AURC

AUSTRALIAN
UNIVERSITIES
ROCKET
COMPETITION

2024 AURC Rocket Specifications

Draft A: 18th December 2023

AYAA

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Revision History

Revision	Description	Date
Draft A	Initial Pre-Release	18/12/2023

Authors

Person	Role	Position	Signature	Date
Sachio Ingrilli	Originator	Director, AURC		19/12/2023
Rowan Sobey	Reviewer	Deputy Director, AURC		19/12/2023

Endorsements

Draft A of the 2024 AURC Rocket Specifications has been pre-released for team registration period. Following endorsement by stakeholders the document will be released as revision Version 1.0 which may include changes to areas across the document.

Purpose and scope

This document outlines the restrictions imposed and minimal design requirements of rockets launching in the 2024 Australian Universities Rocket Competition (AURC). Subsequent information outlining the process in which rocket launches are to take place is outlined in the “2024 AURC SOP” document and a list of assessable items and their associated due dates, submission instructions, penalties and judging is available in the "2024 AURC Rules" document. Please contact an AURC representative for further queries either by email at aurc@ayaa.com.au or through the AURC 2024 Slack channel.

Terms Used

See Table 1 for a list and definitions of the terms used in this document.

Table 1: Terms used and their definitions.

Term	Definition
AGL	Above-ground-level
AURC	Australian Universities Rocket Competition
AWG	American Wire Gauge
AYAA	Australian Youth Aerospace Association
CASA	Civil Aviation Safety Authority
COTS	Commercial Off the Shelf
GPS	Global Positioning System
NAR	National Association of Rocketry
SRAD	Student Researched and Developed
TRA	Tripoli Rocketry Association

Introduction

Competition Summary

The Australian Universities Rocket Competition (AURC) is a multidisciplinary team engineering competition for tertiary STEM students, organised by the Australian Youth Aerospace Association (AYAA). In the competition universities compete to design, manufacture, and launch a high-power rocket to a target altitude in the span of a year.

In 2024 the competition will take place at Williams Wildfire Westernationals, a 3-day rocket launch festival scheduled on September 20th to 22nd near Williams, Western Australia. The competition will feature both a 5,000 and 10,000 ft target altitude categories for COTS solid rocket motors.

Rocket Specifications Motivation

Whilst written in good faith and with safety in mind, existing rules and restrictions on rocket construction and operation imposed by hobbyist model rocket associations and governing bodies are not all-encompasing nor specific to Australia. The AURC recognises a need for additional supplementary rocket restrictions with the purpose of further mitigating risk. These restrictions are especially valuable for newly formed student teams that are inexperienced in high-power rocketry and unaware of the potential for their actions to cause adverse effects, or typical best practices to mitigate these effects.

The "2024 AURC Rocket Specifications" document was constructed to provide single source of information about the best practices of high-power rocket construction, preparation, testing, launch and recovery. Teams following the specifications imposed in this document, as well as the additional AURC documentation on range standard operating procedures, will be approaching rocketry responsibly and safely and in doing so minimizing the risks imposed to themselves and bystanders. It is a requirement that competing teams meet these specifications, however the AURC further endorses this document as good guidelines for rocketry occurring outside of the competition event. The AURC strives for a 100% recovery rate and believes this document will considerably increase the probability of rockets returning in a reusable state.

Safety is number one priority at the AURC and does not just fall onto the competing students who are making and launching their rockets. AYAA recognizes that safe practice is a system that occurs at all levels and by all parties, extending to the AURC organizers, launch site, sponsors and hobbyist rocketeers. Where possible AYAA will always strive to exercise our responsibility to practice safely. The AURC recognizes its role in encouraging safety culture in up-and-coming STEM professionals.

The specifications in this document arise from consultation with experienced rocketeers, existing literature on rocket design, previous AURC documentation and a heavy influence from the 2023 Intercollegiate Rocket Engineering Competition *"Design, Test, & Evaluation Guide"* from the Spaceport America Cup (SAC). The SAC is a similar high-power rocket competition which has run since 2006 and hence has unique insight of the intricacies involved in launching student rockets for almost two decades. Much like the SAC, defining the AURC Rocket Specifications will be an ongoing process and subject to revisions over the years. This is particularly relevant as the competition approaches its goal of providing a hybrid rocket launch category which carries with it unique safety challenges.

Documentation and Resources

This document outlines the imposed specifications for rockets competing in the 2024 AURC. The document is not all-encompassing and additional safety documentation is available and listed in Table 2. Teams should be familiar with all documentation listed in this table. Range standard operating procedures will be released in accordance with the "AURC 2024 Key Dates" timeline.

