this circuit will be given to the teams on the practise days of the Challenge.

5.5 Challenge Regulations

5.5.1 Mission Boundary

During the mission, UAVs must remain within the designated *mission boundary*. If a UAV appears to be either uncontrolled or moving beyond the mission boundary, the mission will be terminated as described below in Section 5.5.2.

Teams must remain between 200-400 ft (height above ground) at all times during the mission (excluding landing and takeoff phases at the Kingaroy airport). Teams may fly up to 1500 ft height above ground if approval has been granted by CASA but no higher (as specified by the competition organisers).

Airborne Delivery Teams must be capable of executing takeoff and landing from a roughly mown grass runway. **Search and Rescue teams will have access to the sealed runways.**

5.5.2 Criteria for Mission Termination

The Challenge judges may request a mission to be terminated or a mission may be terminated automatically by the onboard system for a variety of reasons. These are:

- If the UAV goes outside the mission boundary;
- If the communications link is lost for more than 5 seconds;
- If the UAV is deemed to be out of control by the judges;
- If the onboard systems lock up (the independent flight termination system - described below - does not receive the heart beat signal)

A mission termination is defined as putting the UAV into the *flight termination mode* as defined in Section 5.4.3

If the UAV remains within the mission boundary teams will have 20 seconds after being told to initiate the *flight termination mode* for the first time to try and switch the UAV back into piloted mode so that the UAV controller can attempt to land it safely within the mission boundary area. If this measure fails or the UAV controller is unable to control the UAV, the flight termination mode must be activated after 20 seconds.

Even if teams regain control of the UAV, the team must finish the mission immediately and no more points will be awarded. Points will also be deducted from the teams score as per the points section (refer Section 6.2). If the flight termination mode is initialised teams lose all mission points (max. 70 points).

Missions must be IMMEDIATELY terminated by the teams upon request of the judges. This will be done through the ground station interface.

5.5.3 Number of Attempts

Each Team will be allowed multiple attempts as per the mission statement (refer Section 2) to complete the mission in their category within the allotted time. New attempts should only be initiated if there is sufficient time remaining to complete the entire mission.

5.6 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 technical report. Sponsors should be aware that footage of a team's UAV could form part of the official ARCAA 2008 UAV Outback Challenge documentary.

5.7 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 will require 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 ARCAA UAV Outback Challenge official website soon.

High school students may enter the competition without the approval of their schools (and be entitled to the full cash prize themselves), however they must do all the work in their own time (not school time) and obtain insurance themselves.

Teams will have to prove that they have insurance cover BEFORE the organising committee will approve the team has been accepted into the competition.

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 team technical report and oral presentation will be ranked and scores assigned to them at this time as they will have been reviewed by the Judges in advance of this static judging.

6.1 Scoring Criteria

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

- Technical Report – 15%
- Oral Presentation – 15%
- Mission Performance – 70%

Each element is a prerequisite before progressing onto the next. Points will be deducted for flying in no fly zones, and the UAV mission will be terminated if it breaches the previously mentioned Rules when in flight. All decisions by the Competition Judges are final.

A final category of the competition is the Team Documentary. Note that it is NOT compulsory for teams to enter the Documentary competition. The points awarded for this component of the competition have no impact on the result for the other 3 Challenge categories.

This section provides a brief summary of each of the three judging elements, followed by a detailed breakdown of the point allocation for each element.

6.1.1 Technical Report

Each Team is required to electronically submit a Technical Report that describes the design of their UAV and the rationale behind the selections. Overall UAV system design, features and expected performance (including test results) and flight data should be included. Descriptions are required for the UAV platform, ground station, data link (frequencies, range, etc), flight duration, payload and method of autonomy. Specific attention should be paid to safety criteria. Photos depicting the UAV must also be included.

The report should include an updated version of the previously developed one page fact sheet that must provide a basic description of the UAV and onboard systems.

This should include the UAV dimensions, payload capacity, radio frequencies, fuel type, battery/s.

The report should also include a detailed budget that lists all hardware, expenses, sponsors and sources of funding. Teams should note that one aim of the Challenge is the development of a low cost solution to the problem, and points will be awarded appropriately based on this (refer Section 6.2).

