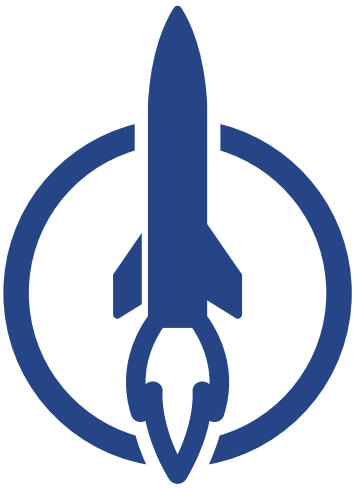
EUROPEAN ROCKETRY CHALLENGE

RULES & REQUIREMENTS



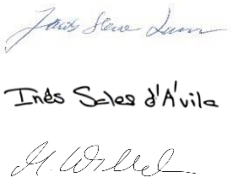
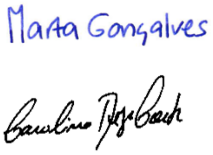
EUROC

EUROPEAN ROCKETRY CHALLENGE

PORTUGAL SPACE

MUNICÍPIO PONTE DE SOR

INTERNAL APPROVAL

PREPARED BY: Jacob Larsen, Copenhagen Suborbitals Inês d'Ávila, Portuguese Space Agency Manuel Wilhelm, Portuguese Space Agency	Signature:  Date: 03/03/2021
VERIFIED BY: Marta Gonçalves, Portuguese Space Agency Carolina Rego Costa, Portuguese Space Agency	Signature:  Date: 03/03/2021
APPROVED BY: Rogério Alves, Municipality Ponte de Sor Ricardo Conde, Portuguese Space Agency	Signature: Assinado por : **RICARDO OLAS MARTINS CONDE** Num. de Identificação: BI077819900 Data: 2021.03.09 12:24:45 +0000 CARTÃO DE CIDADÃO

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LIST OF REVISIONS

REVISION	DATE	DESCRIPTION
Original	19/06/2020	Original edition.
Version 02	03/03/2021	Second version, major revisions for EuRoC 2021.

1. INTRODUCTION

1.1. BACKGROUND

The Portuguese Space Agency – Portugal Space, and the Municipality of Ponte de Sor have partnered to host the EuRoC – European Rocketry Challenge, a competition that seeks to stimulate university level engineering students to fly sounding rockets, by designing and building the rockets themselves.

It is widely recognized that such competitions foster innovation and motivate students to extend themselves beyond the classroom, while learning to work as a team, solving real world problems under the same pressures they will experience in their future careers.

The EuRoC competition is fully aligned with the strategic goals of Portugal Space, namely the development and evolution of the cultural/educational internationalization frameworks capable of boosting the development of the Space sector in Portugal. The Municipality of Ponte de Sor is home to one of the fastest growing aerospace regional clusters in Portugal, including the assemblance process of the first national satellite.

The EuRoC competition builds on the legacy of the joint ESRA – Experimental Sounding Rocket Association and Spaceport America since their first annual IREC – Intercollegiate Rocket Engineering Competition back in 2006, now known as the Spaceport America Cup. Due to COVID-19, the 2020 edition of SA Cup was cancelled, and several European university student teams reached out in order to implement a similar competition in Europe, inexistent so far. Thus EuRoC, the first European university rocket competition was born, with its first edition successfully implemented in Portugal, in 2020. The EuRoC organisers would like to take this moment and thank ESRA and the Spaceport America Cup for their ground-breaking work in the making of the Spaceport America Cup competition.

This document defines the rules and requirements governing participation in the EuRoC, based on the ruleset documentation of Spaceport America Cup. Major revisions of this document will be accomplished by complete document reissue. Smaller revisions will be reflected in updates to the document's effective date and marked by the revision number. The authority to approve and issue revised versions of this document rests with Portugal Space.

1.2. DOCUMENTATION

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

Table 1: Documents file location

DOCUMENT	FILE LOCATION
EuRoC Rules & Requirements	http://www.euroc.pt
EuRoC Design, Test & Evaluation Guide	http://www.euroc.pt

EuRoC Entry Form	http://www.euroc.pt
EuRoC Academic Institution Letter	http://www.euroc.pt
EuRoC Motors List	http://www.euroc.pt (Teams' Reserved Area)
EuRoC Technical Questionnaire	http://www.euroc.pt (Teams' Reserved Area)
EuRoC Waiver and Release of Liability Form	http://www.euroc.pt (Teams' Reserved Area)
EuRoC Flight Card and Postflight Record	http://www.euroc.pt (Teams' Reserved Area)
EuRoC Master Schedule	http://www.euroc.pt (Teams' Reserved Area)

2. FLIGHT CATEGORIES

Teams competing in EuRoC must design, build and launch a rocket carrying no less than 1 kg of payload to a target apogee either 3000 m or 9000 m above ground level (AGL). They can used either commercial off-the-shelf (COTS) or student researched and developed (SRAD) propulsion systems, with SRAD propulsion systems being defined as those designed by students – regardless of whether fabrication is performed by students directly, or by a third party working to student supplied specifications – and can include student designed modifications of COTS systems.

Note: Multistage launch vehicles are allowed.

Projects will be divided into categories based on the propulsion system (solid [S], hybrid [H], or liquid [L]) and target apogee (3000 m [3] or 9000 m [9]). Thus, **the six flight categories are S3, H3, L3, S9, H9, and L9**. To distinguish COTS from SRAD systems, the origin of the propulsion will be noted in the COTS case by addition of the suffix [-c], while SRAD systems will not have a suffix. Propulsion systems of a similar type will compete in the same category, no matter their origin. A summary is given in Table 2.

Table 2: Flight categories

TARGET APOGEE		3000 M		9000 M	
Origin		COTS	SRAD	COTS	SRAD
Propulsion System	Solid	S3-c	S3	S9-c	S9
	Hybrid	H3-c	H3	H9-c	H9
	Liquid		L3		L9

Teams are permitted to switch categories as necessary prior to submitting their final Technical Report, e.g., they may switch from the 9000 m to the 3000 m or vice-versa. EuRoC reserves the right to change the category in which a project is initially entered based on the design presented (from COTS to SRAD, or between S/H/L).

3. TEAM COMPOSITION AND ELIGIBILITY

3.1. TEAM MEMBERS

EuRoC teams shall consist of members who are currently enrolled in a Bachelor's or Master's degree or were matriculated undergraduate or graduate students (i.e., Masters) during the previous academic year (e.g., former students who graduated shortly before the competition remain eligible), from one or more academic European institutions (e.g., "joint teams" are eligible). Each student team is limited to 20 members. Teams may integrate advisory members (e.g., doctorate students, professors), as long as the number of advisors does not surpass 20% of the total number of team members.

The limitation in the number of team members only applies to the number of team members to be present at the event, and not to the constitution of the team itself. The same applies to the number of team advisors, the 20% limitation only applies to the number of advisors to be present at the event, and not the constitution of the team itself (i.e., the number of advisors to be present at the event cannot surpass 20% of the total number of team members to be present at the event).

The EuRoC 2021 edition is limited to a maximum total number of 20 teams. Even though it is a declared goal of the EuRoC organisers to include teams from outside Europe, due to the current limitations only European teams will be admitted in the 2021 edition. National rules regarding vaccination in place at the time of the event, will apply.

3.2. SUBMISSION LIMITATIONS

Each student organisation/association/team may enter ONE project into EuRoC. No project may be entered in more than one category. Deviation from this principle will require case-by-case negotiations with the event officials. To foster the diversity and spirit of the competition, under no circumstances will more than two teams be accepted from any single student organisation.

4. APPLICATION AND REGISTRATION PROCESSES

Although the organisers wish to admit all applicants, it is necessary to have a process in place to down select participating teams from all applicants. Thus, the 20 teams that will be selected under a process aiming to enlist a broad pallet of young European rocket teams. This will NOT be a first-come-first-served process and applications throughout the whole of the application period will be considered. Details on this selection process will be published on the event website once the applications open. All teams will be contacted by e-mail about the outcome of the selection process.

4.1. ENTRY FORM

Each team shall inform EuRoC of their desire to compete in the EuRoC by registering on the EuRoC website. Total completeness of the entry form is required.

Requests for entries made after the application deadline should be accompanied by an e-mail addressed directly to the EuRoC organisation. Requests will be assessed if the upper limit of 20 teams was not achieved during the registration period. If accepted, such entries will receive their Team ID shortly after receipt of the entry form, participation letter and student identification.

The Team ID is the competition officials' primary means of identifying and tracking the teams. Once assigned, any correspondence between a team and the organisers must contain the respective team's ID number to enable a timely and accurate response.

4.2. Academic Institution Participation Letter

Each team is required to ask the academic institution(s), in which its members are enrolled, to provide a signed letter to EuRoC, acknowledging the team as the institution's representative and its intention to participate in the event. The signatory shall be a senior faculty member or senior staff representative (e.g., professor). Academic institutions sending more than one team to the EuRoC need only to write one participation letter, covering all their teams, but each included team must submit an individual copy of that letter. In the case of a joint team, comprised of students from multiple academic institutions, each affiliated institution must provide its own signed letter to the team. The Academic Institution Letter template is available for download on the EuRoC website. On or before a specified date prior to the event, teams shall submit digital, PDF copy(s) of their signed participation letter(s) through the EuRoC website.

