COMPETITION DELIVERABLES

2020

THE AUSTRALIAN
UNIVERSITIES ROCKET
COMPETITION

AYAA

Table of Contents

Revision History

Revision	Description	Date
Baseline	Document created	01/09/2019
1.5.19	Challenge Update	09/02/2020
2	COVID-19 – Major Competition Changes	10/04/2020

1. INTRODUCTION

This document provides a brief outline of all the scheduled deliverables and deadlines of the AURC 2020. Its aim is to provide you with preliminary information only. Further details of the deliverables will be released in due course.

Assessment of a team's performance in the AURC is based on engineering reporting, engineering design and product performance. Overall, the AURC highly encourages a systems engineering approach and will provide resources to assist in the adaptation of one.

For written deliverables, you are expected to adhere to a professional format/style guide. All deliverables will be evaluated for quality and technical aptitude as well as engineering professionalism, punctuation, grammar, spelling and adherences to safety codes.

All compulsory competition deliverables will have associated specific deliverable outlines, marking rubrics and/or templates released in due course. The AURC committee will at all times aim to provide you with this documentation as soon as is reasonably possible.

1.1 Submission

Competition deliverables are to be submitted through the online portal prior to 11:59pm AEST on the date listed in the "Competition Schedule" available through the "Competitors" tab on the AURC website. As the schedule provided in Section 2 could be updated over the duration of the competition, it is important to ensure your team has the latest version of the beforementioned document.

Should any issues with the online portal occur, email your submission to aurc@ayaa.com.au with the specific deliverable name as the subject. Late submission will incur a penalty unless there are extenuating circumstances, in which case pre-approval for an extension of the due date is required.

1.2 Feedback & Scoring

All marks will be awarded out of the total points available per deliverable. Exempli gratia: for progress report one a maximum of 100 points can be obtained and the awarded score might be 67/100. In addition, up to 75 bonus marks are available for teams completing additional deliverables.

Feedback will be provided for each compulsory deliverable. Further detail and supporting information can be requested up to 7 days after the score has been released, after which the leader board will be updated and finalised.

2. DELIVERABLES

The following sections outline the full competition deliverables schedule, including points that can be obtained. It is the competitor's responsibility to check the **AURC 2020 Competition Schedule** document to ensure your team has the latest updated schedule.

Table 1 - Competition Deliverables Schedule

Date	Deliverable	Points
Monday, 29th of July 2019	**AURC registration opens** Formal registration form will be sent out to successful applicants	N/A
Monday, 7th of October 2019	**AURC registration closes**	N/A
October/November 2019	**AMRS L3 Documentation** If applicable (use of a M, N or O motor in project)	P/F
Friday, 13th of December 2019	**Progress Report 1** Preliminary Design, Engineering Management, Team Organisation & Safety Standards	100
Friday, 13th of December 2019	**Open Rocket Simulation**	P/F
Friday, 6th of March 2020	**Progress Report 2** Design Updates, Manufacturing, Testing & Selection and Scientific viability of Payload	100
Sunday, 31st of May 2020	**Modelling & Simulation Approach (Report)**	50
Sunday, 5th of July 2020	**Payload Report**	50
Sunday, 4th of October 2020	**Progress Report 3**	100
Sunday, 6th of December	**Modelling & Simulation Results (Report)**	100
Sunday, 7th of February 2021	**Final Report**	200
Wednesday, the 7th of April 2021 -- Saturday, the 10th of April 2021	**Presentation** **Scrutineering** **Flight** **Recovery** **Payload Inspection**	150 P/F 200 100 50
	Total available marks:	1200

2.1 Registration Form

After online registration, the file **Registration_form_v1.1.19.xlsx** will be provided to the listed team leader of successful applicants. While this document is not worth any marks, it is a compulsory component of the competition, that includes justification for your preliminary motor selection, timelines and team composition.

Note that if your registration form is not completed in full, your team will not be accepted into the competition. All details will be kept confidentially.

2.2 L3 Documentation

If your team wishes to utilise a M, N or O motor in their project, and your team leader does not currently hold a Level 3 AMRS (or equivalent) certification. You are required to submit a L3 design & construction report. It should contain the following data:

- Completely filled out Pre-Flight Data Capture form, and;
- Drawings of the rocket showing airframe components, fins, bulkheads, recovery system components, payloads, etc., and;
- A parts-listing that includes material descriptions, adhesive types, screw sizes, gauges, thicknesses, etc., and;
- A simplified wiring diagram of the electronic recovery system that shows the major components, and;
- Pre-flight checklist describing field assembly of the rocket, motor installation, recovery system preparation, launcher installation, system arming, etc.

