Australian Universities Rocket Competition 2018/2019

Awards and Scoring

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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 ahead 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

This document defines the scoring breakdown and awards for competing teams. Provided will be a description of how scoring categories and awards will be assessed. 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 AURC website.

1.3 Revision

AURC 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 AURC website (http://aurc.ayaa.com.au/).

2 Scoring (Total marks = 250)

Assessment of a team's performance in the AURC is based on engineering reporting, engineering design and product performance. The competition score will be a maximum of 250 marks, spread over multiple categories. The scoring breakdown and assessment criteria for each score category is outlined below.

2.1 Progress Updates (2 x 5 marks = 10 marks)

The report shall adhere to the format/style guide, and will be evaluated for quality and technical aptitude. There are two progress reports throughout the competition. 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. Progress reports will have a maximum length of 20 pages (excluding appendices) unless otherwise specified in the detailed marking rubric.

2.2 Project Technical Report (55 marks)

A complete technical report must be submitted before launch. This report shall adhere to the MEA report writing guide, and will be evaluated for quality and technical aptitude. The report must contain details about the team's: research, design process, design decisions, manufacturing processes, payload details, adherence to safety guidelines, adherence to legal requirements, and adherence to competition requirements, final design, estimation of performance, suggested improvements/limitations, and any other relevant details.

In addition, the submission of the Project Technical Report shall include all relevant documentation supporting the team's Virtual Vehicle Design and Analytical Simulation sections. There will be no other opportunity to justify the team's Virtual Vehicle Design and Analytical simulation results outside of the Project Technical Report. The Project Technical Report will also be assessed for logical structure, engineering professionalism, punctuation, grammar, spelling, technicality, and appropriate usage of appendices.

The specific criteria and mandatory content for this document are currently under development and will be released in advance of the deadline.

2.3 Virtual Vehicle Design (17.5 marks)

All teams are expected to submit their CAD models and drawings for their final designs. These will be evaluated for applied best modelling practice and technical drawing conformance to AS1100 (mechanical drawings) and AS1103 (circuit/wiring diagrams). This will require dimensioning and constraining each part with appropriate tolerancing and surface finishes specified. An organized model tree and clear assembly drawings will also be required.

2.4 Analytical Simulation/Analysis (17.5 marks)

Teams are expected to undertake simulation and modelling of their vehicle in order to justify their design decisions and to ensure the vehicle will survive the flight and will behave as expected. As a minimum the following areas should be addressed and the results included within your Project Technical Report:

- Trajectory Simulation:
  - All teams are expected to utilise OpenRocket to simulate the trajectory and stability of their launch vehicle.
  - The use of OpenRocket for trajectory simulation is a bare minimum and it is highly desirable for teams to develop their own trajectory simulation software package (in Python, MATLAB, or equivalent) or to utilise higher order commercial software.
  - Any custom software must ultimately add value over the OpenRocket baseline, assisting teams in optimising their vehicle performance.
  - If custom software is developed the code must be submitted along with the Project Technical Report. The submitted code must display best programming practice, with clear commenting, and is required in order for launch. Supporting documentation must be included to explain the code and appropriate assumptions made, and must be packaged in a way that the judges can run it.
- Structural Simulation/Analysis
  - The structural integrity of the team's launch vehicle shall be assessed to ensure that the vehicle will not fail during flight.
  - Ideally, the assessment of the vehicle should be undertaken within a commercially available finite element package. However, hand calculations can also be used where appropriate.
  - Structural simulations that could be undertaken include, but are not limited to, modal analysis, static analysis or transient analysis.
  - The results from the structural simulations should be used to justify the materials and geometry selection within your Project Technical Report.
- Electrical Simulation/Analysis
  - If a team's launch vehicle contains any custom electronics it is expected that basic electrical calculations/simulations will be undertaken to verify the selection of components and the overall design.
  - Detailed simulations are not expected for the electrical systems, but enough evidence should be provided to prove the proposed system will function as intended.

The list of simulation details presented above represents the minimum requirements for the AURC. In order to achieve top marks for this section teams will need to demonstrate additional simulation/analysis capabilities. Some other potential simulation areas that could be investigated include:

- RF interference analysis (of any on board antennas and electrical equipment),
- Thermal analysis (of motor mounts, leading edges or electrical equipment etc.), or
- Computational fluid dynamics (CFD) analysis of your launch vehicle.

Ultimately, the analytical simulation results that your team presents should prove that your design is safe and will meet your mission requirements. These results will form hence form the justification behind design decisions presented in the Project Technical Report and should be supported with all relevant assumptions as required.

2.5 Prototype Vehicle Design (50 marks)

The design of the vehicle will be evaluated for quality of construction and design decisions made by each team. Teams will be expected to provide substantiation for their major design decisions when prompted by AURC representatives during the launch days. Consideration of vehicle flight operation safety will also be assessed in this section. The team must demonstrate an understanding of the physics behind their rocket, consideration of manufacturing in the design, and utilization of COTS components. Judges will look for utilization of a systems engineering approach in the design and construction.