4.3. Student University Identification

Each team shall submit copies of documents proving that all team members are eligible – i.e., team members are either currently enrolled in a Bachelor's or Master's degree or were matriculated undergraduate or graduate students during the previous academic year.

- The accepted documents as student identification proof are:
- Student card, with valid expiration date OR;
- Certificate of enrolment issued by the academic institution OR;

A print screen of the student personal area from the academic institution website that clearly shows that the team member is enrolled or was enrolled during the previous academic year.

Each team member must choose one, and only one, of the above documents. The documents from all team members must be submitted accompanied by the Academic Institution Participation Letter in a package format (e.g., zip/rar file), on the designated area of the EuRoC website, on or before the specified date prior to the event.

4.4. Deposit Fee

Once a team is accepted to take part in the competition, to complete the registration process and for commitment purposes, a deposit fee of 100€ per team member will be charged. For teams attending the event, the deposit fee will be refunded after the team arrival and check-in at the event. Due to possible time constrains between banking times, it may take some days for the team to receive the refund on their bank account. As such, teams should not consider the deposit fee available to them during the event. The refund will be carried out as a single money transfer.

The refundable deposit will be due shortly after the completion of the registration process.

All teams admitted to the event will receive an info email, containing all necessary payment information. Proof of the transfer (e.g., scan/photo/PDF of the transfer receipt) must be submitted in the EuRoC website through the dedicated submission form with clear identification of the team making the deposit and the bank account number for refund purposes.

The latest date for withdrawal from the competition will be the date the Technical Questionnaire is due, as will be announced on the EuRoC website. After this date, if a team (accepted, registered, and confirmed as a participating team at EuRoC) withdraws, gets disqualified, arrives late or does not attend the event at all, the deposit fee will NOT be refunded.

5. MANDATORY MILESTONES

There are several events, briefings, and reviews that form mandatory milestones to be completed in order to qualify for flight and to enter competition scoring. These are listed below. A more detailed overview of other building blocks of EuRoC that the teams can expect is given in Appendix B: Event sessions and areas.

5.1. Registration

Teams are expected to arrive in time so they can register, receive their event badges, and be assigned their respective areas. It is generally expected of every team to attend with all team members from day one. If individual team members cannot attend from the start due to reasons related to travel restrictions or similar, event officials should be notified before the event, at the latest two weeks in advance before the first event day. This should however only be an EXCEPTION to the rule.

5.2. Welcome Briefing

During the morning of the first event day, a welcome briefing will be given to the teams to introduce the event officials, announce on-site details, and kick-off all activities. Attendance is expected.

5.3. Safety Briefing

During the first days of the event, a safety briefing will be given by range safety officials to ALL team members. Attendance is mandatory for all team members and advisors, without exception.

5.4. Jury Presentation

During a dedicated day (Jury Day) the jury will visit all team areas. The teams are required to have at least two team members to present the team and the vehicle to the jury, using a poster (see Section 9.4 for details), and supported by any other suitable hardware and multimedia, within a frame of maximum 10 minutes.

5.5. Flight Readiness Review (FRR)

A major milestone to get the clearance to transfer the vehicle from the team area to the launch area and start the dedicated launch preparations is the Flight Readiness Review (FRR). Within this review, the technical evaluation board (TEB) will visit the team area and go through a detailed Flight Readiness Review checklist (see Appendix C of the Design, Test & Evaluation Guide) that all vehicles need to comply with. All criteria can be scored “red” (Denied), “yellow” (Provisional), “green” (Nominal), or “grey” (not applicable).

If any single criterion is scored “red”, the overall Flight Status is “Denied”. This will cause the teams to FAIL the FRR and not be allowed to launch their vehicle.

If any single criterion is “yellow”, while no criterion is “red”, the overall Flight Status is “Provisional” (Further details in the Design Guide). Any criterion that is scored “yellow” will result in an Action Item (= a mandatory task) that needs to be resolved by the team.

Any Action Items preventing a “Nominal” flight status can be addressed by the teams after FRR and before the subsequent Launch Readiness Review (LRR). Providing all Action Items have been addressed accordingly, the flight status can then be raised to “Nominal” by the jury during LRR.

5.6. Launch readiness Review (LRR)

For a team to be accepted to proceed to the Launch Readiness Review (meaning to start the LRR, not to pass it), the following conditions need to be met by the teams:

- The team has completed the Flight Readiness Review with AT LEAST “Provisional” Flight Status
- Following the FRR, the team has addressed all issues scored as “yellow”.

- The team has moved their vehicle to the launch range and is ready to begin launch activities, the next step being loading the solid motor/energetics or moving the launch vehicle to the launch rail for loading of liquid propellants.

During the Launch Readiness Review, the teams will be expected to explain:

- How they resolved the FRR Action Items, if applicable.
- Explain any changes on documentation/checklists they made prior to launch, if applicable.
- Why their rocket can now be considered ready to launch verification.

Furthermore, the launch officials will conduct the following steps:

- Re-inspect Action Items if necessary.
- Final visual inspection of the vehicle.

For a team to successfully PASS the Launch Readiness Review, the officials will have to raise all criteria to “green” and the flight status to “Nominal”. They will do so if they are convinced all Action Items have been resolved by the teams and there are no further criteria preventing a safe and successful launch. At the end of the LRR, the issuance of the Flight Card by the officials to the team certifies that the LRR has been passed successfully.

5.7. Flight card and Go for Launch

The Flight Card will be issued after successful LRR. With the Flight Card, the teams will have the clearance to get the solid motor/liquid propellants from the pyrotechnics personnel and install the solid motor/prepare the loading of liquid propellants. The steps that follow, depending on the type of motor, are listed next:

- For solid motors: The team will need to obtain the launch pad official to approve that the motor has been installed correctly.
- For liquid motors: The team will need to obtain the launch pad official to approve that the loading of liquid propellants onto the vehicle may start.
- For hybrid motors: The team will need to obtain the launch pad official to approve that the solid part of the motor has been installed correctly, and that the loading of liquid propellants onto the vehicle may start.

The launch pad official will confirm their approval via their signature on the Flight Card. With the signature on the Flight Card, the teams are then eligible to get to GO for launch by the launch control officials.

5.8. Postflight Debriefing

On the back of the Flight Card, the Postflight Record can be found. This is to be filled out by the teams after launch to the extent that they are able to.

After recovery of the vehicle, a maximum of 4 team representatives will bring the vehicle to the dedicated launch range official for the Postflight Debriefing, together with the Flight Card/Postflight Record and any additional telemetry/apogee information if available.

The official will record the condition of the vehicle on the Postflight Record. This is the baseline for the judges to score the success of the recovery operation. Furthermore, the official will review the Postflight Record and fill in any open points not filled in by the teams already, especially the recorded altitude by the official altitude logging system. The Flight Card/Postflight Record will be passed on to the jury by the official. With this, the launch activities are concluded.

Further details can be found in Section 10.10.

5.9. Postflight Highlights

At the last day of the event, before the award ceremony, there will be a postflight presentation session. Due to the large number of teams, only a selected number of teams (ca. 4-6) will be given the opportunity to present. The presentations will not be part of the overall scoring. The choice of which teams will be presenting is up to the jury and is made independently of the teams' performance in any scoring/competition categories.

Instead, the presentation session is meant to provide an opportunity to showcase some stories behind the teams that are not visible through scoring alone, thus give the public a glimpse into all the ups and downs that make for a great event and a memorable experience for all. Consequently, when selecting the presenting teams, the jury will be looking for the teams with the most interesting stories to tell, both of success and failure.

The teams that should present are informed by the event officials after all launch activity has ceased, most likely the evening before the last day. No "high-gloss polished" slideshow is therefore expected, but an INTERESTING AND ENGAGING TALK (5-10 min). The teams are encouraged to be creative, and they can use any aides they like, including, but not limited to, supporting slides, team images, manufacturing/test footage, launch and flight footage (if applicable highly encouraged!), rocket hardware, etc.

6. MOTORS AND PROPELLANTS

6.1. AMATEUR ROCKET LIMITATIONS

Launch vehicles entered in the EuRoC shall not exceed an installed total impulse of 40,960 Newton-seconds. Teams intending on launching vehicles, which exceed the official impulse limit, require prior case-by-case review and EuRoC approval.

6.2. COTS SOLID/HYBRID MOTORS

In due time before the event, officials will provide a list of motors that will be available for the competing teams through the reserved teams' area of the EuRoC website. It is compiled in conjunction with the official EuRoC pyrotechnics supplier and will contain a range of motors from known manufacturers available on the market. Teams will be asked on the Technical Questionnaire (see Section 9.1) to indicate their needed motor. Only COTS motors from the motors list and ordered via the official pyrotechnics' supplier are permitted.