These items should be neatly drawn, and, if possible, lists typed. The primary preparation criteria is that those drawings and lists are neat and legible.

Teams will have to liaise with their respective ACO's directly and respectfully. Your first attempt at the design document is to be provided to AMRS during the month of October. Details for submission will be released to your team directly after registrations have closed.

Teams will have until the 13th of December to obtain approval for their design from AMRS. After approval: ACOs should be kept informed of any changes during construction as soon as possible. This will allow adjustments to the rocket design if deemed necessary by either of the two ACOs.

2.3 Progress Report 1

The primary focus areas of Progress Report 1 are Engineering Management, Team Organisation & Safety Standards. In addition, this report should include a brief overview of your preliminary design. 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.

2.4 Open Rocket Simulation

Teams are expected to submit their proposed rocket as an OpenRocket simulation to Teams Coordinators to verify and edit until they are deemed satisfactory to compete in the AURC. We understand that as teams progress towards the AURC, design changes may occur and thus, minor adjustments to the OpenRocket simulation are permitted but must be communicated to Teams Coordinators for approval. No further alterations to the OpenRocket simulation may be made after the due date of the Final Report.

2.5 Progress Report 2

The primary focus areas of Progress Report 2 are Manufacturing, Testing & Selection and Scientific viability of Payload. In addition, this report should include a complete updated overview of your design. 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.

2.6 Modelling & Simulations Approach (Report)

The Modelling & Simulations Approach Report challenges teams to develop a plan for future work on the aspects associated with simulations through the use of either commercial or internally developed software. This is not a report for showing or producing results; it is instead to be focussed on the methodology and engineering approach.

2.7 Payload Report

Teams will be required to submit a report detailing the objectives of their payload and that it meets the requirements of the payload criteria. Teams must justify their use of either a functional or non-functional payload and, if it functions, how it functions, its intended use and benefits based on its performance and results in flight. Teams may also expand on whether the payload is designed to accomplish the goals set by researchers, the community or students and educators.

The Payload Report must adhere to a scientific format as opposed to the technical/engineering style of the Progress Updates and Final Reports. Further details on the Payload Report will be updated in due course.

2.8 Progress Report 3

The primary focus areas of Progress Report 3 is innovation. Further details will be provided in due course.

2.9 Modelling & Simulation Results (Report)

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;

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 necessity 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 Final Report. The submitted code must display best programming practice, with clear commenting, and is required 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, all FEA simulations need to have accompanying hand calculations validating the simulation results.
- 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 Final 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. Specific marking criteria for this will be released in due course.

2.10 Final Report

A complete technical report must be submitted before launch. This report shall adhere to a professional 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 Final 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 Final Report. The Final 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.

2.11 Presentation

Further details will be provided in due course.

2.12 Scrutineering

A full inspection of the flight vehicle will need to be passed to be approved to launch, while no marks will be awarded, due to its pass/fail nature, failing this component will result in 0 marks for flight performance and recovery as the launch will be scrubbed. Further details will be provided in due course.

2.13 Flight Performance

The vehicle's flight performance will be demonstrated by its achieved altitude relative to the target apogee (10,000ft or 30,000ft AGL). A maximum of 200 points can be achieved, with height above target being penalised just as severely as height below target.

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. Points will be awarded for apogees within ±25% of the 10,000 ft AGL or 30,000 ft target apogee according to the following formula:

$$Points = 200 - \left(\frac{200}{0.25 \times Apogee_{target}}\right) \times \left|Apogee_{target} - Apogee_{actual}\right|$$

2.14 Recovery

Successful recovery of the flight vehicle is worth a maximum of 100 points. A designated AURC official will need to attend the physical recovery of the flight vehicle to obtain any marks for this deliverable to avoid any tampering. Recovery marks are based on whether the rocket's recovery subsystem performed to its design specifications as well as its condition post flight. Judgment is subject to the scrutiny of an AURC official on the day of the launch and recovery. To achieve full marks for recovery, all necessary deployment events must take place at their expected times. Partial failures are off-nominal recovery, including parachute tangling, parachutes not being deployed, separation events not occurring, and mistimed deployment events. The severity of partial failures will be determined by damage to the airframe and internal components, which will be up to the discretion of an AURC official on the day of the launch and recovery. A complete failure will be considered when the airframe is damaged beyond repair and the rocket is unflyable.

Marks for recovery will be awarded in the following structure:

0-10 points: No nominal recovery events
10-80 points: Partial failure
80-100 points: All recovery events nominal

Note that all launch vehicles require a dual deployment system. Streamers and/or varieties of this may be approved but will be assessed at a case-by-case basis.

