Australian Universities Rocket Competition 2018/2019

Rules, Standards, & Guidelines

Revision History

Revision	Description	Date
Baseline	Document created	20/01/2018
AURC Director SA State Representative Operations/Projects Manager	Formatting, Proofreading & Fact Checking	17/03/2018 - 25/03/2018
Operations/Projects Manager	Updated Sections 2.3, 2.5, 2.6 and changed Appendix B to reflect the most current CASA documentation	26/03/2018

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1 Introduction

The Australian Universities Rocket Competition is Australia's first national university rocketry competition hosted by the Australian Youth Aerospace Association. Commencing in 2018, the AURC was designed with the aim to provide graduate engineers and scientists with the skills required for the growing aerospace industry in Australia. It also aims to provide a practical competition for Australian students passionate about rocketry. The AURC was inspired by a number of rocket competitions around the world, with the intention is to integrate the best parts of other rocket competitions around the globe to design the greatest tertiary rocket competition in the world. Furthermore, the AURC aims to encourage student teams to be as multidisciplinary as possible to reflect complex, real life space projects that require a mix of engineers and scientists from different backgrounds. This event continues the AYAA's legacy of promoting education, awareness and involvement in the aerospace industry to young Australians.

1.1 Background

Australia is no stranger to space; the nation's involvement can be dated back as far as the 1940's when the Woomera Rocket Range was established in South Australia. This site eventually became a landmark in the west as the world's second largest launch and tracking facility. Paul Scully-Power, the first Australian to enter space as an Oceanographer in 1985, and Andy Thomas the first Professional Australian Astronaut acting as payload commander in 1996 are a few famous names in Australia's space adventures. Fast forwarding to recent times, in 2017, South Australia hosted the International Astronautical Congress, where the Australian Space Agency was announced. Exciting times are certainly abound for Australians, and the AYAA hopes to strengthen this by fostering a greater interest in aerospace with a national rocketry competition. Additionally, this competition aims to increase the interest in STEM careers for Australian university students and provide them with a practical outlet to extend themselves beyond the lecture halls to design and build rockets themselves. The students that compete will develop their skills in a team environment, solving real-world problems under the same pressures they would experience in their future careers. This will be the inaugural AURC and the AYAA hope to continue this as an annual competition.

1.2 Purpose and Scope

This document defines the deliverables for teams with respect to scoring, as well as the guidelines involving what is and is not acceptable. If there are any further questions that are not answered by this document and all other subsequent resources, do not hesitate to contact an AURC representative whose details can be found on the AYAA website.

General guidance for student teams entered in the AURC can be found on the Australian Model Rocketry Society (AMRS) webpage (https://rocketry.org.au/). The AMRS is Australia's premier representative body for rocketry, which advocates for its various member groups and exists to serve the broader rocketry community. Organisers of the AURC highly recommend joining a local AMRS club for mentorship in rocket building. Departures from this guidance may negatively impact a student team's rocket design and launch performance.

1.3 Documentation/Resources

The following documents include standards, guidelines, schedules, or required standard forms. The documents listed in Table 1 are either applicable to the extent specified in this document, or contain reference information useful in the application of this document.

Table 1: Document File Locations

Document	Location
AURC Master Schedule	AYAA Website (https://ayaa.com.au/AURC)
AURC Scoring	AYAA Website (https://ayaa.com.au/AURC)
AURC Entry Forms	AYAA Website (https://ayaa.com.au/AURC)
AURC Progress Update	Coming soon
AURC Project Technical Report Template	Coming soon
Civil Aviation Safety Regulations 1998: Part 101—Unmanned aircraft and rockets	(https://www.legislation.gov.au/Details/F2017C00742/Html/Volume_3#_Toc493165511)
AMRS Safety Information	(https://rocketry.org.au/safety-information/)
AMRS Affiliated Organisations	(https://rocketry.org.au/organisations)

1.4 Australian Universities Rocket Competition Overview

Student teams competing in the AURC must design, build, and launch a single-staged rocket with a commercial-off-the-shelf (COTS) solid rocket motor. This rocket must carry a 4 kg payload to a target height of either 10,000 ft or 30,000 ft above-ground-level (AGL). Student teams will need to submit several progress updates and a project technical report throughout the duration of the competition to the AURC organising committee. Teams are strongly encouraged to work with local AMRS rocketry clubs for mentoring and safety input.