Table 2: AURC 2024 Safety Resources

Resource	Description	Location
Rules	Competition details, assessment criteria and due dates, eligibility criteria and payment deadlines.	https://aurc.ayaa.com.au/competitor-info/
Range SOP and Launch Infrastructure	Standard operating procedure for all rocket launches and details of provided launch site equipment	https://aurc.ayaa.com.au/competitor-info/
Civil Aviation Safety Regulations 1998: Part 101	Regulations for Unmanned Aircraft and Rockets under *Civil Aviation Act 1988*	https://www.legislation.gov.au/Details/F2023C00499/Html/Volume_3#_Toc139897686
Tripoli Safety Code	Guidelines for the reasonably safe operation of rockets at Tripoli Launches.	https://www.tripoli.org/safety
TRA High-Power Certification Program	Overview of level 1, 2 and 3 Tripoli high power rocketry certifications	https://www.tripoli.org/Certification
ACMA Radiofrequency Spectrum Plan	Regulations for radio frequency transmission in Australia.	https://www.acma.gov.au/australian-radiofrequency-spectrum-plan
Certified motors list	List of solid rocket motors which has been certified for use at TRA, NAR and Canadian Association of Rocketry events.	https://www.nar.org/standards-and-testing-committee/nar-certified-motor-list/
CubeSat Design Specification	Details on permissible CubeSat dimensions	https://www.cubesat.org/cubesatinfo
OpenRocket Tutorials	Instructions on proper use of the OpenRocket simulation software.	https://openrocket.info/tutorials/
RASAero II User Manual	Instructions on proper use of the RASAero II simulation software.	https://www.rasaero.com/

Revisions

AYAA reserves the right to revise the AURC Rocket Specifications. This document amongst all AURC documentation may be subject to change in which case competing teams will be notified. The most recent version will always be maintained on the AURC website. Student teams should always verify they are working with the correct version by checking the version number and date and ensuring it matches the document on the website.

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.

1 Scope

1.1 Terminology

1.1.1 Requirements using the word "**shall**" denote mandatory conditions that teams must meet.

1.1.2 Requirements using the phrase "**shall not**" denote actions that are not permissible.

1.1.3 Requirements using the word "**should**" denote non-mandatory conditions that teams are recommended to meet.

1.1.4 Requirements using the word "**may**" denote permissible actions.

1.1.5 Requirements using the phrase "**as far as reasonably practicable**" reflect teams' responsibility to act in good faith and the unacceptability of negligence. It means doing what you are reasonably able to do to ensure the health and safety of all attendees including competitors, volunteers, and bystanders.

1.2 Purpose

1.2.1 This document shall outline the restrictions imposed on rockets and expectations of teams competing in the 2024 AURC to ensure safe construction, preparation, testing, launch and recovery of rockets.

1.2.2 Safety reviewers may choose to adopt their own experience as a substitute for these rules on a case-by-case basis given endorsement of the chief safety reviewer.

1.3 Safety Review

1.3.1 Teams shall have their rockets inspected by a safety reviewer before competition launch and receive a flight readiness status from one of the following options:

1.3.1.1 'Nominal', corresponding to teams who have met all the requirements specified in this document and whose rocket is deemed safe and ready to launch.

1.3.1.2 'Provisional', corresponding to teams who will have their flight readiness status changed to 'Nominal' once one or more unacceptable elements of the rocket are amended to an acceptable standard.

1.3.1.3 'Denied', corresponding to teams who have failed to meet the requirements specified in this document and whose rocket is deemed unsafe and unready to launch in an unmitigable way.

1.3.2 Safety reviewers shall be appointed by the AURC organising committee and hold notable experience and know-how in high-power rocketry.

1.3.3 Teams unable to obtain a nominal flight readiness status shall not be permitted to launch their rocket in the competition and shall void points associated with the launch and recovery of their rocket.

2 Launch Operation

2.1 Launch Procedure

2.1.1 Launch and testing of all rockets shall be completed in accordance the restrictions laid out in the following documentation:

2.1.1.1 "AURC 2024 SOP" document.

2.1.1.2 Tripoli Rocketry Association rules, regulations, guidelines, safety codes and certification requirements.

2.1.1.3 Civil Aviation Safety Authority (CASA) Regulations for Unmanned Aircraft and Rockets under Civil Aviation Act 1988.

2.1.1.4 Australian Communications and Media Authority (ACMA) Australian Radiofrequency Spectrum Plan.

2.1.1.5 Other federal, state, and local laws, bylaws, rules and regulations.

2.2 Flyer of Record

2.2.1 Rockets shall be launched by a flyer of record who holds the appropriate TRA high-power rocketry certification to launch the installed solid rocket motor.

2.2.2 The flyer of record shall be involved with assembly of the rocket motor.

2.2.3 The flyer of record shall be intimately familiar with the rocket design and functionality.

2.3 Launch Rails

2.3.1 Rockets shall be launched on a launch rail that meets the requirements outlined in the "AURC 2024 SOP" document.

2.3.2 A launch rail is defined as a guiding structure which constrains the rocket orientation until it has gained sufficient momentum to sustain aerodynamic stability.

2.3.3 Modification of launch site provided launch rails is not permitted.

2.3.4 Launch rail shall be set at an inclination to the vertical that follows the restrictions laid out in the "AURC 2024 SOP" document and may be non-zero for the purpose of adjusting the rocket landing zone.