The final mark will be awarded based on the inspected damage on the rocket. Note that scratches from dragging along the ground after landing do not constitute damage. 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. Severe deployment mistiming may also warrant a lower mark in the allocated point bracket.

2.15 Payload

The AURC is currently in the process of finalising deals with industry partners for their respective payload challenges and will finalise their own marking rubric thereafter. Further details will be

provided in section 5 as soon as they are available. Significant components here would include similarity to the payload report, and evidence of functionality.

AURC specific points for payload will also be awarded. These will surround scientific and/or technological research value and capability of the designed payload. Note that within the 10 000ft category; cube-sat compatibility of 1U (10cm x 10cm x 10cm) will be required for maximum payload marks. A more detailed marking breakdown will be released at a later date.

The minimum capacity for the payload shall be no less than two kilograms (2 kg). 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 payload 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.

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 Safety and Conduct Penalties

Safety is of paramount importance to the AURC. As such, the following not only applies to conduct during the final launch event, but will cover the entire duration of the competition, from registration to the end of the closing ceremony.

The AURC and its industry partners want to highlight that teams can (and will) be disqualified for breaching critical safety protocols. However, for minor safety infringements or unsportsmanlike behaviour, a smaller penalty will be enforced. Due to the nature of this competition, infringements will be assessed on a case by case basis.

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 any other relevant officials;
    - Hostility shown towards other teams;
    - Intentionally presenting misleading information to any AURC or any other relevant officials, etc.

3.2 Late Submission

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.

4. CHALLENGES

For the AURC 2020, teams have the opportunity to compete in a specific challenge in addition to the general competition. Note that for all challenges custom development is the underlying intention of the challenge.

Note that using COTS systems to meet payload goals may result in disqualification for the specific challenge. Please ensure you clarify these restrictions where applicable. Cube-sat compatibility of 1U (10cm x 10cm x 10cm) is highly encouraged.

4.1 Royal Australian Air Force Payload Challenge

Payload challenge details will be provided in due course.

4.2 Defence Science and Technology Payload Challenges

Defence Science and Technology will be running three payload challenges for the AURC 2020. The base outline of their challenges can be found below. Note that you are required to express your intent to compete by email to aurc@ayaa.com.au, after which further details and rubrics will be made available in due course.

4.2.1 Challenge 1: Position, Navigation and Timing in a GPS-denied Environment

The first challenge requires a payload that is capable of logging the altitude, attitude and velocity of the rocket without a GPS signal. Some ideas for this challenge include via software defined radio, passive RF, stargazer et cetera. For this challenge, teams are required to include a standardised on-board 'GPS truth' signal. Points will be awarded for accuracy compared to the GPS truth signal, innovation, cost and complexity.

4.2.2 Challenge 2: Communication, Control and Avionics

Using an uplink (i.e. RF) command the launch vehicle to perform an activity post apogee and successfully downlink transmit telemetry to ground station. Points will be awarded for successful RF up and operation of desired command, as well as, the downlink telemetry will be scored based on SWaP and the number of features and data contained. These include balancing:

- Bandwidth, error rates and battery life

- Commercial grade encryption (optional)
- Video (30/90 fps)

4.2.3 Challenge 3: Observation and Space Situational Awareness

Teams are required to deploy a camera at or near apogee to locate and photograph the launch site. A Snellen Eye Chart can be used as an equivalent of a near launch point. Points will be awarded for equipment as well as the resolution of the eye chart; how much of the eye chart is visible in the image.

4.3 Shoal Group Modelling & Simulation Award

Shoal Group will award the best modelling and simulation rocket submission with the Shoal Award for Modelling and Simulation. This award is presented to the team which has demonstrated exemplary efforts in de-risking their rocket submission through thorough modelling and simulation practices.

The submission must demonstrate a well-thought-out modelling and simulation approach, with accompanying validation strategies and methods used. Analysis of results and decision-making surrounding assumptions and parameter selection will also be scrutinised. This award is tool-agnostic and method-agnostic. Each submission will be reviewed by Shoal's world-class engineering team. Shoal engineers have been involved with major space modelling and simulation projects including the JAXA Hayabusa spacecraft re-entry into Australia and the revision of the Australian Space Agency's Flight Safety Code and Maximum Probable Loss Methodology.

Note: No further rubric will be released for this award. Shoal will look at the final report section that discusses modelling and simulation, considering any and all simulations that de-risk the designed rocket to achieving its technical goal. Naturally, technical written communication skills should be of a high standard.