The marking of this section will occur on-site at the launch event, but prior to the range being opened. Teams will be expected to communicate the necessary information to key AURC, AMRS and industry stakeholders via a short oral presentation, followed by a period of questions. Further details on the marking criteria for this presentation will be made available closer to the launch event.

2.6 Flight Performance (100 marks)

The vehicle's flight performance will be demonstrated by its achieved altitude relative to the target apogee (10,000ft or 30,000ft AGL), and successful recovery. Closeness to target altitude will be assessed, with height above target being penalised just as severely as height below target. The condition of the launch vehicle after recovery will also affect the flight performance. Achieving the target altitude will be worth 80 marks of the total 100 marks achievable for this section.

Note that the AURC will only mark one flight at the competition launch event. This is done in order to ensure that teams that can only afford one flight of their competition rocket will not be disadvantaged relative to other teams which have the capacity to fly multiple times.

The following formula will be used to calculate a team's altitude component of their flight performance score:

$$Points = 80 - \left(\frac{80}{0.25 \times Target\ Apogee}\right) \times |Target\ Apogee - Achieved\ Apogee|$$

Successful recovery of the vehicle is worth the remainder of the 20 marks of the total 100 marks achievable for this section. Judgment is subject to the scrutiny of an AURC official on the day of the launch and recovery.
It will be based on an assessment of whether the rocket would be ready to launch again with very minor refurbishment and replenishment of all consumables on the launch vehicle.

As part of the flight performance marks, your team's payload will also be assessed, with deductions made to your overall score if the following criteria are not met. For every payload violation, 5% of your team's final *flight performance* score will be reduced from your total marks. Payload violations include:

- **Payload mass.**
  - Your payload must weigh no less than 4 kg (with a 5% margin, i.e. 3800g is acceptable due to potential calibration errors surrounding the scales).
  - Note that the payload is defined as capable of being replaced with ballast of the same mass with no change to the launch vehicle's trajectory or recovery.
  - No penalties will be applied for payloads exceeding 4000 g, this is a minimum requirement and not a target.
- **Independent payload functionality.**
  - Your payload must be capable of functioning independently to your launch vehicle, failure to do so will result in a payload violation.
  - A payload cannot be a launch vehicle sub-system and must be a separate entity capable of undertaking scientific experiments.
- **Payload location and interface.**
  - Your payload must be able to be safely taken out of your vehicle and weighed independently of your rocket, failure to do so will result in a payload violation.
  - In the interest of time for the competition, the whole weigh-in process should not take longer than 5 minutes per team. The 5% score penalty will apply after this limit is exceeded. Teams are encouraged to practice/determine this variable with prior launches.
- **Restricted payload materials.**
  - The use of restricted payload materials, including live animals, hazardous materials or any other material violating CASA or AMRS regulations will result in a payload violation.
- **Safe payload recovery.**
  - Your payload must comply with the latest AMRS and CASA safe recovery regulations. Contact your local rocketry club should you have any concerns about your proposed payload recovery method.

For example, if your team scores 80/100 for your flight performance with a total competition score of 210, but you have one payload violation, your team's final score would be as follows:

Final Score = 210 - 80(5/100) = 206*

3 Penalties

The team's performance will suffer penalties in the form of score reduction or, more severely, potential disqualification from the current competition/ban from future competitions.

3.1 Flight Performance Payload Penalty

For payload violations, score reduction is limited to a percentage of the team's Flight Performance Score (100 marks). Since there are 5 subcategories of payload violations, a team can suffer a maximum of 25% score reduction off of their *final* Flight Performance Score. For more details on payload violation refer to **Section 2.6**.

3.2 Late or No Submission Penalty

Late submission of any deliverable will result in a 5% *per day* penalty of the overall mark of the deliverable in question, accruing to a total maximum of a 35% reduction. This means that after 7 days, a given team can achieve a maximum of 65% of the original available mark, after which the deliverable will receive a score of 0. This is a blanket policy and shall be automatically applied if there is no prior contact with the AURC. Requests for extensions and special consideration must be made *before* the due date of the deliverable. Leniency and exceptions will be assessed on a case-by-case basis.

3.3 Safety and Conduct Penalties

As per the *AURC Rules, Standards and Guidelines* document, teams can be disqualified for breaching critical safety protocols established by the launch site operators. However, for minor safety infringements or unsportsmanlike behaviour, a penalty of 5 marks per infringement will be removed from the team's total mark.

Minor safety infringements include, but are not limited to:

- Unapproved team members crossing the flight line;
- Unsafe setup and bench testing of your launch vehicle;
- Failure to use appropriate personal protective equipment, etc.

Unsportsmanlike behaviour infringements include, but are not limited to:

- Intentional failure to comply with a reasonable request from AURC committee members or AMRS officials;
- Hostility shown towards other teams;
- Intentionally presenting misleading information to any AURC or AMRS official, etc.

4 Awards

The AURC is currently in the process of investigating industry partners to sponsor a dedicated payload challenge. Further details will be provided as soon as possible.