The budget must list the cost of all hardware used by teams to complete the mission. This cost is the estimated off-the-shelf cost (as if you had to purchase everything in the system from scratch). It does not include software costs. All items must be included – even if they have not been purchased specifically for the competition, and all donations must be included also. The items that you must include is everything in the system to complete the mission – air vehicle, avionics, fuel, batteries, ground station components, etc.

Maximum page limit is 8 pages.

The format for this electronic submission must be a PDF.

6.1.2 Oral Presentation

Each Team will deliver a presentation (not exceeding 15 minutes) highlighting their approach, design, expected performance and what they have learned from the process. Unique or innovative features and safety approaches should be included. Judging will be based on technical merit, safety, craftsmanship and briefing effectiveness.

The oral presentation for the two challenges will be given according to the Schedule in Section 3.

6.1.3 Mission Performance

Judges will score mission performance according to the following criteria for each category:

6.1.3.1 Airborne Delivery Challenge

- Takeoff – *controllability*, stability, safety, autonomy
- Flight - altitude, flight path control, safety
- Payload deployment accuracy
- Landing – *controllability*, stability, safety, autonomy, accuracy, post landing condition of platform
- Mission Time – time required from pre-flight to mission completion
- Safety – demonstration of safety features
- Overall – competence of the Team, resources invested including sponsors, leadership of instructors.

6.1.3.2 Search and Rescue

- Takeoff – *controllability*, stability, safety, autonomy

- Autonomous Control – *ease of transition*, altitude, flight path control, safety
- Target Recognition – accuracy, visualisation, use of autonomy
- Package deployment accuracy
- Landing – controllability, stability, safety, autonomy, accuracy, post landing condition of platform
- *Safe State* – automatic safe state mode, return to base ability, safety
- Mission Time – time required from pre-flight to mission completion
- Safety – demonstration of safety features
- Overall – competence of the Team, resources invested including sponsors, leadership of instructors.

6.1.4 Team Documentary

Each team can create a video (not exceeding 15 minutes) that follows their participation in the UAV Outback Challenge. The video should include all phases of their journey, as well as proving that their UAV has flown at least once. The video shall NOT contain any copyright media or where copyright media has been included evidence of the approval to use such media *must* be provided.

Each team entering the Documentary Challenge is required to submit 2 version of their video. One original copy and a second copy containing no backing audio.

6.2 Points Allocation

The judges will base the final team score on the Scoring Criteria detailed in the following sections. Fractions of the maximum points shown can be given (for example 2.7/3).

Note that ALL judging will stop (no further points awarded) after the allocated mission time is exceeded. Additionally teams are severely penalised for each minute over the allocated time as detailed below.

6.2.1 Airborne Delivery Challenge

Table 3: Points allocation for Airborne Delivery Challenge

Technical Report (total of 15 Points)	
Scoring Components	Maximum Points (15)
One page fact sheet	1
UAV design including rationale	3
Approach for / level of autonomy ³	2
Flight testing results and discussion	2
Budget ⁴	3
Safety Considerations	3
Overall style/presentation	1
Late submissions	MINUS 5 points per day (max 15 points)
Over page limit (8 Pages)	MINUS 2 points per page (max 15 points)

³ Teams do not have to use autonomous systems however will be awarded to the level they have used/considered this

⁴ Teams that operate with a lower budget will be given a higher score in this section.

Oral Presentation (total of 15 Points)	
Scoring Components	Maximum Points (15)
UAV Design	3
Safety considerations / Start-up & flight operations procedures	4
Discussion on flight tests conducted – results / lessons learned	3
Evidence of good teamwork – distribution of project tasks between group members, a number of members participating in the presentation, etc	3
UAV craftsmanship (quality of the overall finish of the UAV – internal systems and external finish)	1
Presentation style	1
Time limit (15 minutes) ⁵	MINUS 1 point / minute over (max 5 points)

Mission Performance (total of 70 Points)		
Subjective Components	Scoring	Maximum Points (30)
Takeoff: - controllability - stability - safety	2 1 1	
Autonomous Control ⁶ : - maintain commanded altitude - maintain flight path control (demonstrated a coordinated flight path from take-off through to landing) - safety	2 3 1	
Landing: - controllability - stability - safety - accuracy - post landing condition of platform and payload	1 1 1 4 3	
Safety – demonstration of safe mission operation; additional safety measures/features of the UAVs	4	
Overall – competence of the Team, resources invested	4	

⁵ Presentations will be stopped at 20 minutes – no exceptions.