6.3. SRAD MOTORS

SRAD motors are subject to the detailed requirements listed in the EuRoC DTEG – Design, Test & Evaluation Guide. SRAD motors should satisfy the highest requirements regarding safety, thus the teams are required to take all necessary precautions during their design, adhering to sound engineering principles and supporting their design with simulations and tests. The event officials will evaluate the designs based on the submitted technical reports and during the Flight Readiness Review. Only if event officials are fully convinced that the design is sufficiently sound, mature, and tested, will teams be allowed to fly.

Teams are welcome and encouraged to approach the officials at any time in the months before the event and during the event to discuss their specific design questions. Officials encourage a culture of open discussion about ANY doubts that might arise regarding design feasibility and safety.

6.4. PROPELLANTS FOR SRAD MOTORS

All chemical propulsion types (solid, liquid, and hybrid) are allowed. Note that all propellants used must be non-toxic. Ammonium perchlorate composite propellant (APCP), potassium nitrate and sugar (aka "rocket candy"), nitrous oxide, liquid oxygen (LOX), hydrogen peroxide, kerosene, propane, and similar substances, are all considered non-toxic. Toxic propellants are defined as those requiring breathing apparatus, special storage and transport infrastructure, extensive personal protective equipment, etc.

(e.g., Hydrazine and N2O4). Home-made propellant mixtures containing any fraction of toxic propellants are also prohibited.

High-level design and acceptance testing requirements are contained in the EuRoC DTEG – Design, Test & Evaluation Guide in order to promote flight safety.

7. PAYLOAD

7.1. GOAL

Event officials encourage the teams to launch functional payloads in the form of creative scientific experiments and technology demonstrations. It is also encouraged that this is done in a collaborative fashion, so that rocket launching teams may reach out to other universities and/or student groups which develop CanSats/CubeSats that could provide payloads to be flown onboard the EuRoC rockets. Nevertheless, non-functional "dummy-mass" payloads are also permitted, if these comply with the Payload Required Form Factor and Mass. The payload choice will be part of the overall scoring, as detailed in Appendix E: Detailed Grading Criteria.

7.2. PAYLOAD DEFINITION

A payload is a defined as an independent component that is replaceable by a ballast of the same mass, with no change to the launch vehicle's functionality and trajectory in reaching the target apogee, or its' successful recovery. Participants are required to carry payload(s) on their vehicle, which can be of the following type:

- Non-functional (dummy mass) OR functional payload (a purposeful device, e.g., an experiment or technology demonstrator);
- Non-deployable OR deployable payload (e.g., deploying a can-sat to the ambient).

If a functional payload is chosen, it can either be:

- Passive (non-powered/non-energetic) OR active (powered/energetic).

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

The payload must comply with the Payload Required Form Factor and with the Payload Required Mass, presented in the next sections.

7.3. Deployable Payloads

Deployable payloads are characterized by the payload being ejected or separated from the main vehicle during flight. Therefore, deployable payloads require their own recovery system.

A special case exists for deployable (lightweight) payloads, in that they may be allowed to utilize a single-stage 8-9m/s descent velocity recovery system from apogee, on a case-by-case approval from the EuRoC technical jury. The justification is that elaborate active deployable payloads will generally benefit from as much airborne time as possible.

If teams plan to develop a deployable payload that requires a specific unique recovery system, they shall contact the event officials prior to the event to clarify if the payload satisfies all requirements.

7.4. Payload required Form Factor

All payloads, whether they are non-functional or functional, must fulfil the requirements for the form factor as detailed below, which are generally based on common CanSat and CubeSat form factors.

The basic form factors are defined as follows:

- CanSat: Cylindrical shape with 115 mm height and 66 mm diameter.
- CubeSat: Cubic shape with one CubeSat Unit (1U) being defined as a 100 mm x 100 mm x 100 mm cubic structure.

The form factors are given not including a parachute, if applicable as in the case of deployable payloads. "Point masses" with odd form factors are not allowed.

The volume of the payload may be a multiple/stack of the basic payload form-factors, e.g., 3 CanSats (345 mm height x 66 mm diameter), 2U (100 mm x 100 mm x 100 mm), or likewise.

7.5. Payload required Mass

The launch vehicle shall carry no less than 1000 g of payload – Payload Required Mass. There is no upper limit on payload mass. The teams are responsible for conducting a “weigh-in” on site in the presence of the competition officials. The weigh-in can be done prior to, or during the Flight Readiness Review. Competition officials will accept payload weigh-ins as much as 5% (50 g) less than the specified minimum. If this requirement is not met, “nominal” flight status for the payload may be denied by the officials during FRR, resulting in an action item to increase payload mass. Any payload unit weight greater than the specified minimum is acceptable.

All payloads, whether they are non-functional or functional, must fulfil either the CanSat or CubeSat mass requirements. The basic mass increments are defined as follows:

- A single CanSat-type payload has a mass between 300 g and 350 g

- A single CubeSat-type payload has a mass between 1000 g and 1330 g

If a functional payload is chosen, with the functional part itself not providing enough mass to reach the minimum requirements, additional dummy-masses may be added to the functional payload until the minimum mass requirement is reached.

7.6. Minimum Payload Examples

Some examples of payloads to fulfil the minimum mass requirements could be:

- A stack of three single CanSat-type payloads (115 mm height and 66 mm diameter each) with a mass between 300 g and 350 g each, amounting to a total mass of at least 1000 g.
- A 3-unit size CanSat-type payload (345 mm height x 66 mm diameter) with a mass of at least 1000 g
- A CubeSat-type payload a minimum form factor of 1U with a mass of at least 1000 g, but not exceeding 1330 g.
- A 4U CubeSat-type payload with a mass of 4000-5320 g.

7.7. Independent Payload Functionality

Launch vehicle recovery systems shall be able to bring the vehicle down in a safe and controlled manner, as per the recovery system requirements, independently of whether the payload is active, passive, deployable or fixed inside the launch vehicle.

An independent payload cannot be a part of the launch vehicle functionality (such as a guidance and control system). The functionality must be completely independent of the launch vehicles' ability to bring the payload to the designated apogee.

7.8. Location and Interface

Neither the payload's location in the launch vehicle nor its method of integration and removal is specified. Therefore, the teams must ensure that the payloads shall not be inextricably connected to other launch vehicle associated components (e.g., the launch vehicle's recovery system, internal structure, or airframe) while being weighed. If the payload cannot be removed for weigh-in, the teams will not get points for an on-board payload.

7.9. Restricted Materials

Payloads shall not contain significant quantities of lead or any other hazardous materials. The use of radioactive materials shall not be permitted.

8. ALTITUDE LOGGING AND TRACKING

For details on the required redundant flight computers etc., teams should refer to the Design, Test & Evaluation Guide (DTEG). The section below is intended to clarify the requirement for an Official Altitude Logging and Tracking system only.

Teams are free to choose the specific flight computer(s) for logging purposes and the tracking system they themselves want to use, as detailed in the DTEG (see DTEG Section 3.3.). However, the event officials will announce in due time before the event a mandatory "official" COTS logging and tracking device in the *Official Altitude Logging and Tracking Addendum* (e.g., based on the "Eggtimer" flight computer and GPS locator or similar device), which the teams will need to implement in their rocket.

The event officials will set up their own receiving station for telemetry based on this system. Consequently, the implementation of this official devices for logging/tracking can be done solely as an independent, standalone add-on or, if so desired, integrated in the main flight computer also used for recovery system deployment, if the requirements in the Official Addendum are met. Please stay posted on the *Official Altitude Logging and Tracking Addendum*.

8.1. Altitude Logging System

Launch vehicles shall carry a COTS barometric pressure altimeter with on-board data storage, which will provide a log of apogee. This may either be:

- A standalone COTS product that will be announced in the *Official Altitude Logging and Tracking Addendum* and works as a totally independent system. This is in addition to the requirement for a main flight computer and redundant flight computer that can be selected freely by the teams.
- Or a feature of a COTS flight computer – also used for launch vehicle recovery system deployment if the system used complies with the requirements defined in the *Official Altitude Logging and Tracking Addendum.*

Standardising a flight computer with barometric pressure sensor eases the overall operation of efficiently extracting flight and apogee data. This measure means that apogee data can most likely be extracted as soon as a launch vehicle is recovered and subjected to post-flight inspection.

If a deployable payload is integrated on the launch vehicle, the altitude logging system shall be mounted to the launch vehicle and not the payload.

8.2. TRACKING SYSTEM

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. Tracking systems using the Global Positioning System (GPS) or equivalent Global Navigation Satellite Systems (GNSS) are mandatory. Details regarding type, frequency, etc. will be announced in the *Official Altitude Logging and Tracking Addendum*. The tracking system may either be:

- A standalone COTS product that will be announced in the *Official Altitude Logging and Tracking Addendum*, as mandatory standalone addition besides a transmitter that is selected freely by the teams.
- Or a feature of a main COTS flight computer if the system used complies with the requirements defined in the *Official Altitude Logging and Tracking Addendum.*

8.3. ALTITUDE LOGGING AND REPORTING

Teams are required to pass in the logs of the official altitude logging system after their flight for determination of the actual apogee. The on-board log of the official flight computer is considered the primary data source for official altitude reporting. Complementary altitude logging data by the teams' own additional flight computer (if applicable) may be supplemented. Furthermore, telemetry (if implemented) from the official (or additional) altitude logging flight computer (may be accepted under certain circumstances, e.g., if the official on-board log cannot be recovered at all or in due time (see Section 10.10).