2.3.5 Teams may provide their own launch rail given that it:

2.3.5.1 Fulfills condition 2.3.1

2.3.5.2 Is placed in the appropriate launch site location as detailed in the "AURC 2024 SOP" document.

2.3.5.3 Is inspected and deemed appropriate for use by safety reviewers and pad managers prior to launch.

2.3.5.4 Is all-encompassing and does not require additional components beyond an ignition system.

2.3.6 Launch rails should be transportable by foot up to 100m distance.

2.3.7 Launch rails should be operable without actuation by hydraulics or electronics.

2.3.8 Launch rails which require the following to function are prohibited:

2.3.8.1 a generator.

2.3.8.2 a wet cell lead acid battery.

2.3.9 Teams providing a launch rail in the form of a launch tower are exempt from the rail button requirements in Section 3.5.

2.3.10 A launch tower is defined as a variation of a launch rail which constrains the rocket through guides which support the rocket exterior on multiple sides, removing the need for rail buttons.

3 Airframe

3.1 Design Integrity

3.1.1 Teams shall make efforts as far as reasonably practicable to ensure that all components of the launch vehicle are adequately designed to function as intended without failure.

3.1.2 Launch vehicles shall be constructed to withstand the operating stresses and retain structural integrity under the conditions encountered during handling, transportation and rocket flight, particularly those pertaining to motor thrust, aerodynamic loading and deployment events.

3.2 Materials

3.2.1 Rockets shall be built using lightweight materials, for example fiberglass and carbon fibre, or when necessary ductile lightweight metals, for example aluminium.

3.2.2 PVC (and similar low-temperature polymers), Public Missiles Ltd. (PML) Quantum Tube, and steel (including stainless-steel) shall not be used in any rocket airframe structure.

3.2.3 The rocket airframe structure is defined as the components making up the main external load-bearing structure of the launch vehicle and includes fins, body tubes, and nosecones.

3.2.4 Rockets shall not contain environmentally hazardous materials, such as those which are radioactive or poisonous, for example lead, mercury and uranium.

3.2.5 Rockets shall not contain live animals.

3.3 Anchoring Points

3.3.1 All load bearing eye bolts, eye nuts, U-bolts, and links shall be steel.

3.3.2 All load bearing eye bolts/eye nuts shall be of the closed-eye, forged type.

3.4 Couplers

3.4.1 Couplers are defined as any component with the purpose of joining two concentric sections of the rocket.

3.4.2 Sliding couplers shall meet be designed such that the coupling tube extends no less than 1 body tube diameter (1 caliber) into the airframe section from which the coupler will separate during flight.

3.4.3 Sliding couplers are defined as those which are intended to separate during a recovery event.

3.4.4 Teams may receive exemption from condition 3.4.2 for joints extending into a nosecone, tail cone or transition section with variable diameter where 3.4.3.1 is not possible, in which case couplers may extend to the maximum depth permissible by the design of the components.

3.4.5 Sliding couplers shall not extend less than 0.5 body tube diameter into the airframe section from which the coupler will separate during flight.

3.4.6 Fixed couplers shall meet the following requirements:

3.4.6.1 Be designed such that the coupling tube extends into the mating component to the lesser of 1 body tube diameter (1 calibre) or the maximum depth possible by the design of the mating component.

3.4.6.2 Joints shall be affixed by mechanical fasteners and/or permanent adhesive.

3.4.7 Fixed couplers are defined as those which are not intended to separate during flight.

3.5 Rail Buttons

3.5.1 Rockets shall have a minimum of two (2) rail buttons.

3.5.2 Rail buttons are defined as "hard points" for sliding mechanical attachment of the rocket to the launch rail which guides it during boost.

3.5.3 Rail buttons shall fit a standard 15 series 1.5" x 1.5" (aka 1515) 80/20® Aluminium T-slot extrusion and slide with minimal friction.

3.5.4 Rail button attachment points to the airframe shall be reinforced using at least one metallic fastener.

3.5.5 Rail buttons made from the following materials are not permitted:

3.5.5.1 3D printed polymers.

3.5.5.2 Metals other than aluminium.

3.5.6 Teams using rail buttons made from aluminium shall provide evidence of their necessity to safety reviewers.

3.5.7 Rail buttons made from aluminium shall have rounded or chamfered edges to prevent damaging the rail surface.

3.5.8 The aft most launch rail button shall support the launch vehicle's fully loaded launch weight while the rocket is in a vertical orientation.

3.5.9 Rail button placement shall not result in the rail blocking access to arming electronics.

3.5.10 Fly-away rail guides are not permitted.

3.5.11 Fly-away rail guides are defined as any rail button design which becomes detached from the rocket after exiting the launch rail.

3.6 Venting

3.6.1 Launch vehicles shall be adequately vented to the atmosphere to prevent internal pressures developing during flight and causing either damage to the airframe or premature separation and recovery deployment.

3.7 External Appearance

3.7.1 Each independently recoverable section of the launch vehicle shall be labelled with the team number on the rocket exterior.

3.7.2 Teams should choose the design of the rocket exterior to yield it easily visible during flight and recovery, for example by using high contrast colours and avoiding camouflage patterns.

