UAV Challenge
Medical Rescue 2020

Competition Rules

Version: 5
Date: 22 January 2020

NOTICE TO COMPETITORS

This document is subject to change by the UAV Challenge organisers. Flight operations during the UAV Challenge Medical Rescue event will be governed by, in order of priority, the UAV Challenge Medical Rescue Operations Manual and the UAV Challenge Medical Rescue rules (this document). There is an expectation that teams will enter into the UAV Challenge Medical Rescue event with a desire to compete within the spirit of the Challenge and not to exploit loopholes for an unfair advantage. The UAV Challenge Technical Committee and judges reserve the right to take action against any team or individual that conducts themselves in a manner judged contrary to the intent and spirit of the UAV Challenge.

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Revision Record

Version 5

- Date of the flying event changed to September 29 to October 2.

Version 4

- Date of the flying event changed.
- Fixed broken link to Airservices Australia in Section 3.4.3.

Version 3

- Updated requirements for aircraft during Remote Landing phase and Entering the Shed phase of the mission.
- Added a requirement for an E-Stop for any Ground Vehicles used.

Version 2

- Introduced a Demonstration Category for teams that have an actual or perceived conflict of interest with sponsors or organisers of the UAV Challenge event.
- Removed specification of Dynamic No Fly Zone interface. Includes removing Appendix C. Details of this will now appear on the UAV Challenge website.
- Added note that it is allowable for a team's ground vehicle (if used) to deposit communications relay devices at the Remote Accident Site.

Version 1

- Initial Release

Glossary

Base	The bounded area of ground operations for the teams and where all aircraft must launch and any returning aircraft must be recovered.
Base Controller	The member of the organising personnel in charge of the *Base* area.
CASA Designated Coordinator	The member of the UAV Challenge Technical Committee regarded by CASA as the coordinator of UAV Challenge air operations.
Demonstration Category	Category of participation for teams with an actual or perceived conflict of interest.
Dynamic No-Fly Zone (DNFZ)	A type of *No-Fly Zone* that changes its location during a mission representing other airspace users.
E-Stop	A latching button that is red in colour with a yellow surrounding disk that de-energizes all aircraft propulsion and actuation systems.
Flight Termination System	A mandated system on-board all competition unmanned aircraft that guarantees that an aircraft will not fly a significant distance outside the *Geofence* boundary.
Geofence	A specified boundary in the airspace that must not be crossed by a competing unmanned aircraft.
Joe's Reported Location	The reported GPS location of Outback Joe's farm.
Judges	The UAV Challenge organising team personnel who judge and award points during a team's mission.
Non-transit Aircraft	An unmanned aircraft that is deployed and flies entirely within the Remote Accident Site area. It must be deployed by a *Transit Aircraft*.
Range	The operating area of the UAV Challenge event as defined by the *Geofence.*
Range Safety Coordinator	The member of the organising personnel in charge of the range (the flight areas outside the *Base*).
Remote Landing Point	The resting location of a team's landed UAV at the *Remote Accident Site.*
Remote Accident Site	The area immediately around *Outback Joe's shed area.*
Rescue Aircraft	An unmanned aircraft that may land enter the *Remote Accident Site.*
Rescue Ground Vehicle	A small robotic ground vehicle deployed by a *Rescue Aircraft* within the *Remote Accident Site*.
Static No-Fly Zone	An area of airspace that a competing unmanned aircraft must not fly through. These will be typically around farm buildings.
Support Aircraft	A unmanned aircraft that does not land at the *Remote Landing Point* but is used to support a *Rescue Aircraft* in some way.
Team Communicator	The nominated team member who the Judges and Event Marshals communicate with during a mission
Technical Committee	The committee of UAV Challenge organisers and industry experts that write these rules and manage the flight operations of the UAV Challenge.
Transit Aircraft	An unmanned aircraft that flies somewhere between the Base and the Remote Accident Site.
Transit Waypoint	A defined location that all aircraft must pass through during their transit to and from the *Remote Accident Site.*
UAV Controller	A team member in command of an unmanned aircraft.

1 The Mission

The goal of the UAV Challenge is to demonstrate the utility of Unmanned Airborne Vehicles (UAVs) for civilian applications, particularly in those applications that will save the lives of people in the future. In this competition, competitors will be required to develop an autonomous flying system that could save lives by quickly and cost effectively providing a live video and audio stream from a remote accident site in the Australian Outback to a medical team travelling to provide medical assistance.

1.1 Overview

Outback Joe is at his property in remote Queensland, Australia and has been maintaining his farm equipment in his shed. He has had a serious accident in the shed and requires urgent medical attention. Before he lost consciousness, Joe managed to make an emergency radio call to a family member. The area around Joe's farm does not have mobile phone coverage. The emergency services have now been alerted but will take at least two hours to travel to Joe's farm. They want to dispatch a UAV to the farm ahead of their arrival in order to establish a live video and audio streaming system that will help them assess Joe's condition and potentially allow them to communicate with Joe should he regain consciousness.

Teams are invited to develop a system that can fly at least 20km to Joe's farm, can enter the shed, locate Joe and provide the video and audio stream back to the emergency control centre. Teams are encouraged to develop systems that can carry out the mission in a fully autonomous manner using Type 2 Autonomy. Teams must provide at least 5 minutes of continuous video and audio stream that clearly shows Joe and allow emergency service personnel to attempt to talk to Joe.

Any vehicles deployed into the shed (either flying or ground-based) must weight under 2Kg and have no dimension greater than 800mm. All flying aircraft must safely land at the completion of the mission either at the *Remote Accident Site* or back at the *Base*. The video and audio streaming must begin within 40 minutes of the start of the mission.

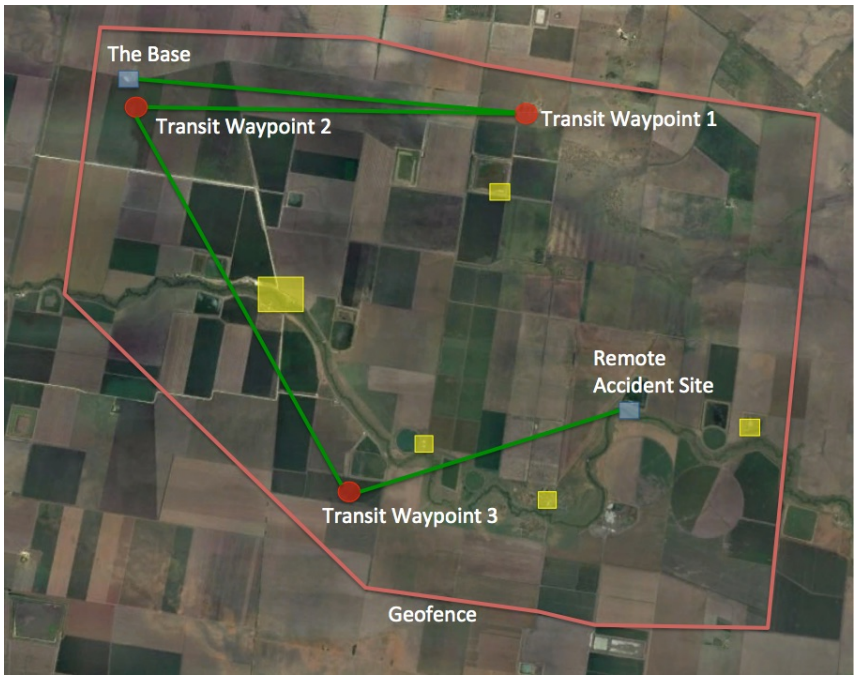

Figure 1: An example layout for a mission. Note that this figure is an example and does NOT show the actual Geofence, *Transit Waypoints*, *Static No-Fly Zones* (in yellow) or the actual *Remote Accident Site*.

The *Remote Accident Site* will be located approximately 5.4 to 6.5 nautical miles (as the crow flies) from the takeoff location known as the *Base*. Teams must not fly above 400ft AGL at any time during the mission and must maintain an altitude of at least 100ft AGL while not flying over roads and at least 200ft AGL if flying over roads (this restriction does not apply during take-off and landing manoeuvres). All aircraft must also fly to and from the *Remote Accident Site* via a number of *Transit Waypoints*.

1.2 Finding Joe's Shed

1.2.1 Planning

The location of Joe's farm (referred to as *Joe's Reported Location*) will be given to the teams, but they must take into account that the reported location is of the farm in general and not the exact location of the shed where Joe is located. It is expected that team's will use an online aerial mapping service to find a photograph of Joe's farm and locate the shed.