The AYAA reserves the right to change the category in which a project is initially entered based on the design presented. Teams are permitted to switch categories as necessary prior to submitting their final Project Technical Report.

1.5 Project Deliverables

The Project Deliverables outline what is required to be submitted by the participating teams for marking. Failure to meet these deliverables will result in a penalty and potential disqualification, thus it is imperative that all deliverables are met. All deliverables, unless otherwise noted, must be submitted to the AYAA via the AYAA website. Each time a deliverable is due, a submission portal will be made available on the AYAA website. The scheduled due dates of all required deliverables are recorded in the AURC Master Schedule, maintained on the AYAA website (https://ayaa.com.au/AURC).

Note: Due to the importance of the Project Deliverables, the AYAA has decided to retain most of the current information, and release them in their complete form in the weeks to come.

1.5.1 Entry Form

Each student team intending to compete in the AURC is required to fill out a registration form available on the AYAA website (https://ayaa.com.au/AURC). After a team has submitted an entry form, the AYAA will issue the respective team with a numeric Team ID which is used to identify the student team and their rocket throughout the duration of the AURC. Any official correspondence between the student team and the AURC organising committee must contain the Team ID to ensure a reliable and punctual response.

1.5.2 Progress Updates

Each team is required to submit three progress updates throughout the duration of the AURC. Refer to the 2018/2019 Competition Schedule document found on the AYAA website (https://ayaa.com.au/AURC) for dates on progress update submissions. Each progress update will be used to ensure the teams are on track and following the correct safety procedures whilst working with high powered rockets. Progress updates will be scored on engineering professionalism, punctuation, grammar, spelling, technicality and adherences to safety codes. Specific criteria and mandatory content for each progress update will be released in advance of the deadline.

More information will be released after the AYAA's Aerospace Futures conference (16th to 19th of July).

1.5.3 Project Technical Report

One month before the launch event is scheduled to occur, each team must submit their Project Technical Report to the AURC organising committee. The Project Technical Report serves as an overview of the respective team's project to the judging panel and other competition officials. Further information on the scoring criteria of the project technical report is contained in the AURC Awards and Scoring document, maintained on the AYAA website (https://ayaa.com.au/AURC).

More information will be released after Aerospace Futures (16th to 19th of July)

1.5.4 School Participation Letter

Teams are required to have a participation letter that is signed by an academic institution, acknowledging the teams' participation in the event. A sufficient signature is one that is provided by either a faculty member or other paid, non-student staff representative. The purpose of this signature is to confirm that the team is representing that academic institution. Regardless of the number of teams from an academic institution, only one participation letter is needed, as long as each participating team is clearly identified. If multiple academic institutions are contributing to a singular team then each of the representing institutions must provide a signed letter for that particular team.

Note that this is not a replacement for the Entry Form, but rather a requirement from the AYAA.

1.5 Revision

AYAA withholds the right to revise the AURC Rules, Standards & Guidelines. Minor revisions which do not impact the design goals of the teams competing may be made throughout the year. Major revisions which affect the design goals of competing teams will only be made during the transition between competition years. It is the responsibility of the participating team to ensure that they are correctly using the most recently revised document, available on the AYAA website (https://ayaa.com.au/AURC). Student teams will be made aware of revisions (both minor and major) through email to the people listed on the registration submission.

2.1 Team Composition and Eligibility

Teams are encouraged to diversify their educational background when selecting or recruiting new team members. The AURC is designed to be as multidisciplinary as possible, by encouraging students from all programs to take part in the project and work alongside each other. Real world complex projects, like launching rockets with a scientific payload, require efficient teamwork by people from different educational backgrounds and experiences. Every team entered into the AURC is required to abide by the rules and guidelines outlined in the following section.