4 Flight Profile

4.1 Simulation

4.1.1 Teams shall provide a trajectory simulation of the rocket flight completed in either OpenRocket or RASAero II software.

4.1.2 Teams shall make efforts as far as reasonably practicable to ensure that the trajectory simulation is completed with accurate input parameters, particularly those pertaining to rocket mass, dimensions and propulsion.

4.2 Altitude

4.2.1 Apogee of the rocket shall not exceed 15,000 ft AGL, as predicted by the trajectory simulation.

4.3 Fin Flutter

4.3.1 Fin flutter velocity of the rocket shall be at least 50% more than the maximum expected rocket velocity.

4.4 Thrust to Weight

4.4.1 The thrust to weight of the rocket shall exceed 5.

4.4.2 Thrust to weight is defined as the lesser of the initial or average thrust of the motor divided by the take-off weight (product of wet mass and gravity) of the rocket.

4.5 Stability

4.5.1 Rockets shall be aerodynamically stabilised in the direction of their momentum during flight.

4.5.2 During ascent launch vehicles shall maintain a static stability margin between 1.5 and 6 calibres, regardless of CG or CP movement with time.

4.5.3 Static stability margin is defined as the ratio of the rocket aerodynamic pitching moment coefficient gradient and aerodynamic normal force coefficient gradient.

4.5.4 Rail departure velocity of the rocket shall exceed 30 m/s.

4.5.5 Rail departure is defined as the instant at which the launch vehicle first becomes unconstrained about the pitch, yaw, or roll axis.

4.5.6 Teams may receive exemption from condition 4.5.4 provided detailed analysis proving that stability is achieved at a lower rail departure velocity is available, preferably via flight testing.

4.5.7 Rail departure velocity shall not be less than 15m/s.

5 Recovery

5.1 Design Integrity

5.1.1 Teams shall make efforts as far as reasonably practicable to ensure that all components of the launch vehicle return to the ground in a safe manner and undamaged.

5.1.2 The launch vehicle recovery system shall implement adequate protection, for example fire resistant material, pistons, or baffles, to prevent energetics from damaging recovery components such that they would be unable to perform their intended function.

5.2 Dual Deployment

5.2.1 Each independent (un-tethered) piece of rocket shall implement its own dual-deploy recovery system to return it to the ground.

5.2.2 A dual-deploy recovery system is defined as one which involves the successful deployment of one of the following recovery configurations:

5.2.2.1 Two parachutes, a drogue and a main parachute

5.2.2.2 A single 'reefed' parachute acting as a drogue which becomes 'unreefed' during a main deployment event, increasing its drag coefficient.

5.2.3 Drogue and main parachutes shall have independent and contrasting colours from each other.

5.2.4 Parachutes shall be coloured so that they are easily distinguishable from the sky and clouds.

5.3 Drogue Parachute

5.3.1 A drogue deployment event of a drogue parachute or reefed main parachute shall occur at or near apogee.

5.3.2 Vertical descent of the launch vehicle under the drogue configuration shall be between 20 and 50 m/s.

5.4 Main Parachute

5.4.1 A main deployment event of a main parachute, or un-reefing of main parachute shall occur at an altitude less than 450 m AGL.

5.4.2 Vertical descent of the launch vehicle under the main configuration shall be less than 11 m/s.

5.5 Deployment Mechanism

5.5.1 Deployment of all recovery systems shall be electronically controlled through a flight computer as outlined in section 6.1.

5.6 Recovery Testing

5.6.1 Teams shall demonstrate nominal deployment of all their recovery systems either through a ground or flight test before the competition rocket launch.

5.6.2 Video evidence of the ground or flight tests shall be presentable to competition organisers.

5.6.3 Ground and flight tests shall be implemented within the intended launch vehicle with the same major components as the competition flight.

5.6.4 Sensor electronics shall be functionally included in the ground test demonstration by simulating the environmental conditions under which their deployment functions are triggered.

5.6.5 Ground and flight tests shall comply with the rules imposed by the location of testing, particularly those pertaining to transportation and handling of energetics.

5.6.6 Teams shall demonstrate that rocket tethering methods will not fail under the expected operating conditions, either through experimental testing or calculation.

6 Electronics

6.1 Flight Computers

6.1.1 Timing of deployment of all recovery systems shall be electronically controlled through a flight computer.

6.1.2 Each recovery deployment stage of Condition 5.2.1 shall be dual redundant:

6.1.2.1 Deployments systems shall have two independent arming switches, flight computers, power supplies, ignitors, and energetics.

6.1.2.2 Both drogue and main deployment may be actuated by the same redundant system of two switches, flight computers and power supplies.

6.1.2.3 Condition 6.1.2 shall not apply to the recovery components themselves such as shock cord, linkages, swivels and parachutes.

6.1.2.4 Teams should choose dissimilar redundant components with different brands or form factors.

6.1.3 A dual redundant system is defined as one in which any single point of failure cannot result in loss of function.

6.1.4 At least one of the flight computers used in deployment of each recovery stage shall be manufactured by a third-party and from the list of options provided in Appendix A.

6.1.5 Flight computers with modification from the stock option, including software changes, shall not fulfill Condition 6.1.4.