9. DELIVERABLES

The following sections define the deliverable materials (e.g., paperwork and presentation materials) competition officials require from teams competing in EuRoC – including each deliverable's format and minimum expected content. All deliverables will be submitted to EuRoC per the instructions provided to the teams. Only correct, complete, and timely submission of deliverables will guarantee that the maximum points possible are achieved in the overall team score (see Appendix E: Detailed Grading Criteria).

The scheduled due dates of all required deliverables will be recorded on the EuRoC website.

9.1. TECHNICAL QUESTIONNAIRE

On or before a specified date prior to the event each team shall fill in a Technical Questionnaire that will be made available at the reserved teams' area in the EuRoC website. In this questionnaire, each

team shall submit the information regarding the chosen motor (from the list of available motors, see also Section 6), SRAD motors specifications, necessary propellants and respective quantities, special cares to have in consideration (e.g., handling, hazards, transport needs), among other technical information.

Teams should be aware that some of the information given in the questionnaire will be made available in the public teams' area in EuRoC website and/or social media. The purpose of this is to showcase the team on the EuRoC website.

9.2. VIDEO PRESENTATION

Each team shall submit a short video presentation, with a duration of no more than 2 minutes, with the purpose of presenting the team and their project. The video can and should include, e.g., pictures or videos of the team history and team members, previous flights, tests, working facilities, hardware, teamwork, successes, and failures, etc. The video shall be submitted on or before a specified date prior to the event in the teams' area in EuRoC website.

The video will be displayed on the EuRoC website and social media to showcase the participating teams. The footage submitted can be used by Portugal Space for publicity and marketing purposes.

9.3. TECHNICAL REPORT

Each team shall submit a Technical Report which describes their project to the judges and competition officials. The Technical Report can be formatted using any style guide.

On or before of a specified date prior to the event, teams shall submit a single digital PDF copy of their Technical Report through the reserved teams' area in the EuRoC website. The Technical Report shall not exceed 20 Megabytes in size. Teams shall submit their Technical Reports through the reserved teams' area in EuRoC website. Teams should also bring at least one hard copy to EuRoC so members of the judging panel and other competition officials may consult the contents at will during interactions with the team.

The Technical Report's main title is left to the team's discretion, however the paper shall be subtitled "Team [Your Team ID] Technical Report to the [Year] EuRoC". For example, a team assigned the team-ID "12", competing in the 2021 EuRoC, would subtitle their Technical Report "Team 12 Technical Report to the 2021 EuRoC".

The competition officials welcome concise reports, that should not exceed 50 pages, including figures etc. (A4, standard font size 11 in Times New Roman or Arial, line spacing 1.0, standard page margins 2.5 cm). This does not include the Appendices, however. The Appendices can have additional pages but are not necessarily read in detail by the officials. Further information is given in Appendix D: Details for

the Technical Report, including an overview of the required minimum Technical Report sections and appendices. Additional sections, subsections, and appendices may be added as needed.

9.4. Technical Poster

The technical poster – as well as any practicable non-energetic project hardware – will be exhibited and visible to the general public, industry representatives, other students and competition officials in the paddock area.

The technical poster will also form the basis of the mandatory poster presentation event in the presence of the jury. The jury and general public will visit each team in turn on the Jury Day, having 10 minutes of interactive one-on-one poster presentation sessions.

Please note that the poster is a point-awarding deliverable with a stringent submission deadline.

The information provided on the poster should approach at least the following topics:

- Team, rocket and university name, team country, official team number, launch category
- A very short summary of the team history and prior number of launches
- Mission goals and mission key events, including a description suitable for the nature of the payload.
- Trajectory illustration of the flight cycle.
- An illustration of the major rocket components, providing an overview of the internal layout of the rocket.
- Highlights of new innovations, concepts and technologies, which makes this mission and flight vehicle unique.

The poster shall measure approximately 85 cm × 120 cm (A0 format) and must be self-supporting on either an organizer-provided table or stand. No partitions or other structures for hanging posters will be provided. Finally, the poster shall prominently display the team's Team ID in the top, right corner.

On or before a specified date, prior to the event, teams shall submit a digital, PDF copy of their poster display through the reserved teams' area of the EuRoC website. The event organizers will post these files in the EuRoC website, enabling the public to get a little bit of insight into what technical marvels will be launched during the EuRoC launch campaign.

9.5. Proof of Insurance

The event's insurance policy covers EuRoC. It will cover Launch Third Party liability, including accidents, damaged property and injuries directly related to the event. However, if a team's flight damages a person or property, and the person or property owner decides to sue the team specifically (not EuRoC), for additional costs, the event's insurance does NOT protect the team from additional litigation.

While the majority of teams can be covered by their college or university insurance, some could not be. Teams wishing to acquire insurance have to do so on their own. The insurance, mandatory for all teams,

should cover travels, personal injuries (for injuries occurring outside EuRoC) and additional coverage of potential litigation not covered by EuRoC (either personal or to the team).

The EuRoC organisation can advise the teams, within its possibilities, on how to obtain this insurance coverage. On or before a specified date prior to the event, teams must submit the Proof of Insurance (e.g., photo/scan/pdf of the insurance policy dated and signed), through the reserved teams' area of the EuRoC website.

9.6. Waiver and Release of Liability Form

It is mandatory that every individual attending EuRoC – including team members, faculty advisors, and others – signs the Waiver and Release of Liability Form. Individuals who do not sign this form will be unable to participate in any activities occurring at the EuRoC site.

The Waiver and Release of Liability Form can be downloaded on the teams' reserved area of the EuRoC website and must be signed, in handwritten form or digitally (qualified signature). On or before a specified date prior to the event the teams should submit the totality of such documents in a package format (e.g., zip/rar folder) through the reserved teams' area in the EuRoC website.

Underaged team members should submit the specific underage version document of the EuRoC Waiver and Release of Liability Form, signed by their guardian.

9.7. Flight Card

The Flight Card (together with the PostFlight Record, see Section 9.8) should be filled out by the teams prior to launch. A template will be made available in the reserved teams' area at the EuRoC website, so the teams know what to expect. However, the officials will hand out printed copies at the event.

This document will identify each team flight category, propulsion type, mission events as well as the mission objectives. The Flight Card is necessary for the Launch Pad Official to acknowledge the inspection completion and that the team is ready for launch. See Section 5.7 for further details.

9.8. Postflight Record

The Postflight Record must be filled out by the teams (to the extent they are able to) after the launch and will contain flight information data, such as flight performance and recovery. See Section 5.8 for further details.

10. SCORING AND AWARDS

10.1. SCORING CATEGORIES

Teams will be scored in four different scoring categories or areas, which are (1.) the Technical Report, (2.) the Design Implementation, (3.) the Team Effort, and (4.) the Flight Performance. These are weighted according to the table below.

Table 3: Weight of the scoring categories

SCORING CATEGORY	POSSIBLE POINTS	% OF TOTAL POINTS
(1.) Technical Report	200	20%
(2.) Design Implementation	300	30%
(3.) Team Effort	200	20%
(4.) Flight Performance	300	30%
TOTAL:	1000	100%

10.2. COMPETITION CATEGORIES

Teams will compete against all other participating teams in scoring categories (1.), (2.), and (3.). For scoring category (4.) Flight Performance teams will compete against other teams within their respective flight categories (S3, H3, L3, S9, H9, L9) (as defined in Section 2). The summed point score of each team is the sum of all four categories (1–4).

For each individual competition category (1.), (2.), (3.), and flight category (S3, H3, L3, S9, H9, L9), there will be a dedicated winner. The respective competition category winner is the team with the most points in the respective competition category.

Across all competition categories, the points will be added to determine the overall winner of the EuRoC.

Points are awarded according to criteria, weighted individually in each scoring category, as detailed in Appendix B: Event sessions and areas .

Each competition category is also weighed against the other categories.

10.3. AWARDS

In correspondence to the competition categories, the following awards will be given:

- The Technical Award for the winner of category (1.) for the best Technical Report
- The Design Award for the winner of category (2.) for the best Design Implementation
- The Team Award for the winner of category (3.) for the best Team Effort

For each of the six Flight Awards for the winners of the categories (S3, H3, L3, S9, H9, L9) for the respective best flight performance in each of these categories.

The EuRoC Award will be presented to the overall winner of the EuRoC.

A summary of all the awards is given in Table 4.