⁶ Teams do not have to have autonomous control however are awarded if they do so.

including sponsors, leadership of instructors, teamwork	
Performance Components	Measure
	Maximum Points (40)
Autonomous take-off (yes/no)	5
Dropping object in close proximity to the centre of the target drop zone (in the sandpit)	<10 cm: 10 Points; or <20 cm: 7 Points; else 5 Points
Dropping object outside of the target drop zone (outside the sandpit)	Within 1 meter any direction: 2 Points
Spherical package dropped automatically	5
Autonomous mission phase of flight (yes / no)	3
Autonomous landing (yes/no)	5
Entire flight Autonomous ⁷ (yes/no)	5
Mission Time (30 minutes) – total time elapsed from pre-flight to mission completion ⁸	2 Points (time < 25 minutes); or 4 Points (time < 20 minutes); or For each minute over 30 minutes teams loose 2 Points. If teams exceed 45 minutes they loose ALL POINTS for the mission (max 70 Points)

6.2.2 Search and Rescue Challenge

Table 4: Points allocation for Search and Rescue Challenge

Technical Report (total of 15 Points)	
Scoring Components	Maximum Points (15)
One page fact sheet	1
UAV design including rational	3
Approach for autonomy ⁹	4
Flight testing results and discussion	3
Budget	1 Point (budget less than AUD\$50,000) MINUS 3 points (budget between AUD\$100,000 and AUD\$200,000) MINUS 5 points for each AUD\$100,000

⁷ Note that this only includes the flight of the UAV – it does not include whether the spherical package is dropped manually or automatically.

⁸ The time is started when teams enter the flight area and stopped when teams leave the area for the final time with ALL equipment including the air vehicle

⁹ Teams do not have to use autonomous systems however will be awarded to the level they have used/considered this

	over AUD\$200,000
Safety Considerations	3
Late submissions	MINUS 5 points / day (max 15 points)
Over page limit (8 Pages)	MINUS 2 points / page (max 15 points)

Oral Presentation (total of 15 Points)

Scoring Components	Maximum Points (15)
UAV Design	2
Safety considerations / start-up & flight operations procedures	2
Discussion on flight tests conducted – results / lessons learned	3
Approach used for locating / detection of Outback Joe	3
UAV craftsmanship (quality of the overall finish of the UAV – internal systems and external finish)	4
Presentation Style	1
Time limit (15 minutes) ¹⁰	MINUS 1 point / minute over (max 5 points)

Mission Performance (total of 70 Points)

Subjective Components	Scoring	Maximum Points (28)
Takeoff:		
- controllability		2
- stability		1
- safety		1
Autonomous Control:		
- maintain commanded altitude		2
- maintain flight path control (demonstrated a coordinated flight path from take-off through to landing)		3
- safety		1
Landing:		
- controllability		1
- stability		1
- safety		1
- accuracy		4
- post landing condition of platform and payload		3
Safety – demonstration of safe mission operation; additional safety measures/features of the UAVs		4
Overall – competence of the		4

¹⁰ Presentations will be stopped at 20 minutes – no exceptions.

Team, resources invested including sponsors, leadership of instructors, teamwork	
Performance Components	Measure
	Maximum Points (42)
Autonomous take-off (yes/no)	5
Emergency package comes to rest in close proximity to Outback Joe (UAV height above ground greater than 100m)	Between 5 and 15 meters: 12 Points Less than 5 meters: 6 Points <20 meters: 6 Points <30 meters: 4 Point <50 meters: 1 Point If you hit Outback Joe – NO POINTS
Emergency package comes to rest in close proximity to Outback Joe (UAV height above ground between 50m and 100m)	Between 5 and 15 meters: 6 Points Less than 5 meters: 3 Points <20 meters: 3 Points <40 meters: 1 Point If you hit Outback Joe – NO POINTS
Visually Detect the target zone and drop emergency package automatically	10
Autonomous mission phase of flight – navigating all waypoints ¹¹ (yes / no)	5
Autonomous landing (yes/no)	5
Entire flight Autonomous (yes/no)	5
Mission Time (1 hour) – total time elapsed from pre-flight to mission completion ¹²	2 Points (time < 55 minutes); or 4 Points (time < 45 minutes); or For each minute over 1 hour, teams loose 2 Points. If teams exceed 1 hour 15 minutes they loose ALL POINTS for the mission (max 70 Points)
Flight Termination Mode requested (UAV regains control and flown home safely): No More points awarded for the Mission;	MINUS 10 points Flight Termination Mode is requested but the UAV regains control and flown home safely: No More points awarded for the Mission; If Flight Termination mode is initiated - ALL Mission points LOST (max. 70 points)
Team fails to identify the location of Outback Joe after 3 attempts.	MINUS 10 points Team fails to locate Outback Joe after three attempts: The team must finish the mission immediately and no more points will be awarded for the Mission.