The coordinates of *Joe's Reported Location*, the vertices of the *Geofence*, and the coordinates of the *Transit Waypoints* that aircraft must pass through will be given to teams at the commencement of the Event. A list of *Static No-Fly Zones* and their coordinates will also be issued to teams. *Static No-Fly Zones* will be defined by 4 vertices. All coordinates will be provided to teams in a single KMZ file.

A team may opt to undertake the mission containing an optional Extension Autonomy Challenge of *Dynamic No-Fly Zones (DNFZ) and a Follow-The-Leader Task*. There is an additional cash prize for the winner if the winning mission was completed with a successful Extension Autonomy Challenge component.

The technical details of how teams will receive live updates of the coordinates of *Dynamic No-Fly Zones* and the *Follow-The-Leader Task* will be made available on the UAV Challenge website in the future.

The aircraft must at all times during the mission remain within the *Geofence.* The *Geofence* boundaries will form an irregular polygon with no more than 18 vertices.

Teams must plan a flight path from the *Base* to the *Remote Accident Site (and optionally back)* that avoids the *Static No-Fly Zones* and ensures that the unmanned aircraft fly through the *Transit Waypoints*. The outward and inward flight paths may differ and flight paths may be changed during the competition flight.

There is a requirement that aircraft must fly through the first two waypoints in the order they are given. Aircraft may then fly through the remainder of the waypoints in any order.

1.2.2 Launch from the Base

Teams will launch their aircraft from the *Base*. Teams will be given time to prepare and setup for the takeoff. Launching from the *Base* may be autonomous or manual (remembering that manual take-offs will not qualify teams for the greater prize money – Section 2). The area at the *Base* for the takeoff will be limited but there will be a prepared grass runway available.

The event organisers will determine the GCS set up area (based on conditions and safety considerations) and teams must operate their GCS in that location. The GCS set up area may vary during the event due to changing conditions.

An autonomous takeoff is defined as a takeoff where a single command is issued to an aircraft or an aircraft launch system and the aircraft launches into the air in response to this command. For example, the command may come via the GCS or could be a foot pedal on a bungee launch system. Aircraft that are launched by hand (e.g. by being thrown) will be considered to have had a manual takeoff.

1.2.3 Transit to the Remote Accident Site

The competition aircraft must fly through a series of *Transit Waypoints* to the *Remote Accident Site*. The total length of the shortest possible flight path through the *Transit Waypoints* (from the Base to the *Remote Accident Site*) will be less than 16 nautical miles but greater than 11 nautical miles. Aircraft must fly within 50m of a *Transit Waypoint* to have been considered to pass through the waypoint. The layout of the *Transit Waypoints* may result in an aircraft backtracking.

There will be:

- a maximum of 8 *Transit Waypoints*.
- a minimum distance of 200 metres between a *Transit Waypoint* and a *Static No-Fly Zone.*
- a minimum distance of 200 metres between a *Transit Waypoint* and a public road.

Aircraft must automatically engage their *Flight Termination System* if they breach the *Geofence*.

Aircraft must not fly through any designated *Static No-Fly Zone*. These will typically be areas around farm buildings. Teams observed flying through a *Static No-Fly Zone* will be disqualified and asked to command their aircraft to return to The Base.

If an aircraft has to overfly and cross a public roadway, it should cross at right angles to the road to minimise the transit time over the road. Aircraft must also overfly public roads at a minimum altitude of 200ft AGL.

Aircraft should not fly closely alongside or directly above roads unless crossing the road.

1.2.4 Arriving at the Remote Accident Site

On reaching the *Remote Accident Site*, aircraft must maintain the minimum flight altitude of at least 100ft AGL unless landing or entering Joe's shed.

1.2.5 Locating Joe's Shed

Once a team's aircraft arrives at the *Remote Accident Site*, the team must indicate to the judges and Range Marshals where they determine the shed is (Figure 2 shows similar sheds). At this point, the judges will either allow or deny a team to continue their mission. If it is clear to the judges and the Range Marshals located at the *Remote Accident Site* that a team has misidentified the shed and that continuing the mission based on this error will be dangerous, they may be asked to abort the mission and may be asked to return their aircraft to *The Base*.

Figure 2: Sheds similar to Outback Joe's shed.

1.3 Remote Landing Outside the Shed (optional)

Once the *Remote Accident Site* has been identified, one of the team's aircraft may land within the *Remote Accident Site*. The area around the *Remote Accident Site* will be largely cluttered and will impede low glideslope

landings. It is expected that the aircraft will have a method of assessing the *Remote Accident Site*, and that the assessment produced, will assist the aircraft determine how to land. The aircraft must not land closer than 5m from a farm building. If the aircraft does land within 5m of a farm building, the mission will be declared over and aircraft will be deactivated and removed from the *Remote Accident Site*.

A remote landing manoeuvre must be fully autonomous in nature. The location of the landed aircraft will be referred to as the *Remote Landing Point*.

If the team's intent is to keep the aircraft at the landing point, for example to deploy a ground vehicle, and there is no need for the aircraft to takeoff again, then the aircraft must automatically remove power from any propellers indicating that its flying is over and making it safe for anyone to approach.

If the landed aircraft is landing to deploy a ground vehicle or a communications package or any other hardware required to complete the mission and the aircraft needs to take-off again to continue its mission, then the aircraft's propellers must remain moving during its time on the ground. This is to indicate to any ground personnel involved in the event, that the aircraft is still active and will be taking-off again.
Aircraft that have deactivated their propellers outside the shed may not take off again during the mission. They will remain where they landed and will be returned to *The Base* by the UAV Challenge organisers after the mission is completed (via ground transport).

If devices are deposited outside the shed, they should be made in a way that they are highly visible to the human rescue personnel on their arrival to minimise the trip hazard.

1.4 Entering the Shed and Establishing the Video and Audio Link

Teams may deploy a ground vehicle from a landed aircraft into the shed, or they may fly an aircraft into the shed. The navigation of either type of vehicle in the shed does not need to be autonomous to qualify for the Fully Autonomous Mission prize. That prize only relates to flying from the *Base* to the *Remote Accident Site* (and optionally back).

If a team is using a ground vehicle or an aircraft, either type of vehicle is permitted to deposit communication relay devices on the ground in or outside the shed. Such devices should be made in a way that they are highly visible to the human rescue personnel on their arrival to minimise the trip hazard.

Teams may direct their shed entering vehicles using remote control; based on what they see from any imaging or video systems they may have on the vehicle. Vehicles should find and navigate close to Joe so that the vehicle's video streaming camera can clearly see him.

The requirement to keep propellers moving if temporarily landed does not apply once an aircraft is within the shed.

Once in position, the vehicle should remain stationary during the 5-minute video and audio streaming period. If the in-shed vehicle is flying, it must deactivate any rotors prior to the commencement of 5-minute video and audio streaming session.

Teams must inform the judges when they start their 5-minute video and audio streaming session. This must commence no later than 40 minutes after mission start.

A large digital clock/timer will be visible next to Joe. This clock will have the seconds clearly changing so that the judges back at the *Base* can see that the video stream is continuous and has not frozen.

The song “Rescue Me” by Fontella Bass will be playing (the speaker will be close to Joe) and this music must be heard by the judges at the Base to confirm that the audio is working correctly.

The basic mission is considered complete at the end of the 5-minute video and audio streaming period. If a team has already landed all aircraft at that time, then the mission is over.

1.5 Return to Base (optional)

1.5.1 Transit to the Base

If teams wish to fly back their non-landed aircraft to *The Base* at the conclusion of their mission, they may. However, the time that an aircraft takes to return to *The Base* is included in the total elapsed mission time of a team. Any returning aircraft must fly back to *The Base* via the *Transit Waypoints (with only the final two to be completed in reverse order)* and avoid all *Static No-Fly Zones* and *Dynamic No-Fly Zones* (if a team has chosen to undertake the Extension Autonomy Challenge option).

1.5.2 Landing at the Base

The area at the *Base* for the landing will be limited but there will be a prepared grass runway available. The mission clock will be stopped at the time of the last of the team’s aircraft landing.

1.6 Pack up

Teams will be given time to pack up any aircraft that retuned to *The Base* and their *Ground Control Station*, and any other equipment associated with their operation at the *Base*.

1.7 Extension Autonomy Challenge - Dynamic No-Fly Zones and Follow-The-Leader Task

Teams have the option to participate in an **Extension Autonomy Challenge** while completing the primary goal for which an additional prize is available (Section 2).

1.7.1 Dynamic No-Fly Zones

The Extension Autonomy Challenge includes the definition of multiple *Dynamic No-Fly Zones* (*DNFZs*) into the *Geofence* defined operating area in addition to the pre-defined *Static No-Fly Zones*. *DNFZs* represent other virtual airspace users and potential threats to aircraft and as such are regions of airspace that UAVs should not enter when airborne. Multiple *DNFZs* can exist at any time, are of varying size, and move with time depending on the type of virtual event they represent.