Table 4: Competition categories and respective awards

COMPETITION CATEGORY	CORRESPONDING AWARD
(1.) Technical Report	Technical Award
(2.) Design Implementation	Design Award
(3.) Team Effort	Team Award
(4.) Flight Performance: S3	Flight Award – Solid 3000m
(5.) Flight Performance: H3	Flight Award – Hybrid 3000m
(6.) Flight Performance: L3	Flight Award – Liquid 3000m
(7.) Flight Performance: S9	Flight Award – Solid 9000m
(8.) Flight Performance: H9	Flight Award – Hybrid 9000m
(9.) Flight Performance: L9	Flight Award – Liquid 9000m
(10.) Overall Winner	EuRoC Award

The emphasis and focus of each of the awards are as follows:

- **Technical Award:** Recognizes the best technical report, displaying the ability to document clearly, correctly, and without unnecessary complication a complex technical system, aided by high quality figures, exhibiting exceptional quality in all formal aspects, making it an enjoyable and enriching read.
- **Design Award:** Honours the overall best design implementation, which displays a high competency in all its characteristics, is based on stringent strategic decisions, provided an exceptional challenge to realise, and might even go beyond pure rocketry to put special attention towards its innovation and/or payload.
- **Team Award:** Credits the team that has displayed an outstanding effort as working as a unit towards a common goal, by being exceptionally organized, reliable, and prepared in all aspects of the competition, be it deliverables, communication, or operation, and goes above and beyond to display a great sense of team spirit and sportsmanship.

- **Flight Awards:** Measures the degree of merit in meters away from the target apogee, but also by the state of the rocket after recovery, and thus honours designs that not only survive the harsh contact with reality, but furthermore represent an incredible achievement in concept, simulation, system integration, control, and practical realisation.
- **EuRoC Award:** Awarded to the team that has displayed excellence across the board in all aspects of the competition, honouring an overall exceptional and well-balanced effort without cutting back on any of one of the competition aspects, be it technical documentation, design implementation, team effort, or flight performance, thus identifying a truly remarkable effort and achievement.

10.4. Grading Criteria

In each scoring category, a set of grading criteria is established. These criteria will be evaluated by the jury for each team individually. Each grading criterion has several, more detailed, topics that establish what the jury will look for during the grading process. These detailed topics are weighed equally within each criterion, while the main criteria are weighed differently within each competition category. The details of the grading criteria can be found in Appendix E: Detailed Grading Criteria.

10.5. Grading Explanation

The grading will be conducted by the jury based on the individual grading criterion as defined in Appendix E: Detailed Grading Criteria in the respective competition categories and scored according to a scheme of -1 | 0 | +1. This is meant to be an intuitive and transparent scheme for the jury to follow and the teams to understand.

For countable criteria, "0" is the standard grade and can be understood in a sense that a criterion is fulfilled by the team in general conformity, but no complete conformity is reached (corresponding to "+1"), nor complete lack of conformity (corresponding to "-1").

An example of a countable criteria would be the amount of errors in scientific terms or formulas in the technical report.

For relative criteria, "0" is the standard grade and can be understood in a sense that a criterion is fulfilled by the team in an average satisfactory manner, but neither sticks out to be particularly well done or to be of exceptional quality (corresponding to "+1"), nor does it stick out to be poorly done or of below average quality (corresponding to "-1").

An example of a relative criteria would be the quality in description of system architecture and mission concept of operations in the technical report.

If teams were to obtain a grading of "0" throughout all criteria, the cumulative score would amount to 50% of the maximum achievable points, and accordingly a grading of "+1" throughout corresponds to a score of 100%, while a grading of "-1" throughout corresponds to a score of 0%.

An exception to this general rule is absolute criteria, meaning things that can be either done or not done, the scoring scheme simplifies to -1 | +1, representing a fulfilment or non-fulfilment of the criterion (No/Yes) and corresponding to either 0% or 100% of the points.

An example of an absolute criteria would be the submission of deliverables (they are either delivered or not).

An exception, where the general scheme is not applied, is the criterion "actual apogee" in the flight performance category. These points are solely based on the apogee reached according to a separate formula (see Section 10.9 for details).

Teams will get a feedback on their scoring during the award ceremony. A summary and overview of the grading scheme is given below for clarity (Table 5).

Table 5: Grading scheme

COUNT	FOR COUNTABLE CRITERIA
1	complete conformity
0	general conformity
-1	lack of conformity

REL	FOR RELATIVE CRITERIA
1	exceptional
0	average
-1	poor

Y/N	FOR ABSOLUTE CRITERIA
1	yes
-1	no

APOGEE	FOR FLIGHT PERFORMANCE
Apogee	see formula

10.6. SCORING - TECHNICAL REPORT

The points listed in this and the following sections are to be understood as the maximum achievable number of points. Points will be awarded for each criterion (as defined in Appendix E: Detailed Grading Criteria). Therefore, obtaining a partial number of points for each scoring category and/or criterion is possible.

Technical Reports will be awarded as many as 200 points – 20% of 1,000 points possible.

- For their correctness (40 points – 20% of 200 points)
- For their completeness (40 points – 20% of 200 points)
- For their analysis (120 points – 60% of 200 points)

What will also be taken into account is the team's general ability to give the technical jury detailed insight into the rocket, its systems, the design, and safety considerations, facilitating a quick and efficient Flight Readiness Review before the launch campaign.

Only timely Technical Reports will be evaluated and scored. A Technical Report is considered timely if it is submitted before the deadline specified in the EuRoC Schedule.

If teams miss the deadline, they will not receive ANY points for the technical report, however they are still required to make the submission of the technical report as soon as possible, at the latest 72h after the deadline has passed, unless that team no longer plans to attend the EuRoC.

If the submission window of 72h is not met, the team will not be able to participate in the EuRoC.

No deadline extensions will be given!

10.7. Scoring – Design Implementation

Teams will be awarded as many as 300 points for their Design implementation – 30% of 1,000 points possible.

- For the overall competency of design (120 points - 40% of 300 points)
- For strategic design decisions exhibited in their work (60 points – 20% of 300 points)

Furthermore, additional points are specifically targeting innovation and ingenuity.

- The successful implementation of especially challenging designs (60 points - 20% of 300 points),
- Commitment to payload above and beyond a dummy load, embracing innovation, technical elegance, and perhaps even audacity (60 points - 20% of 300 points).

Competition officials will evaluate these criteria based on the information given in the technical report, through interactions with the teams and their systems, occurring throughout the EuRoC, and especially within the poster presentation and the Flight Readiness Review.

10.8. Scoring – Team Effort

Teams will be awarded as many as 200 points – 20% of 1,000 points possible.

- For the overall effort as a team, when it comes to complying with formal requirements for correct, complete, and timely submission of deliverables (60 points – 30% of 200 points),

- For the Organization/Operation/Communication during the event (80 points- 40% of 200 points)
- For Sportsmanship and Team Spirit (60 points – 30% of 200 points).

Competition officials will evaluate these criteria through interactions with the teams occurring throughout EuRoC.

10.9. Scoring – Flight Performance

Team's will be awarded as many as 300 points – 30% of 1,000 points possible – for their project's flight performance during launches at EuRoC, demonstrated by altitude achieved relative to the target apogee and successful recovery of the system.

The accuracy of the launch vehicle's actual apogee achieved relative to the target apogee is worth 70% (240 points – 80% of 300 points). Precise Trajectory planning is important. Points will be awarded for apogees within ±67% of the 3000 m or 9000 m target apogee above ground level according to the following formulas:

$$P_{TA}(AA) = a - \left(\frac{a}{b \cdot TA}\right) \cdot |TA - AA| \qquad \textit{Eq. 1}$$

$$h_0 = \frac{TA}{3} \qquad \textit{Eq. 2}$$

$$b = \frac{TA - h_0}{a} \qquad \textit{Eq. 3}$$

Within these formulas, the following definitions are used: *AA* – actual apogee, *TA* – target apogee, *P* – points awarded, *a* – maximum number of points, *b* – interval of acceptable apogees that will still lead to points, h_0 – minimum apogee that needs to be achieved to still obtain points within a category. The points distribution is plotted for both target apogees in **Error! Reference source not found.** and **Error! Reference source not found.**.

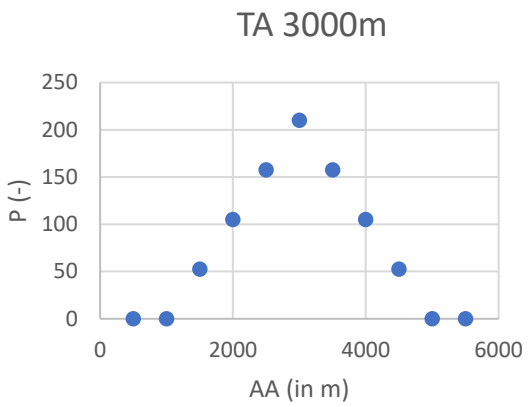

Figure 1. Points (P) awarded depending on actual apogee (AA) for a target apogee (TA) of 3000m

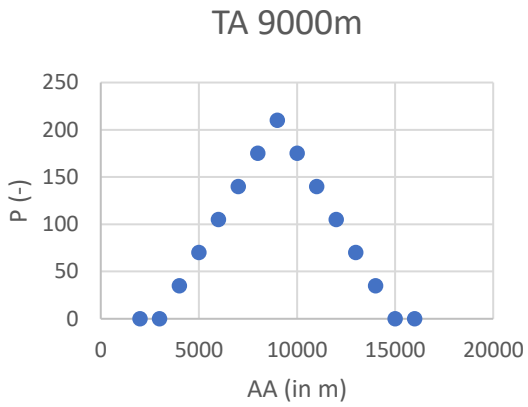

Figure 2. Points (P) awarded depending on actual apogee (AA) for a target apogee (TA) of 9000m

The successful recovery of the launch vehicle is worth 20% (60 points) of the overall value assigned to flight performance. Competition officials will visually inspect the launch vehicle upon its return to the designated basecamp area to determine the success of the recovery operation, with one of these three outcomes:

- A recovery operation is considered fully successful if the damage to the launch vehicle is minimal, in essence if the systems intended consumables were replenished, it could be launched again safely.
- A recovery operation is considered to be of average success if the vehicle has experienced only little damage that could be fixed within a couple of days, e.g., replacing exchangeable fins.
- A recovery operation is considered unsuccessful, if the vehicle has experienced major damage and could only be flown after significant repairs taking more than a couple days.