¹¹ Teams will be given a series of waypoints to follow through a defined corridor out to the search area. Teams should also demonstrate a coordinated search pattern.

¹² The time is started when teams enter the take off flight area and stopped when teams leave the area for the final time with ALL equipment including the air vehicle

7 Awarding of Prizes

For the Airborne Delivery Challenge the school that the team is from with the highest points will be awarded the prize money / prizes for first place.

Australian high school students may enter the competition without the approval of their schools (and be entitled to the full cash prize themselves), however they must do all the work in their own time (not school time) and obtain insurance themselves.

In the Search and Rescue Challenge Category, 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.

The Search and Rescue Challenge mission is only considered successful if:

- The mission is completed within 1 hour
- The UAV does not cross the mission boundary
- At least 500 mL of water is recovered by the judges
- The emergency package comes to rest within 100m of Outback Joe
- The emergency package does not touch Outback Joe

8 Definitions

Term	Definition
2008 UAV Outback Challenge Organising Committee	This includes representatives fro QUT, CSIRO, Boeing Australia, South Burnett Local Government Association and Queensland Government
Autonomous / Autonomy	The UAV operates without any human interaction / intervention
CASR101	Civil Aviation Safety Authority (CASA) Regulation Part 101 – Unmanned Aircraft and Rocket Operations
Categories	Refers to the three categories in the competition <ul style="list-style-type: none"> • Airborne Delivery Challenge; • Search and Rescue Challenge; and • Team Documentary
Competition Safety Personnel	Staff responsible for ...
Controllability	The ability to operate the system using only certain admissible manipulations on the control surfaces.
Ease of Transition	Refers to the ability of the system to move from one commanded or controlled position to the next
Flight /mission termination	Refer Section 5.5.2
Hobbyist	A person who pursues and activity in their spare time for pleasure

Term	Definition
Kingaroy	Kingaroy is located in Queensland Australia: 26°34'50.08"S; 151°50'23.79"E (Kingaroy Airport)
Mission Boundary	The area which the UAV must remain within at all times. If the UAV leaves this area the <i>flight termination</i> will be initiated
MTOW	Maximum Take-off Weight
Nomination	Teams who have submitted the 2008 UAV Outback Challenge nomination form
Participant	Teams who have been accepted by the 2008 UAV Outback Challenge Organising Committee
Privateers	Hobbyists
<i>Range Safety Officer (RSO)</i>	Person that will indicate if the mission has to be terminated because at any time the air vehicle goes outside the mission boundary for the competition
Safe State	A vehicle is in safe state, if from that state there exists known dynamically feasible trajectory to a state or sequence of states that is obstacle and collision free, and in which the vehicle can remain for an indefinite period of time.
Safety	The condition of being safe; freedom from danger, risk, or injury
Stability	Refers to both static and dynamic stability. Static stability refers to the aircraft's initial response when disturbed from a given angle of attack, slip or bank and also to Dynamic stability refers to the aircraft response over time when disturbed from a given angle of attack, slip or bank. Refer to a book on aircraft control for details
UAV	Unmanned (or Uninhabited) Aerial (or Air or Airborne) Vehicle (or System), also known as an Aerial Robot
Undergraduate Student	A college or university student who has not yet received a bachelor's or similar degree
Unmanned	Not having or needing a crew or staff : an unmanned space flight

9 Disclaimer

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