The "spirit” of the Extension Autonomy Challenge is that the set of *DNFZs* cannot be predicted before the mission begins and therefore there is no ability for teams to pre-plan a route that avoids the *DNFZs*. Dynamic mission re-planning and activity prioritisation will be the resulting development area.

The *DNFZs’* location, size and velocity will be fed to the team’s aircraft via a digital feed. Specific technical details of this feed and the DNFZ definitions will be outlined on the UAV Challenge website.

The DNFZ tracks will be generated by a mix of simulation and recorded data from real world air traffic.

There are no implications for Flight Termination System for violating the *DNFZ* regions. The consequence of breaching the *DNFZ* is to become ineligible for the Extension Autonomy Challenge award only. A team violating a DFNZ may still win the Medical Rescue Challenge.

Any team attempting the Extension Autonomy Challenge should factor in a longer flight path and flight time to and from the *Remote Accident Site*. The *DNFZs* will not be created with the intention of making teams fly more

than 10% further than without *DNFZs* but the response of the unmanned aircraft to the *DNFZs* will ultimately determine how much further an aircraft will fly.

1.7.2 Follow-The-Leader Task

The second component of the Extension Autonomy Challenge is a *Follow-The-Leader Task*. At some point during the flight, the DNFZs will reach a point of complexity that will make avoidance without help a challenge. At this time, a virtual cooperative aircraft will enter the range whose role is to guide a team's aircraft through a section of DNFZs.

Teams will receive the coordinates of this virtual leader aircraft in real-time and their aircraft should follow the leader aircraft through the complex DNFZ area.

Full details on the implementation of this aspect of The Extension Autonomy Challenge will be published on the UAV Challenge website in the future.

1.8 Unmanned Aircraft

All aircraft must comply with Section 3 of these rules.

Teams are allowed to have a maximum of two *Transit Aircraft* and one *Non-transit Aircraft* for the mission. This means that three aircraft can be airborne at any time but one must always stay within the Remote Accident Site area – the Non-transit Aircraft. An aircraft that lands at the *Remote Accident Site* or enters the *Shed* will be referred to as a *Rescue Aircraft*. Another aircraft may assist the *Rescue Aircraft* in some way, and will be referred to as a *Support Aircraft*. All aircraft must remain within all defined boundaries at all times and all aircraft must have automatic *Geofence* crossing flight termination systems. Transit Aircraft must not fly above 400ft AGL at any time during the mission. Non-transit aircraft must not exit the Remote Accident Site area at any time during the mission and must not fly above 100ft AGL at any time.

Tethered aircraft count as regular aircraft for the purposes of the Medical Rescue Challenge. For example, if a team uses a free-flying *Rescue Aircraft* and a tethered balloon or multi-rotor for a communications relay platform, the team will be deemed to have used two aircraft.

1.9 Timing

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

- Set up at the *Base* and launch: 15 mins
- Maximum off-Base time (the clock stops on the final landing at the *Base* if aircraft return): 60 mins
- Recovery (optional) and pack up at the *Base*: 15 mins

Point penalties will be incurred for having an aircraft flying past the stipulated main mission time limit.

If the video and audio stream has not commenced by 40 minutes from the initial aircraft take-off from the *Base*, then the mission will be declared over.

The setup, recovery and pack up periods may be run in parallel to other team operations (to be determined by the scrutineers and judges).

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

Variations in set up and recovery can be made at the *Judges'* discretion. However, the stipulated maximum mission time will be strictly enforced.

Teams may be required to hold while their aircraft is airborne for operational requirements such as separation management with other manned or unmanned airspace users operating outside the competition. These holds will not be included in the team's mission time. The *Judges* may make additional time adjustments to ensure fairness, taking into account such matters as establishing and exiting holding patterns. Teams must make endurance data available to the *Range Safety Coordinator* and at the time of request the team shall advise any implications of the requested hold or if the circumstances change during the requested hold.

1.10 Flying order

The order of flying for the UAV Challenge Medical Rescue competition will be determined by drawing team names out of a hat. All teams shall be ready to fly from the beginning of each competition day, as there will be no allocated launch time. The team next in the order of flying will be given a 15 minute notification of when their "Set up and launch" time commences. The teams will be transferred to the *Base* area in batches to maintain schedule efficiency.

If a team cannot meet the order of flying as detailed above, or elects to go to the back of the queue, then they will deemed to have competed in the UAV Challenge Medical Rescue for the purposes of deciding a winner. If no takeoff or launch has been attempted the team will be given another opportunity to compete if time and opportunity permits after all other teams have had an opportunity to compete. Additional days will not be activated for these teams.

Any teams taking part in the Demonstration Category will fly after all other teams have been deemed to have been given an opportunity to fly. If there is more than one team in the Demonstration Category, the flying order of the Demonstration Teams will be decided by drawing team names out of hat.

1.11 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 *Base*, or
- it is raining or it is considered likely that rain will occur within the mission time allocation.

Adverse weather time has been built into the schedule.

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 time) due to adverse weather, the competition will be declared incomplete and no prizes or prize money awarded. The organisers will do all they can to have all teams that pass scrutineering 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 weather conditions.

1.12 Criteria for a Completed Mission

The *mission* is deemed complete if all of the following criteria are achieved:

- An aircraft does not cross a *Geofence* boundary.
- A team demonstrates 5 minutes of continuous video and audio of Outback Joe within 45 minutes of mission start time.
- All aircraft that did not land at the *Remote Accident Site* land back at the *Base*.

- No entry or transit of static no fly zone.
- Any *Non-transit Aircraft* remains within the *Remote Accident Site*.
- Not requested to terminate or advised of disqualification.
- Meeting of all time constraints.

1.13 Criteria for a Fully Autonomous Mission

The *mission* is deemed to be fully autonomous (Type 2 autonomy) if:

- No team member touches any ground station elements for any aircraft (including antenna equipment) while that aircraft is flying between the *Base* and the *Remote Accident Site*. This is known as the "no-hands rule".
- All aircraft that are launched and landed do so autonomously.

Allowable exceptions to the no-hands rule above include:

- An instruction by the competition judges or marshals to the team to put the aircraft into a holding pattern, and the subsequent instruction to resume the mission after the hold.
- An instruction by the competition judges or marshals to the team to check something on a ground station screen that may require a user interface interaction.

If a team has elected to take part in the Extension Autonomy Challenge, they may at any time choose to withdraw from the Extension Autonomy Challenge, ignore the *DNFZ* regions and complete the primary challenge. Interaction with the airborne UAS to explicitly make that change does not violate the "no-hands rule" provided the

1. intent is advised to the adjudication team prior to execution
2. interaction is as short as reasonably practicable
3. interaction provides no other control commands to the airborne systems

1.14 Criteria for completing the Extension Autonomy Challenge

Successful execution for the Extension Autonomy Challenge is achieved if:

a) a team successfully completes the primary Medical Rescue mission
b) none of the team's aircraft violated a *DNFZ*
c) there is clear evidence that avoidance of the *DNFZs* has been conducted in the "spirit of the Challenge"
d) Aircraft DNFZ avoidance behaviour exhibited at least once
e) all of the team's aircraft provided a situational awareness data feed for the entire period the aircraft was airborne
f) the team has not chosen during the mission to withdraw from the Extension Autonomy Challenge

2 Rewards

2.1 The Prize

The team to achieve the highest points total and have also completed the *mission, that is not a Demonstration Category Team*, and after the competition is complete, will be declared the winner and will win the prize money.

If the winning team was deemed to complete the mission, then the winner's prize money will be calculated as follows:

- AUD$25,000 for a valid 5-minute long video and audio stream
- An additional AUD$25,000 for a fully autonomous flying between the *Base* and the *Remote Accident Site*
- An additional AUD$25,000 for completion of Extension Autonomy Challenge containing *Dynamic No-Fly Zones*

The maximum prize is hence AUD$75,000.

The two additional AUD$25,000 prizes (fully autonomous transit flight and the Extension Autonomy Challenge) will only be awarded to the winner.

In the case of a tie on points the following count back system will be implemented:

1. Team that completed the mission containing *Dynamic No-Fly Zones* wins.
2. Team with the shortest mission time wins.
3. If there is still a tie, joint winners will be declared and the prize money will be equally split among the winning teams.

2.2 Rod Walker Trophy

The team achieving the highest points total, whether or not they have completed the *mission*, will be awarded the Rod Walker Trophy, presented in memory of Professor Rod Walker, co-founder of the UAV Challenge.