10.10. Postflight Reporting of Apogee and Recovery

Postflight, the teams will attend the Postflight Debriefing, as specified in the dedicated Section 5.8. Teams will need to deliver the Postflight Record, which will among other things include the following information that needs to be passed on to the officials:

- Apogee of the official altitude logging system(s) (see Section 8), to determine the actual apogee above ground level
- Status of the systems after recovery by showing hardware to officials

In addition, the teams are asked to upload digital images of the recovered vehicle and components to the website team area, to document the degree of success of the recovery

Teams shall report in person to competition officials this information after retrieval and return to the designated basecamp area, prior to the end of eligible launch operations on the respective launch day. Only in the special case that recovery operations cannot be concluded during the respective launch

day, teams are allowed to provide this information before the end of the respective next eligible launch day. Further information on the official altitude logging system is given in Section Altitude Logging and Tracking of this document.

If telemetry data from the EuRoC official altitude logging system is available, teams may report the apogee revealed in this telemetry to competition officials when a confirmation of nominal ascent and recovery system deployment event has taken place. This apogee information, provided by the EuRoC telemetry system (and the mandatory GPS tracking system), will be used for scoring only in the event the launch vehicle is not recovered prior to the end of eligible launch operations on the final scheduled launch day.

Telemetry provided apogee information recorded in flight may be utilized in case no apogee data is retrievable from any onboard systems after "landing". A minimum criterion is however that a GPS lock has been maintained around apogee and that the apogee trajectory is visible in the recorded data.

10.11. Penalties For Unsafe Or Unsportsmanlike Conduct

Teams will be penalized for every instance of unsafe or unsportsmanlike conduct recorded by competition officials (e.g., judges, volunteers, or staff members) by a minimum of 20 points off their total earned score for each incident (but possibly more) depending on the severity of the incident. Unsafe conduct includes, but is not limited to, violating the EuRoC Range Standard Operating Procedures, failure to use checklists during operations, violating motor vehicle traffic safety rules, and failure to use appropriate personal protective equipment. Unsportsmanlike conduct also includes, but is not limited to, hostility shown towards any EuRoC participant and staff, intentional misrepresentation of facts to any competition official, intentional failure to comply with any reasonable instruction given by a competition official.

10.12. Announcement Of Winners

The competition category winners will be announced at the Award Ceremony. The jury will document their judgement in individual scoring sheets for each team. These will be distributed to the teams after the event to give them feedback regarding strengths and weaknesses in all aspects of their performance in the competition.

10.13. Handling of Questions and Complaints regarding Scoring

Teams are welcome to approach the officials to ask for specific, non-binding, oral feedback regarding their perception of the teams' work during all points of the competition to provide the teams with an opportunity to learn and improve.

In the case the teams have more detailed questions or specific complaints regarding the scoring after the scoring has been announced, such as they would like to receive elaborate feedback on a particular aspect of the score for clarification, e.g., to improve upon for the next competition, or if they identify an honest mistake made by the jury, the following process applies:

ONLY the team leader can submit a written feedback request ONCE to info@euroc.pt. Submissions of the feedback are accepted until no later than one week (7days) after official announcement of the score at the Award Ceremony. To keep the workload on the officials to a reasonable amount, teams are asked to limit their questions PLUS complaints to THREE IN TOTAL. Competition officials will then review these three questions and/or complaints and provide written feedback.

If an honest mistake in scoring is apparent, competition officials will review the score provided to the team and decide on a case-by-case basis if and how to account for this, ESPECIALLY and ONLY if this would affect SIGNIFICANTLY the overall score and placement of the team.

It should be noted that teams are expected not to abuse this possibility of questions and complaints for bagatelle. Officials will NOT partake in a discussion questioning the jury's principal REASONING of the score given.

11. DISQUALIFICATION

A limited number of criteria constitute grounds for disqualification from consideration for any award. These can include a failure to meet the defining EuRoC mission requirements as recorded in this document, failure to submit a Technical Report (or otherwise failing to provide adequate project details in required deliverables), and failure to send eligible team member representatives to the EuRoC. Finally, any team found to have accrued at least 3 safety or unsportsmanlike conduct infractions at any time during the EuRoC will be disqualified. Any individual observed committing a single, severe safety or unsportsmanlike conduct infraction may be summarily removed and barred from participation in the remainder of the EuRoC.

A special case of mismanagement/misconduct makes an entire team immediately and without further warning, eligible for expulsion from the EuRoC event in disgrace: substance abuse and intoxication (or after-effects thereof) during launch operations.

If one or more members of a team fails to be utterly sober and clear-headed at the beginning of their launch day, this is regarded as outright contempt of the EuRoC spirit and safety guidelines, and a complete failure on a team level.

The consequence is the immediate and irrevocable grounding of the rocket and removal of the team from the EuRoC event.

12. WITHDRAWAL FROM COMPETITION

Teams which decide to formally withdraw from the EuRoC at any time prior to the event must send an e-mail entitled "TEAM [Your Team ID] FORMALLY WITHDRAWS FROM THE Competition [Year] EuRoC" to info@euroc.pt. For example, a team assigned the Team ID 12" would withdraw from the 2021 EuRoC by sending an e-mail entitled "TEAM 42 FORMALLY WITHDRAWS FROM THE 2021 EuRoC".

APPENDIX A: ACRONYMS AND ABBREVIATIONS

AA	Actual Apogee
AGL	Above Ground Level
APCP	Ammonium Perchlorate Composite Propellant
APRS	Automatic Packet Reporting System
ANAC	Portugal´s National Civil Aviation Authority
CONOPS	Concept of Operations
COTS	Commercial of-the-shelf
DTEG	Design, Test and Evaluation Guide
EuRoC	European Rocketry Challenge
ESRA	Experimental Sounding Rocket Association
FRR	Flight Readiness Review
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
H	Hybrid
HPR	High Power Rocket
IREC	Intercollegiate Rocket Engineering Competition
L	Liquid
LRR	Launch Readiness Review
LOX	Liquid Oxygen
P	Points
RF	Radio Frequency
S	Solid
SAC	Spaceport America Cup
SRAD	Student Researched & Developed
TA	Target Apogee

TBD	To be determined or defined
TBR	To be resolved
TBC	To be confirmed
TEB	Technical Evaluation Board
U	Unit, as in Cube-Sat unit

APPENDIX B: EVENT SESSIONS AND AREAS

Table 6: Event sessions and areas

EVENT SESSIONS	
Welcoming Session	With the main purpose of welcoming and acquaint the teams to EuRoC, the Welcoming Session integrates the Registration and Welcome Briefing. See Sections 5.1 and 5.2 for more information.
Jury Day	The Jury Day is be a dedicated day where the jury members visit all teams' areas while each team performs a poster presentation. See Sections 5.4 and 9.4 for more information.
Postflight Session	After all launches completed the jury will select a number of teams to present their highlights and share the results and experiences achieved in EuRoC. See Section 5.9 for more information.
Award Ceremony	During the Award Ceremony the winners of the different universal scoring and flight performance categories will be announced. See Section 10 for more information.
EVENT AREAS	
Paddock	Pre-flight area where teams can work/prepare/test and exhibit their projects prior to launch, as well as get to know the other teams better, socialize, get in touch with the public and do some networking. Each team will have their own private area with the team identification, designated by team's booth. The Welcoming Session, Safety Briefing, Jury Day, Flight Readiness Reviews and the Award Ceremony will take place at the Paddock area.
Launch Range	Designated area where the launches will take place. All launches and Launch Readiness Reviews will take place in the Launch Range area.
PyroShop	The EuRoC area where teams can find all motors and propulsion related items. It will work as a shop, where teams can go and ask for what they need.

Note: The event overview is intended to provide the teams with roadmap of what to expect at EuRoC. It should be noted that the specific order and timeline of the different parts of the event are subject to change and will be announced close to the event date.