6.1.6 Teams may use SRAD flight computers for deployment of recovery stages given the following criteria are met:

6.1.6.1 The flight computer is well documented in the submitted competition technical report.

6.1.6.2 The flight computer takes appropriate recognition of effects of noise and sensor error and evidence of sensor filtering testing is provided.

6.1.6.3 The flight computer has demonstrated nominal deployment of recovery through the conditions in section 5.6.

6.1.7 SRAD flight computers are defined as those which meet the following criteria:

6.1.7.1 COTS flight computers that have been modified from the stock option, including software changes.

6.1.7.2 Kit flight computers that are not assembled by the manufacturers.

6.1.7.3 COTS microcontrollers running custom flight software.

6.2 Tracking

6.2.1 Each independent (un-tethered) piece of rocket shall contain a GPS tracking solution.

6.2.2 Tracking shall be functional and have GPS lock before launch.

6.2.3 All tracking systems shall abide by the Australian Communications and Media Authority (ACMA) Australian Radiofrequency Spectrum Plan.

6.2.4 Teams shall only use a transmission frequency for which they have a member with the appropriate radio license and use their callsign.

6.2.5 Using a radio frequency illegally may result in federal offences and disqualification from the AURC.

6.2.6 Teams should ask local TRA prefectures for guidance on products to use and where to purchase them.

6.2.7 Teams should be cautious when using tracking equipment that is not from an Australian manufacturer and ensure the equipment complies with Australian regulations.

6.2.8 The AYAA is not liable for the conduct of, nor penalties incurred by teams due to inappropriate usage of radio or other electromagnetic frequencies.

6.2.9 Teams shall have the ability to quickly change frequencies on their transmitting and receiving equipment.

6.2.10 The AYAA reserves the right to re-assign teams tracking transmission frequencies.

6.2.11 All transmitting devices shall be documented in competition reports.

6.2.12 SRAD GPS tracking systems shall include documentation detailing the design, fabrication, operation, and testing of the system in competition reports.

6.2.13 Any transmitter with 200 mW or less output power may be used anywhere in the rocket.

6.2.14 Any transmitter over 200 mW output power shall not be used in a rocket containing SRAD avionics controlling energetics.

6.2.15 Teams may be exempt from Condition 6.2.14 given they have deemed appropriate for use by the chief safety reviewer. Factors such as spatial separation, time separation, frequency separation, antennas, and filters may be considered.

6.3 Apogee Measurement

6.3.1 Rockets shall contain at least one COTS altimeter manufactured by a third-party and from the list of options provided in Appendix A for the purpose of measuring apogee during launch.

6.3.2 Altimeters with modification from the stock option, including software changes, are not permitted.

6.3.3 Rockets that meet the following conditions shall void competition points associated with flight performance:

6.3.4 Those which do not fulfil Condition 6.3.1 including the exclusion imposed by Condition 6.3.2.

6.3.5 Those which fulfil Condition 6.3.1, but with an altimeter that is not functional during the competition flight.

6.3.6 Those which fulfil Condition 6.3.1, but where altimeter data is not retrievable immediately after flight, for example through malfunction or damage.

6.4 Batteries

6.4.1 All batteries shall have polarity clearly labelled, preferably by colour coding with red on the positive terminal and black on the negative terminal.

6.4.2 The following battery types are permitted in rockets:

- 6.4.2.1 LiFePO4 chemistry cells in any form factor and in any casing (plastic or metallic).
- 6.4.2.2 NiMH (Nickel-Metal hydride) batteries in metal casing and any form factor.
- 6.4.2.3 Alkaline (non-rechargeable) batteries in metal casing and any form factor.
- 6.4.2.4 Other Li-Ion batteries, if packaged in a cylindrical metallic casing.
- 6.4.2.5 Lithium primary coin cell batteries in metal casing.
- 6.4.2.6 LiPo (Lithium-Polymer) batteries, given they are installed in the powered device by the manufacturer or recommended and supplied by the manufacturer.

6.4.3 The following battery types are not permitted:

- 6.4.3.1 Li-Ion batteries in a rectangular form factor.
- 6.4.3.2 Li-Ion batteries with plastic casing.

6.4.3.3 Wet cell lead acid batteries.

6.4.3.4 Lithium-Polymer (LiPo) batteries which are not installed in the powered device by the manufacturer or recommended and supplied by the manufacturer.

6.4.4 Teams should inquire about battery chemistries and form factors not listed here.

6.5 High Voltage

6.5.1 Any electronic system that utilizes voltages 50 volts (AC or DC) or higher shall be identified with the following warning external to the electronics enclosure; "CAUTION: High voltage inside. Internal access by team personnel only."

7 Safety Critical Wiring

7.1 Design Integrity

7.1.1 Conditions in Section 7 shall apply to safety critical wiring of rockets.

7.1.2 Safety critical wiring is defined as any electrical wiring or associated components which are responsible for recovery system functionality, GPS tracking and deployment energetics.

7.1.3 Teams shall make efforts as far as reasonably practicable to ensure that safety critical wiring can withstand the operating stresses and retain function under the conditions encountered during handling, transportation, and rocket flight.