2.3 Incentive Awards

In the case that no team is successful at completing the *mission* the UAV Challenge Organisers may choose to award incentive prizes based on the team points totals. Likely awards would be:

The highest points scoring team	AU$ 10,000
The second highest points scoring team	AU$ 5,000
The team that performs best through the Extension Autonomy Challenge	AU$10,000

2.4 Airmanship Award

The airmanship award will be presented to an individual who in the judges' opinion has displayed the best airmanship during the competition.

Airmanship Award	AU$ 1,000

3 The Unmanned Systems and their Operation

3.1 Aircraft Requirements

3.1.1 General requirements

Aircraft taking part in the UAV Challenge Medical Rescue will be subject to the following requirements and limitations.

Each aircraft:

1. Must not be a commercial off-the-shelf complete system (i.e., aircraft with all avionics, sensors and ground mapping processing systems that would result in completion of the mission already integrated);
2. May have an airframe and on-board systems can be commercial off-the-shelf or custom made;
3. Must be capable of *autonomous* flight;
4. Must have a maximum gross weight (MTOW) of less than 20kg;
5. Each aircraft must have continuous telemetry radio communication with the *UAV Controller* who will be located at the *Base.*
6. Must have an easily accessible E-Stop to render the aircraft deactivated.

3.1.2 Combined aircraft

One aircraft is allowed to carry another. It is permissible to launch a single combined aircraft from the *Base* and have the aircraft split into two free flying aircraft during the mission. Mid-air docking is also allowed.

3.1.3 The Geofence

All aircraft must implement automatic (on-board) detection of crossing a *Geofence* boundary.

Note: The term "Geofence" includes both horizontal and upper vertical boundaries.

Aircraft MUST AUTOMATICALLY activate flight termination settings on crossing a *Geofence* boundary in all operating modes (no ground interaction can be involved). The autopilot is allowed to detect the *Geofence* boundary crossing and activate the flight termination system, or the *Geofence* boundary crossing can be detected external (but on-board) to the autopilot with activation of the flight termination system, or incorporated into a flight termination system.

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 these rules.

Note: Static No-Fly Zones and Dynamic No-Fly Zones are not considered Geofence areas and there is no requirement for flight termination if an aircraft does fly through them. The penalty for flying through a Static No-Fly Zone is disqualification.

3.1.4 Flight Termination System

All aircraft must include a flight termination system with the following conditions:

1. The system must be on-board the aircraft and it's function must not be dependant on the correct function of other on-board systems (implying separate power supply, processor, etc.).
2. The system must be able to command the motors or actuators, OVERRIDING any other on-board system, to close the throttle on any propulsion system and set any control surfaces to cause the aircraft to descend near vertically to the ground.
3. Flight termination must be able to be activated from the ground by the *UAV Controller* at the command of the judges or *Range Safety Coordinator*.

4. 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 aircraft.
5. Once flight termination has been activated it may not be overridden by any means. This includes all modes, Autonomous and Manual.

3.1.5 Flight Termination Method

The flight termination method will vary depending on the aircraft type. In all instances, the throttle or power to any propulsion system must be closed, and any control surfaces set to cause the aircraft to descend near vertically to the ground.

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

Teams may choose to implement a flight termination method that will slow the descent of the aircraft to the ground, such as a parachute system.

Regardless of the termination method used teams must conduct analysis of the maximum distance their air vehicle could reach outside the *Geofence*, if the flight termination system was activated at the *Geofence*, and the air vehicle was travelling at maximum velocity and maximum altitude. This analysis should include:

- Analysis of the rate of descent after termination is activated.
- Analysis of the impact of wind and rate of descent data to gauge maximum drift distance.
- Details on how the system is triggered and activated.
- Consideration of different modes of flight (eg hovering or forward flight) for transitioning aircraft

It is not mandatory to conduct flight tests of the termination system but teams must demonstrate a good understanding of how their aircraft will perform in the event of a flight termination. If flight-testing is conducted it is acceptable that the data be gathered on a proxy aircraft of similar size and weight.

In the case of lighter than air aircraft, strategies should be included that detail how the aircraft can be brought to ground in the case of failure.

3.1.6 Criteria for Flight Termination

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.

The following events must result in immediate activation of the flight termination system:

- The aircraft crossing the *Geofence*;
- Concurrent failure of GPS and failure of communication to or from the aircraft;
- Failure or “lock up” of any processor and/or hardware implementing the *Geofence* crossing detection;
- 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.

Additionally, the following events must result in immediate activation of flight termination when under autopilot control:

- Failure or “lock up” of the autopilot;

Crossing of the *Geofence* boundary must always result in immediate cutting the power to the blades. Teams may propose, with a supporting safety case, the implementation of a soft flight termination mode for *non-Geofence* activations of flight termination that will lead to a powered descent. Activation of full flight termination with engine cut must still be possible after this soft flight termination.

Teams may introduce additional criteria for flight termination in response to their Safety Case.

3.1.7 GPS failure

Aircraft must have a GPS failure mode that is well thought through and safe. If the GPS used by a *Geofence* system fails for more than 10 seconds, then Flight Termination must be automatically activated. If a GPS unit fails that is not associated with *Geofence* crossing detection fails, teams may propose other solutions to deal with that failure.

Teams should identify that loss of GPS is a risk in the D1 Risk Assessment and document the planned response of their system in both their D2 Risk Management plan and D3 Safety Case. Loss of GPS is an abnormal condition that must be responded to quickly.

3.2 Ground Vehicle Requirements

Ground Vehicles taking part in the UAV Challenge Medical Rescue will be subject to the following requirements and limitations.

Each Ground Vehicle:

1. Must have an easily accessible E-Stop to deactivate the vehicle.

3.3 Unmanned System Requirements

3.3.1 Two-way communication between aircraft and the Ground Control Stations

Continuous communication is required between all aircraft and the Ground Control Stations located at the *Base*. This includes aircraft that have landed at the *Remote Accident Site*. Note that the communication link does not need to be point-to-point and may be achieved using other aircraft, or satellite networks.

The communication link must be bidirectional in that as well as telemetry data coming from the aircraft to the Ground Control Station, the *UAV Controller* must be capable of sending a radio command to the aircraft. This is a requirement mandated by the Flight Termination requirement (Section 3.1.4 point 3).

Teams should identify that loss of communications is a risk in the D1 Risk Assessment and document the planned response of their system in both their D2 Risk Management plan and D3 Safety Case. Loss of communications is an abnormal condition that must be responded to, but is not an emergency. **Immediate flight termination is not mandated**.

These rules do not mandate a specific procedure in response to loss of communications as a single procedure is unlikely to account for the variety of possible system configurations, such as different aircraft roles and capabilities that may be used to attempt the UAV Challenge.

3.3.2 UAV Controller Override

Systems may include a capability where the aircraft can be changed from autonomous flight to a manually flown radio mode when operating in normal visual/control range of the safety pilot who is located at the *Base*. Flight outside the *Base* area must be autonomous, except when conducting a recovery due to an in flight failure or emergency with approval from judges and/or range safety personnel, as detailed in the teams Deliverable 3 Safety Case.

3.3.3 Situational Awareness

Teams must have a ground control station that provides a graphical display of waypoints and aircraft current location.

The minimum required is that the Judges and Range Marshals should be able to observe the following data for each aircraft being flown:

- Location (from GPS),
- altitude,
- air speed and
- heading.

Data must be provided in accordance with Section 3.3.3.

Teams are required to provide a data feed from their ground station reporting their aircrafts' location, heading and speed to the *range safety coordinator*. There must be a separate output for each aircraft if the team is using 2 aircraft. The specific data format required is:

- NMEA 0183 formatted messages
- GPGGA and GPRMC sentences
- Update rate of 1 Hz
- Maximum latency of 1 second

Two physical interfaces are available:

NMEA 0183 serial output

- RS232, 4800 baud, 8 data bits, 1 stop bit, no parity
- Male DB9 connector

or

NMEA over Ethernet

- 100Base-T Fast Ethernet connection
- Server socket accepting connections and sending NMEA strings
- Statically addressed
- Address, netmask and port must be configurable at the event

For either physical interface the data will be received by a computer running GPSD version 3.17.
http://www.catb.org/gpsd/

Teams may use adapters such as USB to RS232 serial adapters or USB to Ethernet adapters to provide the output connection and if doing so must provide their own adapters.

This requirement is mandatory and will be tested during the safety inspections. Failure to provide a working data feed will result in failing the safety inspection.

3.3.4 Radio equipment

This scenario assumes no phone coverage. Teams must hence **NOT USE mobile phone communications** at all as part of their mission solution. A satellite network maybe used for aircraft-GCS communication, but teams must accept that there is a reliability risk, and that a team's safety case (part of Deliverable 3) will have to account for the risk of losing/leaving coverage.