2.1.1 Student Team Members

AURC teams shall consist of members who are current undergraduate or graduate students (including Masters or PhD students) during the current academic year from one or more academic institutions (e.g. "joint teams" are eligible). Students who graduate throughout the course of a competition (e.g. are enrolled at the time of registration opening but have graduated by the time of competition) remain eligible to compete in the AURC. There is no limit on the overall number of students per team, or on the number of graduate students per team. Students are free to participate in multiple teams, so long as each team is led by a different individual.

2.1.2 One Project per Team

Only one rocket per team may be submitted for the AURC and can only participate in a single category (it is permissible to change categories as desired prior to the submission of the Project Technical Report). This is not to be confused with what is mentioned in the School Participation Form; many students from multiple universities can contribute to a single rocket. This restriction is to ensure the fairness of the competition such that no team can launch multiple rockets and/or participate in a variety of categories.

2.2 Payload

The payload challenge for student teams is to design, build, and launch a four kilogram (4 kg) payload to one of the two height categories of the AURC. The objective of the payload is to encourage student teams to design and develop payloads that achieve a meaningful function and provide a learning outcome. Whilst the AURC recognises that teams will more than likely be composed of engineering students, students teams are encouraged to engage with and invite science students (graduate or postgraduate) to develop and manage the scientific aspect of the payload. Student teams are also encouraged to invite electrical, software, and computer science students to develop the flight controllers, communications, and other associated electronics. The payload has no specific criteria, but will be scored on technical/scientific objectives, construction, readiness, and deployment. Additionally, teams are encouraged to engage non-technical students to help with strategic planning, marketing, media, sponsorship or otherwise. Further information regarding the payload can be viewed in Appendix A: Payload Specifications.

2.3 High-Powered Rocket Compliance

Launch vehicles entered in the AURC are considered rockets of high power type and will be treated as such in compliance with Civil Aviation Safety Authority (CASA) Regulations and all other federal, state, and local laws, rules and regulations. High Power Rockets (Commonly known as High Power Rocketry (HPR)) are rockets that weigh greater than 1.5kg Gross Lift-Off Weight (GLOW) and/or have greater than 62.5 grams in an individual motor and/or produce more than 160 Ns in an individual motor ('H' impulse motor). Refer to Part 101 of the Civil Aviation Safety Regulations 1998 (https://www.legislation.gov.au/Details/F2017C00742/Html/Volume_3#_Toc493165511). For the relevant heights to be achieved in the AURC a significantly higher powered motor than the H class is expected to be used. An acceptable range of total impulse for the AURC is between 160 and 40,960 N.s.

During testing, teams must launch from a CASA approved area (see CASR 101.425) in order to operate high power rockets regardless of how high student teams plan to fly. It is best to speak with your local club to discuss what size motors you can fly at their relevant launch sites.

The CASA High Power Safety Code is attached as Appendix B: High Power Rocket Safety Code.

2.4 Tracking systems

Launch vehicles, and any deployable payload(s), shall carry a radio beacon or similar transmitter aboard each independently recovered assembly to aid in locating them after launch. Live telemetry implementation is highly encouraged, however all tracking systems must abide by the Australian Communications and Media Authority (ACMA) Australian Radiofrequency Spectrum Plan. Using a radiofrequency illegally can result in a federal offence. Local AMRS clubs can provide guidance on which products to use and where to purchase them. Purchasing equipment from overseas is allowable, however care must be taken to ensure the radio frequency used by the overseas products abide by the ACMA's requirements. The AYAA is not liable for any federal offences that teams may receive during testing.

2.5 Official Altitude Logging

The AURC organising committee will provide a list of approved altimeters to record the official data log of height for scoring purposes at a later date. In addition, you may want to consider GPS for altitudes for the 30,000' flights. Teams will be required to prove the accuracy and precision of their chosen altimeter by performing a test and outline the results in one of the progress updates and project technical report. If a deployable payload is used, the altimeter shall be integrated into the launch vehicle and not the payload. Officials will review each altimeter before launch, and extract altitude data upon successful recovery of the rocket before handing the recovered rocket back to the team.

2.6 Cheating

Teams will be disqualified from the AURC if they fail to meet any of the following:

- The mission rules, standards and guidelines as set out in the *AURC Rules, Standards & Guidelines* document;
- Any progress report deadlines (refer to the *AURC 2018/2019 Competition Schedule*); and
- Any safety protocols established by rocket launch site operators during the launch week.