7.2 Cable Management

7.2.1 Wiring shall be labelled or color-coded to allow easy determination of the subsystem to which it is attached.

7.2.2 All insulating tubing other than the stock wire insulation, such as heat-shrink, shall be transparent to facilitate easy inspection.

7.2.3 Wiring shall be bundled together to prevent tangling and excessive free movement through one of the following methods:

7.2.3.1 A light twist

7.2.3.2 Short lengths of clear heat-shrink tubing every 5 centimetres.

7.2.3.3 Cable ties every 5 centimetres.

7.2.3.4 Wire mesh sleeving, provided it allows for inspection of the wiring inside.

7.2.4 Safety critical wiring should be bundled separately from non-safety critical wiring.

7.3 Wire Type

7.3.1 Wire shall be stranded, insulated and 22 AWG or lower numerical AWG with wire strands made from copper and plated with either silver or tin along the entire wire.

7.3.2 Teams may receive an exemption to condition 7.3.1 given one of the following conditions is met:

7.3.2.1 Where a piece of off-the-shelf equipment has flying leads, in which case the leads may be used unmodified.

7.3.2.2 Where a piece of off-the-shelf equipment is sized to use wire smaller than 22 AWG, for example by connection through screw terminals, in which case the appropriate size may be used for that portion of the circuit only.

7.3.3 Wire shall not be manually reduced in strands, for example for the purpose of fitting into a smaller hole or terminal.

7.3.4 Wires shall not be insulated with tape, glue, or room-temperature-vulcanizing silicone.

7.4 Wire Termination

7.4.1 Ends of a wire shall be terminated by one of the following methods:

- 7.4.1.1 By crimping into a crimp terminal
- 7.4.1.2 By screwing into a binding screw terminal

7.4.2 Wires terminated by the method in condition 7.4.1.2 shall meet the following conditions:

- 7.4.2.1 The end of the wire shall make a 180-degree hook around the screw and be uninsulated for this entire length.
- 7.4.2.2 The strands shall be visible exiting the screw head.
- 7.4.2.3 The wire shall bend clockwise around the screw so that it will tighten as the screw is torqued.
- 7.4.2.4 Screws shall not secure more than one wire.

7.4.3 Teams may receive an exemption to condition 7.4.1 given one of the following conditions is met:

- 7.4.3.1 Where a piece of off-the-shelf equipment has built-in terminal blocks, in which case the wire may be secured using the terminal block.
- 7.4.3.2 Where a piece of off-the-shelf equipment has built-in solder terminals, in which case the wire may be terminated by soldering.

7.4.4 Wire terminations shall not have exposed (uninsulated) wire with potential to cause a short circuit.

7.5 Joining Wires

7.5.1 Wires shall be joined by one of the following methods:

- 7.5.1.1 By crimping a ring terminal onto each end and screwing them into barrier block, with an appropriate number of barrier block jumper pieces
- 7.5.1.2 By screwing bare wires under binding head screws in a barrier block, with an appropriate number of barrier block jumper pieces
- 7.5.1.3 By crimping wires into an un-insulated butt-splice terminal and insulating with clear heat-shrink tubing
- 7.5.1.4 Through connectors as outlined in section 9.1

7.5.2 Wires shall not be connected with any wire-twisting splice method, for example through wire nuts.

7.5.3 A maximum of two crimped ring or spade terminals shall be connected under a common screw in a binding screw terminal.

7.6 Connectors

7.6.1 Electrical connectors shall use crimp contacts.

7.6.2 Teams may receive an exemption to condition 7.6.1 given one of the following conditions is met:

- 7.6.2.1 Where a piece of off-the-shelf equipment implements its own connector, in which case the existing wire connection may be utilized.
- 7.6.2.2 Where the connector is of the co-axial type, in which case they may be soldered.

7.6.3 Electrical connectors shall utilize a positive locking mechanism to keep the two halves mated under vibration and tension.

7.6.4 Teams should avoid electrical connector latches made from plastic.

7.6.5 Threaded coaxial connectors shall be finger tight.

7.6.6 Connectors for wires delivering power shall be polarized to prevent reversed power application.

7.7 Mounting

7.7.1 Safety critical wiring components shall be rigidly fixed to the rocket structure to prohibit movement.

7.7.2 Rigid fixing is defined as attachment with standoffs, threaded fasteners or glue.

7.7.3 The following methods shall not be used as the primary method for rigid fixing of safety critical wiring components:

7.7.3.1 Cable ties.

7.7.3.2 Tape.

7.7.3.3 Velcro.

7.7.3.4 Solderless (AKA plug-in) breadboards.

7.7.3.5 Electrical connectors.

7.7.4 Bundled wiring shall be supported to reduce movement or tangling, for example through clamps, tie bases, or by tie wraps.

7.7.5 Wiring shall incorporate strain relief with a visible curve at all connections to prevent unintentional de-mating/disconnection.

7.7.6 All wire terminations shall undergo and pass a 'pull test' whereby a moderate pull is exerted on the wiring to verify that it remains attached.