If two aircraft are used for a mission, one aircraft may act as a communication relay for the other.

Teams are permitted to use any combination of frequencies as long as they comply with Australian Communications and Media Authority (ACMA) regulations (Section 7.5).

Teams must present any radio licences that they may have obtained and need to use during the UAV Challenge Medical Rescue to the scrutineers during scrutineering.

3.3.5 E-stops

All aircraft must have an e-stop. The e-stop must function to break the electrical path to all motors and radios. In the case of an internal combustion engine, the e-stop must break the electrical path to the engine ignition.

The e-stop must be external, easily accessible and easily understandable. Example interfaces are a standard, latching, red, e-stop button with yellow surround, or a removable safe/arm plug where Red = Armed and Green/Absent = Safe (ESA colours).

The e-stop must function without requiring the correct operation of any other system in the aircraft and must not use software. Specific details of the e-stop functionally and design must be included in the Deliverable 2 document, not simply a statement confirming such a system will be implemented.

A conceptually simple e-stop is a latching button in the circuit between the aircraft battery and motors and radios. Pushing the button would break the circuit. For aircraft with high current requirements or multiple batteries a single button may not be possible and relays can be used to break the circuit from the batteries when the e-stop is pushed.

3.4 Operational Requirements

3.4.1 Location of infrastructure

Team infrastructure cannot be located outside the *Base* operation area. Remote computer equipment such as servers may not be used and all processing must occur either on the aircraft or on the GCS computers within the *Base*.

3.4.2 Altimetry

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

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

3.4.3 Aeronautics

All documents and operations in the UAV Challenge will comply with the following sections of the Aeronautical Information Publication (AIP) Australia, which is published by the Aeronautical Information Service (AIS), Airservices Australia (https://www.airservicesaustralia.com/aip/aip.asp):

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

This means that teams MUST use the following units in all documentation and verbal communication with the judges, scrutineers and range marshalls at the event:

Distances used in navigation	nautical miles (NM) and tenths
Short distances	metres
Altitudes, elevations and heights	feet
Horizontal speed, including wind speed	knots
Vertical speed	feet per minute
Wind direction for runway operations	degrees magnetic
Wind direction except for runway operations	degrees true
Visibility	kilometres or metres
Altimeter setting	hectopascals
Weight	Kilograms

For example, if a team member is asked by the judges at the UAV Challenge event, “what is the current altitude of your aircraft?” the team member must reply in units of feet. Consistency with these aeronautical units (and the international standard) is critical to safe operation of unmanned aircraft in areas with manned aviation.

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

Aircraft fly on airspeed, not ground speed (which is what GPS provides). Ground Speed may be reported, however the Technical Committee will be looking for an understanding as to how teams will maintain their aircraft within its airspeed envelop. This should be included in Deliverable 2.

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

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

3.4.4 Flights after an In Flight Failure or Unintended Recovery

If an aircraft recovers to an area outside of the competition *Base,* other than a controlled landing of a *Rescue Aircraft* within the *Remote Accident Site*, it will not be allowed to make further flights in the UAV Challenge.

If an aircraft is recovered to within the competition *Base* the UAV Challenge scrutineering team will examine it. This activity will be undertaken in allocated mission time. The CASA Designated Coordinator, in consultation with the UAV Challenge Head Scrutineer and the UAV Challenge Technical Committee, will make a decision as to whether the aircraft can be repaired and further flights attempted. Any repairs will need to be scrutineered before flight. The UAV Challenge Technical Committee may decide to adjust the remaining mission time to account for delays in bringing the necessary people together for the reviews.

3.5 Safety Requirements

3.5.1 Challenge Safety

Safety is a priority for the UAV Challenge, and the rules 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; UAV controller override capability; flight termination mode; range marshals observing the aircraft and airspace and a proven history of safe flight operations.

Teams will provide safety documentation with increasing levels of detail as the competition progresses, through the three deliverable documents (D1, D2 and D3).

Entrants based in Australia are reminded that during their research and development phase, all test flying must comply with the relevant CASA regulations.

Teams based outside Australia should ensure that they comply with local regulations when testing for the UAV Challenge.

The UAV Challenge Committee may disqualify a team that they deem to pose an unreasonable safety hazard to people, infrastructure, and other airspace users. This applies during the event or UAV Challenge related operations and testing during or prior to the event.

Aircraft are not to intentionally overfly any building, or fly within 30m of any building, within the *Base*, while transitting or at the *Remote Accident Site*. Besides being standard aviation practice, this will limit risk exposure in the event of an aircraft failure.

Judges may require a team to return the aircraft to the *Base* or to activate Flight Termination if they believe (either through direct observation or via information from event staff) safety to be compromised or the aircraft is unfit or unlikely to maintain safe operations.

3.5.2 Safety inspections

All aircraft and ground-based equipment will undergo rigorous safety evaluations leading up to the UAV Challenge Medical Rescue event. Physical inspections will occur during the scutineering and competition days. These inspections must be passed before the aircraft will be permitted to fly. All decisions by the Technical Committee in relation to airworthiness are final.

Safety inspections at the event may 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 overrides;
- Radio spectrum frequency compliance;
- Radio range checks with motors off and on;
- Confirmation and documentation of suitable propulsion fuel load for the missions (battery capacity and charge V, or fuel volume/type);
- Flight termination system tested;
- Geofence system tested;
- Aircraft will be weighed to ensure they fall within the weight restrictions;
- Video evidence and flight logs of flight tests demonstrating safe operations;
- Proficiency of team members with respects to operation of UAV software & equipment, communications and procedures.
- Back-up power provisions and or procedures for ground station/control;
- Flight demonstration.

The aircraft used for the mission MUST be the aircraft subjected to the safety inspections.

3.5.3 Safety Case

It is the UAV Challenge Technical Committee's intent to only be proscriptive in essential safety requirements, this being the flight termination system and the requirement to activate the flight termination system on Geofence crossing, failure of critical functions, or on command by the judges. To support this, teams are required to submit a safety case as part of the Deliverable 3 requirements. The objective of this Safety Case is to convince the UAV Challenge Technical Committee that the team has identified risks, abnormal, and emergency conditions and put in place sufficient technology and procedures to provide an acceptable level of safety. The two hazards to be addressed are risks relating to:

- Ground Impact where the Entities of Value are: people, property, livestock, and crops; and
- Mid-Air Collision where the Entities of Value are: other airspace users.

Failure to provide a satisfactory Safety Case will be sufficient grounds for a team to be excluded from the competition.

If two aircraft are used they may be combined into a single flying platform. If this is planned then teams must treat the combined aircraft as a separate aircraft for the safety case, implying that they will need to consider three aircraft types (two individual and one combined) when outlining safety and compliance. Innovative solutions are encouraged but should be checked with the Technical Committee to ensure they remain within the rules and the spirit of the competition.

3.5.4 Airmanship

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

> *Good airmanship is that indefinable something, perhaps just a state of mind, that separates the superior airman/airwoman from the average. It is not particularly a measure of skill or technique, nor is it just common sense. Rather, it is a measure of a person's awareness of the aircraft and its flight environment, and of her/his own capabilities and behavioural characteristics, combined with good judgement, wise decision-making, attention to detail and a high sense of self-discipline.*

Airmanship is the cornerstone of pilot competency. Competency has been defined as the combination of knowledge, skills and attitude required to perform a task well or to operate an aircraft safely — in all foreseeable situations.

The expectation of the UAV Challenge 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.

3.5.5 Pyrotechnic Mechanisms

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

A safe/arm system shall be implemented for any pyrotechnic mechanisms. This shall consist of a minimum of a safe/arm plugs whereby 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 pyrotechnic mechanism.

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.

4 Teams and Personnel

4.1 Team size

There is no maximum limit to team size. However, no more than six members of a team will be allowed entry to the *Base* takeoff and landing area during a mission.

4.2 Team Roles

Team Communicator: Each team must nominate a Team Communicator. That person will be the main point of contact between the Judges and safety personnel during the event and must be one of the team members who will enter the *Base* during the mission. The Team Communicator will be required to wear a high visibility vest during the mission. A vest will be provided to the Team Communicator for the duration of the mission, although they may alternatively provide their own.

UAV Controllers: Each team will nominate **one team member as the *UAV Controller* for each of their aircraft**. If a team uses two aircraft, they must have two *UAV Controllers* (one for each aircraft). If a team utilises a combined aircraft where one aircraft carries another the team must nominate which *UAV Controller* will be in command of the combined aircraft. In normal operation (non-emergencies), only UAV Controllers may issue command through the GCS for their nominated aircraft. If a team elects to perform a manual take-off then another team member (other than the UAV Controller for that aircraft) is allowed to perform the take-off but must hand over "control" of the UAV once it is safely airborne.