In the spirit of the competition, if a team is found guilty of cheating in any way, that team will be subject to scrutiny of the competition officials, with consequences including a possible ban from entry to future competitions. Teams caught cheating are ineligible for any refunds.

2.7 Withdrawal from the AURC

Teams may withdraw from the AURC at any time by sending a formal email to the AURC organising committee with their Team ID in the subject title. Withdrawal may forfeit the competition entry deposit, as stipulated in the competition schedule.

Appendix A: Payload Specifications

A.1 Payload Mass and Physical Dimensions

The minimum capacity for the payload shall be no less than four kilograms (4kg). The definition of a payload is being defined as: *"replaceable with a dead weight of the same mass, with no change to the launch vehicle trajectory in reaching the target apogee, or its' successful recovery."* The weight of the avionics package is not included in the payload.

This payload will be assumed present when calculating the launch vehicle's stability. In other words, launch vehicles entered in the AURC need not be stable *without* the required payload mass on-board.

On competition day, the payload will be weighed and a tolerance of 5% will be accepted. Thus, an acceptable payload weight on the competition scales will be at least 3,800 grams due to the potential calibration errors between the participant scales and the competitions. Note, the payload weight can exceed 4,000 grams as this is a minimum requirement and not a target.

The payload does not have any physical dimension restrictions, but it is required to be fully enclosed in the rocket before launch and must always be either secured inside the rocket or autonomously stable outside with the capability of returning home. If the payload will operate autonomously to the rocket and return home, evidence of the payload's capability to do this must be provided prior to the launch day.

A.2 Payload Functionality

Whilst the payload is not required to be functional, if they are used in a scientific experiment or technology demonstration and have been entered in the AURC, they can be evaluated for awards by sponsors as part of a payload challenge. This challenge will still follow the AURC rules and guidelines for unique and innovative payloads, however a sponsor will select a winning payload based on criteria which may include scientific or technical objectives, construction, turnkey operation, and execution.

A.3 Non-functional Payloads

If a team has elected to not design a functional payload that is in accordance to the payload rules, standards and guidelines, then the team must provide a four kilogram (4kg) ballast to be in place of the functional payload.

A.4 Payload Location and Interface

Whilst the location and integration mechanism of each team's payload is not specified in the AURC documentation, competition officials will be required to weigh the payload, independent of the launch vehicle structure and associated flight systems. Thus it is imperative that the payload is designed to be easily removed from the launch vehicle to be weighed. If the launch vehicle design prevents removal of the payload to be weighed on the competition day, competition officials will impose a point penalty on the respective team.

A.5 Restricted Payload Materials

Due to CASA regulations, there is a restriction on the type of materials that can and cannot be used with a payload. It is imperative that the payload does not contain any major amounts of lead or other dangerous goods/hazardous materials. Dangerous goods are defined as: *"items or substances that when transported by aircraft are a risk to health, safety, property or the environment"*. Likewise, there shall be no usage of radioactive materials unless otherwise permitted by a competition official and signed off. If it is approved, then the materials must be fully encapsulated and must be restricted to 1 μC or less of activity.