7.7.7 Teams should consider the effects of acceleration to determine orientation of electrical components to prevent the following:

7.7.7.1 Electrical connectors being pulled apart.

7.7.7.2 Batteries held in commercial holders compressing contact springs.

7.7.8 Batteries prone to puncture damage shall be mounted such to mitigate the likelihood of such damage occurring during a hard landing or other high impact event.

7.7.9 9V snap batteries shall only be connected using standard snap terminals.

7.7.10 Circuit board components exceeding 7g in mass shall be staked to prevent motion under acceleration, for example through conformal coating.

7.8 Wire Stripping

7.8.1 Wire stripping shall be performed with a stripping tool of the correct gauge.

7.8.2 Stripped wires with severed strands shall not be accepted.

7.8.3 Teams should utilize a thermal wire stripper to strip wires with Teflon, Tefzel or PVC insulation.

7.8.4 Wires shall not be stripped with pocketknives or teeth.

7.9 Crimping

7.9.1 Wire crimping shall be performed with a crimping tool using the crimp terminals sized for the appropriate wire gauge or summation of wires gauges.

7.9.2 Crimping tools shall not be used from multitools, or improvised tools not intended for crimping such as pliers or vices.

7.9.3 A maximum of three wires shall be crimped into a single terminal barrel.

7.9.4 Butt-splice terminals are considered to have separate barrels in each end and therefor may be used to join a maximum of 6 wires.

7.9.5 Crimp terminals with insulated plastic sleeves shall not be crimped without the sleeve being removed to facilitate inspection of crimp quality.

8 Energetics

8.1 Propulsion

8.1.1 Rockets shall use a solid COTS rocket motor for propulsion.

8.1.2 A Commercial Off the Shelf (COTS) motor is defined as a motor which has been certified by the Canadian Association of Rocketry, Tripoli, or NAR, and appears on the current combined Certified Rocket Motors List at time of launch.

8.1.3 Each rocket shall contain a single motor: clusters or staging of motors is not permitted.

8.1.4 Hybrid or liquid rocket engines with non-solid-state constituents are not permitted.

8.1.5 Propellant shall be ignited with an ignition system and igniters provided by the launch site.

8.1.6 Rockets shall not be capable of igniting the propellant without the use of an external ignition system provided by the launch site.

8.2 Deployment Energetics

8.2.1 Rockets shall not contain energetics intended for purposes other than recovery deployment.

8.2.2 Energetics are defined as all stored-energy devices, other than the single rocket motor defined in Condition 8.1.1, that have reasonable potential to cause bodily injury upon energy release, for example black powder charges, compressed gas, or spring-loaded systems.

8.2.3 All energetics shall require two separate arming events to become armed through two separate arming features.

8.2.4 An energetic device is considered armed when only one event is necessary to release the energy.

8.2.5 If a failure occurs in the arming feature, such as a switch falling apart during rocket assembly, the system shall revert to the not-armed configuration.

8.2.6 All energetics arming events shall be externally accessible.

8.2.7 All energetics arming events shall be capable of being carried out according to the following conditions:

8.2.7.1 Whilst the rocket is in the vertical launch position.

8.2.7.2 Without a person placing their head within 100 mm of the rocket.

8.2.7.3 With arming personnel wearing a face shield and eye protection, or additional standard PPE.

8.2.8 The rocket shall be designed such that any inadvertent energy release of energetics will not be directed at personnel arming them.

8.2.9 All energetics arming events shall provide verification when successful either through visual or audible means.

8.2.10 Arming verification shall be easily discernible in in an environment with the following conditions:

8.2.10.1 At least 76 dBA background noise plus at least 32 km/h (20 mph) wind.

8.2.10.2 High level of ambient sunlight.

8.2.11 Pull-pin arming events shall have pins with sufficient friction so that they are not susceptible to accidental removal from snagging or falling under gravity.

8.2.12 Pull-pin arming events are defined as those which become armed upon the removal of a circuit breaking element.

8.2.13 Teams may use wireless arming events, for example WiFi or Bluetooth switches.

9 Payload

9.1 General Restrictions

9.1.1 Rockets shall carry a payload or payloads meeting the conditions in 9.3 or 9.4 according to the competition target altitude category.

9.1.2 A payload is defined as a sub-assembly of the rocket whose replacement with an equivalent volume of 'dead' (non-functional) weight would not alter the launch vehicle trajectory and recovery.

9.1.3 Payloads should be SRAD.

9.1.4 Payloads shall be separable from the launch vehicle within 10 minutes once in the launch-ready configuration.

9.1.5 The effect of the payload on the rocket flight characteristics shall be included for conditions in section 4.

9.1.6 Teams may receive exemption from Condition 3.2.4 and use radioactive materials in a payload given the following conditions are met:

9.1.6.1 Materials are well documented and approved by the chief safety reviewer.

9.1.6.2 Radioactive materials are fully encapsulated.

9.1.6.3 Materials have less than 1 μSv effective dose.

9.1.7 Payload mass conditions in will be accepted given they exceed 95% of the nominal mass requirement.

9.2 Functionality

9.2.1 Payloads shall be a functional instrument performing an experiment, measurement or observation during rocket flight.