4.3 Sharing of equipment between teams

Teams may not share airframes. Teams may share avionics, piece parts and ancillary equipment. If an airframe 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 and model.

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

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

4.4 Cooperation between teams

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

Compliance with the rule relating to originality of a team's work is still required as "shared", "common", "joint", "re-used", or "copied" documentation will not be accepted. The Technical Committee is required to assess each team for safety and proficiency in order to authorise flight and the Deliverables are a significant component of that assessment. The Deliverables shall demonstrate the teams understanding of their system. Any doubt as to compliance or system understanding in any Deliverables with large sections of copied, common, or similar work or wording will be awarded a "No Go" result.

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

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

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

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

4.5 Loss of Team Members

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

4.6 Fatigue management of personnel

The nature of the UAV Challenge Medical Rescue schedule is such that personnel are usually required at the *Base* at sunrise, and will work up until sunset. There may be a number of evening functions scheduled. It is highly likely that personnel and team members will work in excess of 12 hours each day. No formal restriction will be placed on required hours of sleep. Each individual will be expected to manage their fatigue level and ensuring they can conduct their duties efficiently, effectively, and safely. The *CASA Designated Coordinator* and *Range Safety Coordinator* are authorised to replace event personnel if they appear fatigued. The *CASA Designated Coordinator* and *Range Safety Coordinator* are authorised to suspend a team's operation at the UAV Challenge Medical Rescue event if safety is compromised by fatigue or other circumstances.

4.7 Smoking, Drugs and Alcohol Policy

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

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

Competitors are advised not to consume alcohol within 6 hours prior to performing their duties or activities relating to the UAV Challenge Medical Rescue. Anyone reporting for competition showing evidence of being under the influence of drugs or alcohol will not be authorised to continue their activities. No random drug or alcohol tests will be performed by the event, however under existing aviation legislation and regulations CASA have the right to conduct random drug and alcohol testing.

5 Qualification and Judging

5.1 Eligibility

The UAV Challenge Medical Rescue is open to worldwide entrants – university students, privateers and hobbyists. Companies will be permitted to enter at the discretion of the UAV Challenge Medical Rescue Technical Committee provided they are shown to be participating in the spirit of the competition, have a passion for low-cost civilian applications and are not using unaffordable and ultimately unrealistic technology for the civilian market. Teams will be assessed for their eligibility to enter this category on application.

Employees of organisations who are official sponsors, supporters or organising partners of the UAV Challenge Medical Rescue are permitted to enter the Challenge **but may not be eligible to win any prize money or awards**. Exceptions to this rule may be made for junior or casual employees of such organisations. Such entrants will be assessed for their eligibility to win prize money or awards on application. Entrants must declare to the UAV Challenge Medical Rescue Technical Committee any employment relationship with an official sponsor, supporter or organising partner before arrival at the event. Team members who are employed by official sponsors, supporters or organising partners, must ensure that they have alerted their employer via that organisation's conflict of interest procedure, and had approval from their employer to enter the UAV Challenge.

If a team as a whole is considered to have an actual or perceived conflict of interest with a UAV Challenge sponsor or organisation co-running the event, then that team will need to enter in the Demonstration Category and the whole team will not be eligible for the prize money or awards. Teams that think they may fall into this category should contact the UAV Challenge organisers as soon as possible to discuss.

Teams considering entering the UAV Challenge should take into account the tight timelines of the Deliverable documentation stages and the final Go decision (qualification) to attend the event. Teams from a limit number of countries have struggled in the past to obtain travel visas in time to attend the event (after they have qualified). Teams should be aware of any current visa restrictions or visa processing delays impacting the ability of citizens of their country to travel to Australia.

5.2 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 official UAV Challenge video features and other promotional materials.

5.3 Qualification process (the Deliverables)

The UAV Challenge Technical Committee is responsible for determining compliance with the rules up to the point of qualification. At the event, the Judges are responsible for determining compliance with the rules. Note that at least one of the Judges will be a member of the Technical Committee.

There are five assessment elements. The first three are qualifying assessment elements. Some elements are scored and contribute to the final team score, while others are simple Go/No-go decision points within the competition.

The five assessment elements are as follows:

- Technical Report (Deliverable 1): no points - go/no-go

- Technical Report and video (Deliverable 2): max 15 points and go/no-go decision
- Flight Record (Deliverable 3): no points - go/no-go decision
- Team Interview: max 15 points
- Mission Performance: max 150 points

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

5.3.1 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 management of risks. The UAV Challenge organisers want to know how the team plans to complete the mission and how they will minimise risk and operate as safely as possible.

The technical report must address the following:

1. Overall design of the UAV system(s) including
    a. The preliminary design of the flight termination system
    b. The preliminary design of the Geofence System
2. Description of how the UAVs will be employed to complete the Mission
3. An indication as to whether a team intends taking part in the Extension Autonomy Challenge and if so, a brief description of how the UAVs will meet the challenge
4. A Risk Assessment
5. Risk Management including:
    a. The proposed strategies in response to failures such as loss of data link, loss of GPS and loss of engine power

Deliverable 1 should demonstrate understanding and compliance with the UAV Challenge Medical Rescue rules by describing a system that complies with the rules and explaining how it will meet the safety requirements set out in the rules. The document should refer to the rules where applicable rather than “cut and paste” of large sections. While a detailed description of the platform/s is interesting, it should not be at the expense of ensuring that the Technical Committee can assess compliance and safety.

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 2020 UAV Challenge Medical Rescue competition. The UAV 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.

5.3.2 Technical Report and Video (Deliverable 2)

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

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

The technical report must use the following headings and be no longer than 25 pages:

1. Title page (1 page)
2. Table of Contents (1 page)
3. Statement of Originality and Accuracy – see Appendix B (1 page)
4. Compliance Statement – see Appendix A (3 pages)
5. Executive Summary (1 page)

6. Introduction and Design Approach (1 page)
7. Landing site analysis strategy (1 page) including
    a. Details of how the team intends to determine a suitable strategy for landing
8. Shed operations strategy (1 page) – how will a team get a video camera and microphone to Joe?
9. System Design (4 pages) including
    a. A system diagram
    b. Aeronautical requirements
    c. Flight termination system design, state machine diagrams and transitions
    d. Analysis of the flight termination method
    e. Geofence system design
    f. Radio equipment and frequencies to be used and relevant licences
10. Extension Autonomy Challenge design brief (1 pages) including
    a. Implementation approach
    b. Scenarios
11. Risk Assessment (3 pages) including
    a. An update of the Deliverable 1 risk assessment accounting for design changes
    b. An assessment of the risks associated with autonomously taking off and landing
12. Risk Management (4 pages) including
    a. Details of how the system will respond to failures including loss of data link, loss of GPS, lock-up or failure of autopilot and lock-up or failure of GCS, and loss of engine power.
    b. The team's Fuel or Li-Po battery management (if used)
    c. How the team will manage other risks identified in the risk assessment
13. Flight Test Results and Discussion (2 pages)
14. Conclusions (1 page)

No appendices are allowed other than those describing pyrotechnics as specified in Section 3.5.5.

Deliverable 2 should demonstrate understanding and compliance to the UAV Challenge Medical Rescue rules, and should refer to the rules where applicable. A "cut and paste" of the relevant section will not be considered as having understood and complied with that section. Ensure that compliance is clearly stated and if non-compliant a clear justification statement is required.

The report and video will be assessed as shown in Table 1 below:

D2 - Technical Report and Video (total of 15 Points)	
Scoring Components	**Max Points**
Executive Summary	1
Design approach and Strategies	2
Risk Assessment and Management	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 (25 pages)	MINUS 2 points per page

Table 1 Deliverable 2 Scoring

The video must show:

- a Team's *Rescue Aircraft* autonomously landing and taking off,
- the Team's in-shed aircraft or ground vehicle being tested in a shed-like environment, and
- the Team's pre-flight set up and checks.

Note that the movie MUST show the actual aircraft and/or ground vehicles the team intends to use in the competition.

This is a go/no-go checkpoint. If the organisers are not convinced that the team is complying with the rules, the decision will be "no-go" and the team will be informed that they can no longer take part in the 2020 UAV Challenge Medical Rescue competition.