Appendix B: High Power Rocket Safety Code

1. **Certification.** I will only fly high power rockets or possess high power rocket motors that are within the scope of my user certification and required licensing.
2. **Materials.** I will use only lightweight materials such as paper, wood, rubber, plastic, fiberglass, or when necessary ductile metal, for the construction of my rocket.
3. **Motors.** I will use only certified, commercially made rocket motors, and will not tamper with these motors or use them for any purposes except those recommended by the manufacturer. I will not allow smoking, open flames, nor heat sources within 8 metres feet of these motors.
4. **Ignition System.** I will launch my rockets with an electrical launch system, and with electrical motor igniters that are installed in the motor only after my rocket is at the launch pad or in a designated prepping area. My launch system will have a safety interlock that is in series with the launch switch that is not installed until my rocket is ready for launch, and will use a launch switch that returns to the "off" position when released. The function of onboard energetics and firing circuits will be inhibited except when my rocket is in the launching position.
5. **Misfires.** If my rocket does not launch when I press the button of my electrical launch system, I will remove the launcher's safety interlock or disconnect its battery, and will wait 60 seconds after the last launch attempt before allowing anyone to approach the rocket.
6. **Launch Safety.** I will use a 5-second countdown before launch. I will ensure that a means is available to warn participants and spectators in the event of a problem. I will ensure that no person is closer to the launch pad than allowed by the accompanying Minimum Distance Table, shown in Table 1. When arming onboard energetics and firing circuits I will ensure that no person is at the pad except safety personnel and those required for arming and disarming operations. I will check the stability of my rocket before flight and will not fly it if it cannot be determined to be stable. When conducting a simultaneous launch of more than one high power rocket I will observe the additional requirements of AMRS Safe Launch Practices.
7. **Launcher.** I will launch my rocket from a stable device that provides rigid guidance until the rocket has attained a speed that ensures a stable flight, and that is pointed to within 20 degrees of vertical. If the wind speed exceeds 8 km (5 miles) per hour. I will use a launcher length that permits the rocket to attain a safe velocity before separation from the launcher. I will use a blast deflector to prevent the motor's exhaust from hitting the ground. I will ensure that dry grass is cleared around each launch pad in accordance with the accompanying Minimum Distance table, and will increase this distance by a factor of 1.5 and clear that area of all combustible material if the rocket motor being launched uses titanium sponge in the propellant.

8. **Size.** My rocket will not contain any combination of motors that total more than 40,960 N-sec (9208 pound-seconds) of total impulse. My rocket will not weigh more at liftoff than one-third of the certified average thrust of the high power rocket motor(s) intended to be ignited at launch.

9. **Flight Safety.** I will not launch my rocket at targets, into clouds, near airplanes, nor on trajectories that take it directly over the heads of spectators or beyond the boundaries of the launch site, and will not put any flammable or explosive payload in my rocket. I will not launch my rockets if wind speeds exceed 32 km (20 miles) per hour. I will comply with the Civil Aviation Safety Authority airspace regulations when flying, and will ensure that my rocket will not exceed any applicable altitude limit in effect at that launch site.

10. **Launch Site.** I will launch my rocket outdoors, in an open area where trees, power lines, occupied buildings, and persons not involved in the launch do not present a hazard, and that is at least as large on its smallest dimension as one-half of the maximum altitude to which rockets are allowed to be flown at that site.

11. **Launcher Location.** My launcher will be 450 metre (1500 feet) from any occupied building or from any public highway on which traffic flow exceeds 10 vehicles per hour, not including traffic flow related to the launch. It will also be no closer than the appropriate Minimum Personnel Distance from the accompanying table from any boundary of the launch site.

12. **Recovery System.** I will use a recovery system such as a parachute in my rocket so that all parts of my rocket return safely and undamaged and can be flown again, and I will use only flame-resistant or fireproof recovery system wadding in my rocket.

13. **Recovery Safety.** I will not attempt to recover my rocket from power lines, tall trees, or other dangerous places, fly it under conditions where it is likely to recover in spectator areas or outside the launch site, nor attempt to catch it as it approaches the ground.

Table 2: Minimum Distance Table

Installed Total Impulse (Newton-Seconds)	Equivalent High Power Motor Type	Minimum Diameter of Cleared Area (m / ft.)	Minimum Personnel Distance (m / ft.)	Minimum Personnel Distance (Complex Rocket) (m / ft.)
160.01 -- 320.00	H	15 / 50	30 / 100	61 / 200
320.01 -- 640.00	I	15 / 50	30 / 100	61 / 200
640.01 -- 1,280.00	J	15 / 50	30 / 100	61 / 200
1,280.01 -- 2,560.00	K	23 / 75	61 / 200	91 / 300
2,560.01 -- 5,120.00	L	30 / 100	91 / 300	152 / 500
5,120.01 -- 10,240.00	M	38 / 125	152 / 500	305 / 1000
10,240.01 -- 20,480.00	N	38 / 125	305 / 1000	457 / 1500
20,480.01 -- 40,960.00	O	38 / 125	457 / 1500	610 / 2000

Note: A 'complex' rocket is one that is multi-staged or that is propelled by two or more rocket motors