APPENDIX C: DOCUMENTATION SUMMARY

Table 7: Documentation summary

DOCUMENTATION	
Entry Form	Online form (to be disclosed on EuRoC website) teams must fill in order to apply to EuRoC. Total completeness is required. Details: Online form; submission on EuRoC website. See Section 4.1 for more information.
Academic Institution Participation Letter	Letter with all student and advisor teams members to be signed by a senior professor from the academic institution where the students are enrolled. Details: Digital copy in PDF; template on EuRoC website; submission on EuRoC website. See Section 4.2 for more information.
Student University Identification	Document proving the team members applying are either currently enrolled in a Bachelor or Master's degree or were matriculated undergraduate or graduate students during the previous year. Details: Digital copy in PDF/PNG/JPEG; submission on EuRoC website. See Section 4.3 for more information.
Deposit Fee & Transfer Proof	Refundable deposit fee of 100€ per team member, for teams arriving at the event. Transfer proof, a document proving the transfer of the deposit fee (e.g., photo of the transfer receipt). Details: Digital copy in PDF/PNG/JPEG; submission by email. See Section 4.4 for more information.
Technical Questionnaire	Online questionnaire (to be disclosed on EuRoC website) where teams shall fill with technical information regarding their project. Details: Online form; submission on EuRoC website See Section 9.1 for more information.
Video Presentation	Video presentation with no more than 2 minutes showcasing team and their project.

	Details: MP4; submission on EuRoC website. See Section 9.2 for more information.
Technical Report	Report describing the team's project, to be evaluated by the judges and competition officials. Main source of information in what regards to the projects. Details: A4; bring at least 1 hardcopy; digital copy in PDF; submission on EuRoC website. See Section 9.3 for more information.
Technical Poster	Poster to be displayed in the team's booth. To be used while doing the presentation on the Jury Day. Details: A0; bring at least 1 hardcopy; digital copy in PDF; submission on EuRoC website. See Section 9.4 for more information.
Proof of Insurance	Document proving the team (all team members) are covered by an insurance policy. Details: Digital copy in PDF/PNG/JPEG; submission on EuRoC website See Section 9.5 for more information.
Waiver and Release of Liability Form	Form to be signed by each individual team member (i.e., students and advisors) in order to participate in the event. Individuals not signing the form will be unable to participate in any activities. Details: Digital copy in PDF; template on EuRoC website; submission on EuRoC website. See Section 9.6 for more information.
Flight Card	Card to be filled out by the teams with their rocket information. Needs to be signed by the launch pad official to get the GO for launch. Will be handed out by the officials after successful LRR. To be delivered back to the officials together with the Postflight Record. Details: A4; paper copy handed out by EuRoC; template on EuRoC website; submission in person at the event prior to launch. See Section 9.7 for more information.

Postflight Record	Record to be filled out by the teams with flight information (to the extent they are able to). To be delivered to the officials at the Postflight Debriefing. Details: A4; paper copy; template on EuRoC website; submission in person at the event after launch. See Section 9.8 for more information.
Postflight Presentation	Presentation to showcase the highlights, stories, achievements and struggles of the teams. Only a number of teams will be selected by the jury to perform the presentation. Details: Digital copy in PDF/PPT/MP4 (if applicable). See Section 5.9 for more information.

APPENDIX D: DETAILS FOR THE TECHNICAL REPORT

REPORT OUTLINE

For the teams' convenience, an exemplary report outline is included below that should serve as a minimum guideline.

0. Abstract
1. Introduction
2. System Architecture
    - 2.1. Overview
    - 2.2. Propulsion Subsystem
    - 2.3. Aerostructure Subsystem
    - 2.4. Recovery Subsystem
    - 2.5. Payload Subsystem
    - 2.6. Active Flight Control Subsystem (if applicable)
    - 2.7. Special Subsystems (if applicable)
3. Mission Concept of Operations Overview
4. Conclusions and Outlook

---- maximum 50 pages until here, including figures etc. ----

5. Appendices
    - 5.1. System Data
    - 5.2. Detailed Test Reports
        - 5.2.1. Ground Test Demonstration of Recovery System
        - 5.2.2. Flight Test Demonstration of Recovery System (optional)
        - 5.2.3. Static Hot-Fire (SRAD) (if applicable)
        - 5.2.4. Hybrid/Liquid Propellant loading and off-loading (SRAD) (if applicable)
        - 5.2.5. Combustion chamber pressure (SRAD) (if applicable)
        - 5.2.6. Proof Pressure Testing Pressure Vessels (SRAD, Modified COTS) (if applicable)
        - 5.2.7. Burst Pressure Testing Pressure Vessels (SRAD, Modified COTS) (if applicable)
        - 5.2.8. Test of SRAD flight computers with capability of actuating the recovery systems (if applicable)
    - 5.3. Hazard Analysis Report
    - 5.4. Risk Assessment
    - 5.5. Checklists
    - 5.6. Engineering Drawings

---- optional appendices ----

- 5.7. Subsystem Details (optional)
- 5.8. Launch Support Equipment Details (optional)
- 5.9. Detailed Structural and Mechanical Calculation (optional)
- 5.10. Detailed Logical Process Diagrams (optional)

5.11. Detailed Software Architecture (optional)
5.12. Detailed Electrical Architecture (optional)
5.13. Detailed Hydraulic/Fluid Architecture (optional)

ABSTRACT

The Technical Report shall contain an Abstract (ca. 1 page), as a stand-alone synopsis of the report. At a minimum, the abstract shall give a brief general description of the launch vehicle, identify the launch vehicle's mission/flight category, identify any unique/defining design characteristics of launch vehicle (e.g., propulsion, number of stages, active control feature, innovative features, etc.), define the payload's mission (if applicable), and provide whatever additional information may be necessary to convey any other high-level project or program goals & objectives.

Keywords: *vehicle description, mission, flight category, design characteristics, payload, special features*

INTRODUCTION

The Technical Report shall contain an Introduction. This section provides an overview of the academic program, stakeholders, team structure, and team management strategies, the team vision, major suppliers and partners, major technical challenges, and other characteristics and team-defining information. The introduction may repeat some of the content included in the abstract, because the abstract is intended to act as a standalone synopsis if necessary.

Keywords: *academic programme, stakeholders, team, experience, vision, strategy, suppliers, partners, technical challenges*

SYSTEM ARCHITECTURE

The Technical Report shall contain a section on the System Architecture. This section shall begin with a top-level overview of the integrated system, including a cutaway figure depicting the fully integrated launch vehicle and its major subsystems – configured for the mission being flown in the competition. These subsystems are then explained in the subsequent sections, while more extensive details should be moved to the appendices.

- OVERVIEW
  Keywords: *general introduction, vehicle cutaway, cross-section, system diagram, subsystems, interfaces, electrical and software system diagram*

- PROPULSION SUBSYSTEM
  Keywords: *engine design, propellants, total impulse, arming, ignition, overview of propulsion tests, fluid system diagram, nominal pressures, SRAD tanks, SRAD valves*
- AEROSTRUCTURE SUBSYSTEM
  Keywords: *motor retention, thrust structure, staging separation, mechanical connections, flanges, design assumptions, expected forces, overview of structural tests, key results mechanical/structural analyses*
- RECOVERY SUBSYSTEM
  Keywords: *initial deployment event(s), main deployment event(s), parachute, drogue, activation devices, parachute lines, swivel links, parachute coloration, redundant electronics, safety critical wiring, stored energy devices, SRAD pressure vessels, overview of recovery system tests*
- PAYLOAD SUBSYSTEM
  The extent and detail of this section depend on the type of payload. This section can be very brief in the case of a mere dummy payload, and more elaborate for a functional or deployable payload.

  Keywords: *mass, form factor, removal, functionality, experiment, power/energy, interface, deployment, recovery, data output, dissemination of results*
- ACTIVE FLIGHT CONTROL SUBSYSTEM (if applicable)
  Here, any safety, abort, control, or other systems capable of actively affecting the in-flight trajectory shall be described.
- SPECIAL SUBSYSTEMS (if applicable)

MISSION CONCEPT OF OPERATIONS

The Technical Report shall contain a Mission Concept of Operations (CONOPS) Overview. This section shall identify the mission phases and describe the nominal operation of all subsystems during each phase (e.g., a description of what is supposed to be occurring in each phase, and what subsystems are responsible for accomplishing this). Furthermore, this section shall define what mission events signify a phase transition has occurred (e.g., "Ignition" may begin when a FIRE signal is sent to the igniter and conclude when the propulsion system comes up to chamber pressure. Similarly, "Lift-off" may begin at vehicle first motion, and conclude when the vehicle is free of the launch rail). Phases and phase transitions are expected to vary from system to system based on specific design implementations and mission goals & objectives. No matter how a team defines these mission phases and phase transitions, they will be used to help organize failure modes identified in the Risk Assessment Appendix.

To describe the phases, teams should include a figure of the flight trajectory (based on 3D calculation), expected point of descend for different expected wind situations, propulsion thrust curve, predicted apogee, aerodynamic stability over velocity/mission time, position of centre of gravity, position of

centre of pressure over mission time, velocity, acceleration, descent rates at recovery events initiation, and descent rates with drogue/main parachute.