9.3 5000 ft AGL

9.3.1 Conditions in Section 8.3 shall apply to rockets competing in the 5000 ft AGL target altitude category.

9.3.2 Payloads shall be in the form of a CanSat cylinder with exterior dimensions of 66 mm diameter and 155 mm length.

9.3.3 Dimensional conditions in 8.3.2 will be accepted within a linear tolerance of 5%

9.3.4 Payloads shall collectively have a mass of at least 400 g.

9.4 10,000 ft AGL

9.4.1 Conditions in Section 8.4 shall apply to rockets competing in the 10,000 ft AGL target altitude category.

9.4.2 Payloads shall be in the form of one of the following CubeSat configurations with exterior dimensions according to those specified in Appendix B of the 2022 CubeSat design specification Rev. 14.1:

9.4.2.1 1U

9.4.2.2 1.5U

9.4.2.3 2U

9.4.2.4 3U

9.4.2.5 3U+

9.4.3 Payloads shall collectively have a mass of at least 2 Kg.

10 Active Control

10.1 General Restrictions

10.1.1 An active control system is defined as a system within the rocket which is controlled autonomously and capable of altering the flight profile from the ballistic trajectory, for example via aerodynamic control surfaces, reaction control thrusters or thrust vector control.

10.1.2 Active control systems shall have a neutral (powered off) state which does not alter the ballistic trajectory of the rocket.

10.1.3 Active control systems shall be designed to default to the neutral state in the following circumstances:

10.1.3.1 When an abort signal is received for any reason.

10.1.3.2 When primary power is lost.

10.1.4 Active control systems shall be well documented in competition reports and detail the effect that the system will have on the rocket trajectory.

10.2 During Ascent

10.2.1 Conditions in 10.2 shall apply during the ascent of flight which is defined as the period between take-off and the first successful recovery deployment event.

10.2.2 Rockets shall not be guided to a designated spatial target.

10.2.3 Active control systems shall be permissible only in the following circumstances:

10.2.3.1 Aerodynamic braking (drag adjustment), with forces acting along the longitudinal axis of the rocket and inducing no moment in pitch or yaw, for example through air-brakes.

10.2.3.2 Roll rate adjustment, with a moment only effecting the roll axis of the rocket, for example through reaction wheels.

10.2.4 Teams using active control systems shall demonstrate that the conditions in 4.2, 4.3, 4.4 and 4.5 are sustained during operation of the control system.

10.2.5 Active control systems shall remain in the neutral state until one of the following conditions is met:

10.2.5.1 The boost phase has ended, that is the single rocket motor is entirely combusted and acceleration is opposite to the rocket's momentum.

10.2.5.2 The launch vehicle has crossed the point of maximum aerodynamic pressure (max Q) in its trajectory.

10.2.5.3 The launch vehicle has reached 65% of its target apogee AGL.

10.2.6 Active control systems shall be designed to default permanently to the neutral state in the following circumstances:

10.2.6.1 When the launch vehicle's attitude exceeds 30° from its launch elevation.

10.2.6.2 When the apogee of the rocket is reached.

10.3 During Descent

10.3.1 Conditions in 10.3 shall apply during the descent of flight which is defined as the period after the first successful recovery deployment event.

10.3.2 Active control systems shall remain in the neutral state until all of the following conditions is met:

10.3.2.1 The drogue parachute deployment event has occurred.

10.3.2.2 The main parachute deployment event has occurred.

10.3.2.3 Altitude is less than 450 m AGL.

10.3.2.4 Vertical descent is less than 11 m/s.

Appendix A: Approved Flight Computers & Altimeters

Approved Altimeter	Manufacturer	Available from:
StratoLogger	PerfectFlite	http://www.perfectflite.com/SLCF.html
AIM Entacore	Entacore	https://www.apogeerockets.com/Electronics-Payloads/Altimeters/Entacore-AIM-3-Altimeter http://entacore.com/electronics/aimusb
EasyMini	Altus Metrum	https://www.apogeerockets.com/Electronics-Payloads/Dual-Deployment/EasyMini https://altusmetrum.org/EasyMini/
EasyMega	Altus Metrum	https://www.apogeerockets.com/Electronics-Payloads/Dual-Deployment/EasyMega?cPath=52_157& https://altusmetrum.org/EasyMega/
TeleMetrum	Altus Metrum	https://www.apogeerockets.com/Electronics-Payloads/Altimeters/TeleMetrum https://altusmetrum.org/TeleMetrum/
TeleMega	Altus Metrum	https://www.apogeerockets.com/Electronics-Payloads/Altimeters/TeleMega https://altusmetrum.org/TeleMega/
Telemini	Altus Metrum	https://altusmetrum.org/TeleMini/
Blue Raven	Featherweight Altimeters	https://www.featherweightaltimeters.com/raven-altimeter.html
RRC3	Missile Works	https://www.apogeerockets.com/Electronics-Payloads/Altimeters/RRC3-Sport-Altimeter https://www.missileworks.com/rrc3