If the Technical Committee is not satisfied that the team's solution is adequate and safe, but the team have made a reasonable attempt to manage the failure they are unlikely to be given a No-Go. Teams will receive 1 of 4 possible initial responses for their D2:

1. Go: The team have satisfied the Technical Committee that they are developing a safe solution that complies with the rules and have demonstrated in their video and report that they have made the required progress in developing their system.
2. No-Go: The Technical Committee are not satisfied that the team are developing a safe solution, or the team's solution clearly breaches the rules, or the team has not made the required development progress, or the team's D2 does not provide sufficient information to assess their solution.
3. Clarify: In general, the Technical Committee are satisfied with the team's D2, but some aspect/s of the report require clarification or further information before a final decision can be given.
4. Improve: In general the Technical Committee are satisfied with the team's D2, but some safety aspect of the team's solution requires change or improvement before the Technical Committee are willing to allow the team to continue.

If the Technical Committee are not satisfied with the team's solution for a failure scenario they would be asked to improve their solution, with some specific guidance given. If the team has not specified a response to a given failure at all they will be given a No-Go (if the Technical Committee can not find the required information they will consult the team's compliance statement that should have a reference to where in the D2 report the required information is). The more aspects of the D2 that the Technical Committee believe require further information or improvement, the higher the likelihood that the team will be given a No-Go.

The UAV 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.

Note to Teams: If requested by CASA, the UAV Challenge organisers will make available copies of Deliverable 2 to them as part of the compliance information for the UAV Challenge Medical Rescue event.

D2 and multiple aircraft missions
If a team is using two aircraft to complete the mission then reference to both those aircraft must be made in the Deliverable 2 document.

5.3.3 Autonomous Flight Record (Deliverable 3)

All activities undertaken to comply with this sub-section must comply with CASA (if in Australia) and other appropriate regulations for your country of operation.

Overview of Deliverable 3
All teams must provide documentary evidence of five hours of autonomous flight for each *Transit Aircraft* used in the mission. The five hours do not include the time taken to tune the autopilot. It is preferable that all five hours is accumulated on the total system that will be operated during the UAV Challenge Medical Rescue event, however consideration will be given due to incidents during preparation. An equivalence case will be required to demonstrate that the accumulated experience is relevant. Where equivalence is claimed, a minimum of one hour of autonomous flight on the system to be used at the UAV Challenge Medical Rescue event must be documented.

The five hours must have at least one flight with duration in excess of 30 minutes and one flight with a total track length of greater than 11 nautical miles.

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

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

If multiple *Transit Aircraft* are being used then this requirement applies to all aircraft.

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

Deliverable 3 Requirements

Deliverable 3 must include the safety case as described in Section 3.5.3.

The following evidence of autonomous flight for each *Transit Aircraft* must be provided for Deliverable 3:

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

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

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

Deliverable 3 must provide the following aircraft details regarding each aircraft (*Transit and Non-transit Aircraft*) and its flight performance:

- Maximum airspeed (i.e. at full throttle)
- Cruise airspeed (i.e. most fuel efficient)
- Endurance at maximum airspeed
- Endurance at cruise airspeed
- Maximum take-off weight
- Competition take-off weight
- Dimensions of the aircraft
- Identifying marks (if any)
- Aircraft plan form and configuration (to help range marshalls identify the aircraft while it is flying)

This information can be updated on arrival at the event.

If a combined aircraft arrangement is being used where one aircraft is carrying another, then three sets of aircraft details will be required. One set for the combined aircraft and one each for the separate aircraft (when undocked).

5.3.4 Top twenty (20) only to qualify

The competition can only support a maximum of twenty teams at the event. If more than twenty teams are given an initial Go decision at the Deliverable 3 stage, the teams will be ranked using their Deliverable 2 score. The twenty teams with the highest scores will be invited to the UAV Challenge Medical Rescue event and will be deemed to have qualified.

If a team withdraws (for whatever reason) the next team outside the original top-twenty will be invited to the event. If they cannot accept this invitation then the next team will be invited, and so on.

5.4 Event judging

5.4.1 Team Interview

The judges will interview teams during the event (prior to flying) in order to assess their approach to safety and the features of their system. 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 shown in Table 2 below:

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

Table 2 Team Interview Scoring

5.4.2 Mission Performance (Flying)

The mission performance will be assessed as shown in Table 3 below:

Mission Performance (total of 150 Points)	
Scoring Components	**Max Points**
Pre-flight checks, team communication and organisation, and demonstration of good judgement (airmanship) on all aircraft	10
Fully autonomous takeoff from the *Base* of all aircraft used (yes/no)	10
Completion of transit flight of at least one aircraft at *Remote Accident Site* (yes/no)	20
Aircraft or ground vehicle enters the shed (yes/no)	30

Mission Performance (total of 150 Points)	
Scoring Components	**Max Points**
Speed of establishing video and audio link	1 point per 40 seconds prior to 40 minute mission mark (max 30 points)
Video and audio of Joe streaming to the *Base*	1 point per six seconds of completed streamed content (max 50 points)
Time penalty	-2 point for each minute over the hour
Loss of an aircraft	-50 per aircraft
Crossing a Geofence Boundary	Disqualified and team will appear in the final classification as Disqualified with zero points
Full Type 2 Autonomy for the mission	Yes/No

Table 3 Mission Performance Scoring

5.4.3 Extension Autonomy Challenge Performance

The Extension Autonomy Challenge is assessed as successful or unsuccessful based on whether the team has achieved the criteria specified in Section 1.14. Multiple teams can successfully complete the Extension Autonomy Challenge but as specified in Section 2.1 the Prize will only be awarded to the winner of the main video and audio streaming mission, therefore there is no requirement for scoring of the Extension Autonomy Challenge to determine a winner.

6 Schedule and Event Location

6.1 Schedule

Table 4 below sets forth the overall competition schedule.

Activity	Date
Team Registration and Deliverable 1: Flight Safety Review (short Technical Report) A short technical report (Section 5.3.1) on the UAV design concept and proposed safety methodology must be provided.	At the latest: 28th August 2019 at 5pm AEST
Deliverable 2: Flight Readiness Review (Technical Report and Video) - A technical report must be provided. The underlying objective of this report is to convince the Technical Committee that the team has developed a reliable and safe system, along with the appropriate operating procedures. A video must be supplied that includes a flight demonstration of an autonomous landing.	At the latest: 8th April 2020 at 5pm AEST
Deliverable 3: Autonomous Flight Record - Documentary evidence must be provided that details a minimum of five (5) hours of autonomous flight. This deliverable may include an equivalency case when the five hours has been accumulated across different systems.	At the latest: 5th August 2020 at 5pm AEST
Final "Go/No-Go" and qualification announcements Final approval to participate in the 2018 UAV Challenge Medical Rescue given to teams. The final approval to participate will be based on several aspects of the technical report, predominantly the demonstrated ability to operate within the competition safety standards. If more than 20 teams achieve a Go decision then teams will be ranked on points scored for the Deliverable 2 document and the top twenty teams only will qualify.	19th August 2020
CASA Application Update The Technical Committee are to submit an update to CASA advising them of the names of the participants for inclusion in the airspace approvals for the UAV Challenge Medical Rescue event.	2nd September 2020
Team Insurance Deadline Teams must provide documentation illustrating their insurance coverage. More details of insurance requirements and options will be posted on the UAV Challenge website. Teams that have not submitted this documentation by this date may be disqualified from the competition.	9th September 2020
UAV Challenge event - Orientation, Safety Briefing, Scrutineering, Team Interview and competition flights. Includes weather contingency time at the end	Tue 29th September to Fri 2nd October 2020

Table 4 UAV Challenge Medical Rescue Schedule

6.2 Optional Early Delivery of Documentation

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

6.3 Event Location

The UAV Challenge Medical Rescue 2020 event will be held at the Dalby Model Aero Club, 743 Cecil Plains Road, Dalby, Queensland, Australia. This will be the location of the *Base*.

7 Discussion and Recommendations to Teams

7.1 The UAV Challenge Objectives

7.1.1 Background

The first UAV Challenge was called the UAV Challenge Outback Rescue and involved teams undertaking a realistic search and rescue mission. The event took place from an open airport (with manned aircraft operating in concert with the competition's unmanned aircraft), in a relatively remote location, with hot and windy weather and a requirement of a long transit flight to the search area. That Challenge mission took seven years and six events to complete. Four teams completed the mission task in 2014 with a fifth team coming close. With the successful completion of the initial mission, it was time to consider a new mission that would push the boundaries of what low-cost civilian unmanned aircraft could achieve.

The second UAV Challenge mission task was called UAV Challenge Medical Express. That competition required teams to go beyond search and rescue and perform the more challenging task of automated sample return from an unknown remote location. The mission was designed to extend the state-of-the-art in the following areas that will ultimately benefit the low-cost civilian unmanned aircraft industry:

- Improved search algorithms (that can quickly locate a simple visual emergency beacon (a sign).
- Cheap and reliable ground-to-ground communications (between a GCS and a remotely landed unmanned aircraft) over a distance of at least 5.4 nautical miles.
- Unmanned aircraft that can transit long distances and land and take off in a constrained area that is surrounded by obstacles. New hybrid platforms that are neither pure fixed-winged aircraft nor pure multi-rotors are likely to be required to complete the mission.
- Fully automatic takeoff and landing systems that can operate in a remote location – not only at the GCS end.
- On-board situational awareness of remote landing locations that are largely unknown to aircraft operators before a mission commences.

The first UAV Challenge Medical Express took place in 2016 in Dalby, Queensland. The competition was very successful and one team very nearly completed the entire mission at the first attempt. However, one of their aircraft crashed and they hence did not fully complete the mission. But they did successfully return a blood sample from Outback Joe's farm. The second UAV Challenge Medical Express took place in 2018, also in Dalby. Again, no team completed the mission but two teams came very close. Teams were so close to completing the mission that the Technical Committee deemed it not necessary to run the event again with the same mission.

7.1.2 The 2020 Medical Rescue Challenge

The Challenge described in this set of rules has been designed to extend the capability UAVs in such a way that will assist emergency medical professionals responding to patients in critical condition in remote setting.

The UAV Challenge Medical Rescue provides valuable experience to all who enter, 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.

7.2 Soft Geofence

It is recommended but not mandatory that teams implement a "soft Geofence" inside the actual *Geofence* boundaries, set up that when crossed the aircraft commences a manoeuvre that will reduce the possibility of an

actual *Geofence* boundary crossing and the subsequent mandatory activation of the “hard *Geofence*”. The *Geofence* boundary-crossing requirement described in this section is non-negotiable regardless of the “soft *Geofence*” implementation, and will be subject to scrutineering.

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

The following notes are offered for consideration:

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

7.3 Guidance Material for Deliverable 3

Over the history of the UAV Challenge competitions 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 recommended but not mandatory that 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.

7.4 Definition and Levels of Autonomy

7.4.1 Definition

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

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

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

7.4.3 Type 2 Autonomy – Function Activation without Remote Pilot Intervention

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

7.5 RF 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 Technical Committee for the UAV Challenge Medical Rescue.

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

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.

Class Licensing and the UAV 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 thereof, applicable to the UAV Challenge for competitors to use in their link budget designs:

- Radiocommunications (Low Interference Potential Devices) Class Licence 2015
- Radiocommunications (Radio-Controlled Models) Class Licence 2015

Guidelines for Using Class Licences

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

In general, this requires competitors to conform to:

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

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

The ACMA has stated to the Technical Committee that devices used under the Radio communications (Low Interference Potential Devices) Class Licence 2015 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.

ISM Frequencies

Several of the Industrial, Scientific and Medical (ISM) bands fall under the Radio communications (Low Interference Potential Devices) Class Licence 2015 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).

Final Note to Competitors on Spectrum Compliance

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

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

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

Failure to comply with any of the rules 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

7.6 No-Fly Zone Buffer Distance

The adjudicated of the team's aircraft location relative to no-fly zones will be based on the competing team's provided position. This position data contains errors from the current true position due to latency and sensing limitations of the on-board aircraft systems such as GPS. It is advised that teams provide adequate buffer distances in addition to the static no-fly zone boundaries and the volumes of the DNFZ to ensure that no violation of airspace occurs.

7.7 Buzzer

All aircraft should have an audible buzzer that will be activated in the event of a flight termination or other unplanned landing. A functioning buzzer will make it more likely that the aircraft will be found and recovered. Wet weather could result in a lost aircraft becoming damaged so assisting a quick recovery of their downed aircraft is in a teams' best interest.

Appendix A. Deliverable 2 Compliance Statement

Each team is required to submit a Compliance Statement addressing the competition rules and requirements as part of their Deliverable 2. The aim of the Deliverable 2 Compliance Statement is to provide a checklist like template to each team to ensure that essential rules and requirements have been addressed and documented in Deliverable 2 prior to submission.

Team Name:

We declare that this report and the entry that it describes complies with the rules of the 2020 UAV Challenge, and that we enter with the intention of competing in the spirit of the challenge. Specifically we declare that our entry is compliant with the following topics and provide reference to within our Deliverable 2 document were our method of compliance is described:

Rules Reference	**Topic**	**Compliance**	**Deliverable 2 Reference**
Mandatory / Essential *Non-compliance in this section will result in a No-Go finding unless there are significant and/or extenuating circumstances. Please read the rules in detail. If using two aircraft ensure both aircraft are considered and Deliverable 2 references are provided for each aircraft if necessary.*			
1.6	Maximum of three aircraft for the mission	□ Compliant	
3.1.1	Must not be a commercial off-the-shelf complete system	□ All aircraft Compliant	
3.1.1	Must be capable of autonomous flight	□ All Transit Aircraft Compliant	
3.1.1	Must have a maximum gross weight of less than 20kg	□ All aircraft Compliant	
3.1.1	Must have continuous telemetry radio communication with the UAV Controller	□ All aircraft Compliant	
3.1.1	Must have an easily accessible E-Stop to render the aircraft deactivated	□ All aircraft Compliant	
3.1.3	Must implement automatic (on-board) detection of crossing a Geofence boundary	□ All aircraft Compliant	
3.1.4	Must include a flight termination system meeting all conditions	□ All aircraft Compliant	
3.1.5 & 5.3.2	Flight termination method described and analysis provided of maximum distance outside Geofence	□ All aircraft Compliant	
3.1.6	All criteria for flight termination must result in immediate activation of flight termination	□ All aircraft Compliant	
3.2.1	Flight between the Base and Remote Accident Site must be autonomous	□ All Transit Aircraft Compliant	
3.2.3	Must have a ground control station that provides a graphical display	□ All aircraft Compliant	
3.2.3	Must provide an NMEA data feed from the ground station	□ Compliant	
3.2.4	Communication equipment must comply with ACMA regulations	□ Compliant	

Rules Reference	Topic	Compliance	Deliverable 2 Reference
3.3.2 & 5.3.2	AMSL altitudes will be measured and reported as pressure altitudes	□ Compliant	
3.3.3 & 5.3.2	Correct aeronautical units used	□ Compliant	
3.3.3	Description of how aircraft will be maintained within its airspeed envelope	□ All Transit Aircraft Compliant	
3.4.5	Pyrotechnic mechanisms have safety mechanism implemented and safety manual provided	□ Compliant □ Not Applicable	
5.2	Disclosure of sponsors and funding sources	□ Compliant	
5.3.2	Statement of originality and accuracy included	□ Compliant	
5.3.2	Executive summary provided	□ Compliant	
5.3.2	Introduction and design approach provided	□ Compliant	
5.3.2	Landing site analysis strategy provided	□ Compliant	
5.3.2	System Diagram provided	□ Compliant	
5.3.2	Flight termination system design, state machine diagrams and transitions provided	□ Compliant	
5.3.2	Geofence system design provided	□ Compliant	
5.3.2	Radio frequencies to be used and relevant licences provided	□ Compliant	
5.3.2	Updated risk assessment provided	□ Compliant	
5.3.2	Assessment of the risks associated with autonomously landing provided	□ Compliant	
5.3.2	Risk Management provided	□ Compliant	
5.3.2	Details of the system response to loss of data link provided	□ Compliant	
5.3.2	Details of the system response to loss of GPS provided	□ Compliant	
5.3.2	Details of the system response to lock-up or failure of autopilot provided	□ Compliant	
5.3.2	Details of the system response to lock-up or failure of the GCS provided	□ Compliant	
5.3.2	Details of the system response to loss of engine power provided	□ Compliant	
5.3.2	Details of fuel and/or battery management provided	□ Compliant	
5.3.2	Details of the management of other risks provided	□ Compliant	
5.3.2	Flight tests results provided	□ Compliant	
5.3.2	Conclusions provided	□ Compliant	
5.3.2	Video provided showing the Rescue aircraft autonomously landing and taking off	□ Compliant	
5.3.2	Video provided showing the teams pre-flight set up and checks	□ Compliant	
Highly Desirable			
7.2	"Soft Geofence"	□ Implemented □ Not Implemented	
5.3.2	Deliverable 2: Max 25 pages.	□ Compliant □ Non-Compliant	

Additional Information:

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

Appendix B. Statement of Originality and Accuracy

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

> *We declare that this report is entirely the work of the team members listed below, and has not previously been submitted by us, or others for this challenge or any other similar event.*
>
> *We have acknowledged external material with appropriate references, quotes or notes to indicate its source.*
>
> *We declare that this report is an accurate record of activities carried out by us in preparing for this specific challenge. The events, data and other material contained within this report actually occurred and have been fully detailed.*

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

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

END OF DOCUMENT