Keywords: *main logic for arming/ignition/stage separation/deployment events, trajectories, influence of wind, propulsion thrust curve, predicted apogee, aerodynamic stability, centre of gravity, centre of pressure, velocity, acceleration, descent rates*

CONCLUSIONS AND OUTLOOK

The main part of the Technical Report shall close with the conclusions and outlook. Here, a summary should be given of the main achievements, reflections on the overall project outcome, lessons learned, way forward, remaining design challenges, areas for improvement. Lessons learned can span the areas of design, manufacturing, and testing of the project, both from a team management and technical development perspective.

Keywords: *achievements, reflections, project outcome, lessons learned, way forward, remaining design challenges, areas for improvement*

SYSTEM DATA

The first Technical Report appendix shall contain vehicle and system data such as System Weights, Measures, and Performance Data in a TABULAR MANNER. Technical data for electronics systems, stand-by time, telemetry system (frequencies, RF-power, range, antenna system, data rate, etc.), shall be included too, if applicable.

Keywords: *Weights, Measure, Performance Data*

PROJECTS AND TEST REPORTS APPENDIX

The second Technical Report appendix shall contain applicable Test Reports from the minimum tests prescribed in the EuRoC Design, Test & Evaluation Guide. These reports shall appear in the following order. In the event any report is not applicable to the project in question, the team will include a page marked "THIS PAGE INTENTIONALLY LEFT BLANK" in its place.

- Recovery System Testing: In addition to descriptions of testing performed and the results thereof, teams shall include in this appendix a figure and supporting text describing the dual redundancy of recovery system electronics. Ground testing of the recovery system is mandatory, while flight testing is optional.
- SRAD Propulsion System Testing (if applicable): Descriptions of testing performed and the results thereof, including propellant loading and off-loading.

- SRAD Pressure Vessel Testing (if applicable).
- SRAD flight computers with the capability of actuating the recovery system(s) shall be suitably tested and the results documented and included in the Technical Report. The entire chain of equipment and signals, from SRAD flight computer to recovery system actuators shall be tested under representable conditions, to the extent possible. Vacuum chambers are recommended for barometric pressure sensors and emulated IMU data is recommended for IMU sensors, and so forth.

Hazard Analysis Appendix

The third Technical Report appendix shall contain a Hazard Analysis Report. This appendix shall address as applicable, hazardous material handling, transportation and storage procedures of propellants, and any other aspects of the design which pose potential hazards to operating personnel. A mitigation approach – by process and/or design – shall be defined for each hazard identified.

Risk Assessment Appendix

The fourth Technical Report appendix shall contain a Risk Assessment. This appendix shall summarize risk and reliability concepts associated with the project. All identified failure modes which pose a risk to mission success shall be recorded in a matrix, organized according to the mission phases identified by the CONOPS. A mitigation approach – by process and/or design – shall be defined for each risk identified.

A common description of the Risk Assessment is FMECA (Failure Mode and Effect Criticality Analysis). A risk assessment/FMECA is often represented as a spreadsheet matrix. The input to the matrix is listed as follows:

- A description of the identified failure mode
- The likelihood of the failure mode occurring.
- The severity and impact of the failure mode occurring.

The likelihood of a failure mode occurrence and the severity of the occurrence is assigned values according to the following tables:

Table 8: Likelihood of failure

Failure probability	Value	Assessment of risk
Remote	1	This is unlikely to happen
Occasional	2	This might happen
Probable or likely	3	This is likely to happen

Table 9: Severity of occurrence

MISHAP SEVERITY	VALUE	EFFECT OF FAILURE MODE
Minor or negligible	1	Minor impact on mission
Critical	2	Deterioration of performance and mission
Catastrophic	3	Safety hazard and/or likely loss of mission

The "Criticality Ranking" is the product of the Failure Probability and the Mishap Severity. The criticality rating is a measure of how urgent and how severe mitigation actions will have to be taken, to reduce the Criticality Ranking.

Table 10: Criticality ranking

CRITICALITY RANKING (PRODUCT)	OVERALL IMPACT	SEVERITY OF NEED FOR ATTENTION/MITIGATION
1	Minor	This failure mode is not a concern
2	Minor	This failure mode is of very minor concern
3	Medium	Justification needed. Jury may decide to review
4	High	Technical jury approval needed before launch
6	Critical	Action required to reduce ranking before launch
9	Critical	Action required to reduce ranking before launch

The output of the matrix is highlighting and ranking failure mode liabilities to the mission, and the justifications and mitigations to reduce the Criticality Ranking. A typical FMECA scaled for the complexity of launch vehicles attending EuRoC should feature no less than 25 identified, ranked, commented, and justified failure modes – these should address at the minimum all important and critical failure modes. An illustrating excerpt is given below:

Table 11: Risk matrix

FAILURE MODE	MISSION PHASE	FAILURE PROBABILITY	MISHAP SEVERITY	CRITICALITY RANKING	TEAM'S COMMENTS AND JUSTIFICATION
Fin flutter causing fin failure	Ascent phase	2	3	6	Fin-to-fuselage bonding not convincing. Glass fibre reinforcements will be added before launch.
Ignition failure	Ignition phase	1	1	1	COTS solid motor with COTS igniter is highly reliable and consequences of a misfire are very minor.
Pilot parachute ejection failure	Apogee/pilot chute deployment	1	3	3	Pilot chute system is flight proven on earlier missions. Deployment failure is however

					catastrophic. Packing procedure developed.
Vehicle leaves launch ramp at wrong angle	Ascent phase	1	3	3	Leaving the launch rail on a wrong trajectory is a severe safety hazard. Calculated vehicle velocity at top of launch rail is confirmed very high.
[some new cool feature...]	[some flight phase]	2	2	4	A mishap of this new cool feature may lower apogee and this feature has not been flight tested before.
…….		……	…..	…….	…….
…….		……	…..	…….	…….

All identified failure modes must be reduced to a Criticality Ranking of 4 or less in order to successfully pass the Flight Readiness Review and obtain a flight status of Provisional or better.

Assembly, Pre-flight, And Launch Checklists Appendix

The fifth appendix to the Technical Report shall contain Assembly, Pre-flight, and Launch Checklists. This appendix shall include detailed checklist procedures for final assembly, arming, and launch operations. Furthermore, these checklists shall include alternate process flows for dis-arming/safe-ing the system based on identified failure modes. These off-nominal checklist procedures shall not conflict with the EuRoC Range Standard Operating Procedures. Teams developing SRAD hybrid or liquid propulsion systems shall also include in this appendix a description of processes and procedures used for cleaning all propellent tanks and other fluid system components.

Competition officials will verify teams are following their checklists during all operations – including assembly, pre-flight, and launch operations. Therefore, teams shall maintain a complete, hardcopy set of these checklist procedures with their flight hardware during all range activities.

Engineering Drawings Appendix

The sixth Technical Report appendix shall contain Engineering Drawings. This appendix shall include any revision controlled technical drawings necessary to define significant subsystems or components – especially SRAD subsystems or components.

OPTIONAL APPENDICES

Other optional appendices can include, but are not limited to further Subsystem Details, Launch Support Equipment Details, Detailed Structural and Mechanical Calculation, Detailed Logical Process Diagrams, Detailed Software Architecture, Detailed Electrical Architecture, and Detailed Hydraulic/Fluid Architecture.

APPENDIX E: DETAILED GRADING CRITERIA

TECHNICAL REPORT

Table 12: Technical report grading criteria

CRITERION	MAX. POINTS	RELATIVE	DETAILS
Correctness	40	20%	Grammar, spelling, typing errors ("typos"), punctuation, sentence structure
			Correct use of scientific terms, units, dimensions, consistency, and usefulness of significant digits
			Technical clarity and disambiguation, correctness of scientific statements regarding general scientific knowledge
			Coherent stylistic appearance in terms of font, font size, style elements, colours, paragraphs, headlines, sufficient resolution of figures, presence of figure axis labels, clear and readable graphs/tables, etc.

CRITERION	MAX. POINTS	RELATIVE	DETAILS
Completeness	40	20%	Contains all required contents according to the requirements in a complete but concise fashion

CRITERION	MAX. POINTS	RELATIVE	DETAILS
Analysis	120	60%	Explanation of key-design decisions, including trade-space analysis description (e.g., why was one option chosen over the other), constraints, and decision rational
			Clarity, understandability, and thoughtfulness in description of system architecture and mission concept of operations
			Discussion of key verification & validation tests performed on final design and possible previous designs, demonstrate complete and valid conclusions drawn from the results

			Appropriate use of tables, figures, and appendices to clearly organize and communicate information to the reader
			Quality, thoughtfulness, usefulness, and practicability of risk assessments, hazard analysis, checklists, technical drawings

DESIGN IMPLEMENTATION

Table 13: Design implementation grading criteria

CRITERION	MAX. POINTS	RELATIVE	DETAILS
Competency of Design	120	40%	All features of the project hardware reflect strong competency in the physical principals governing the design
			Design quality enables operation as intended without risk of premature failure due to fatigue or reasonably expected loading
			Robustness of design characteristics, decreasing the design's sensitivity to reasonably expected variations in "real-world" operations
			Overall system engineering discipline maintained throughout development (e.g., not having any features which are both critical systems, and yet clearly implemented as "afterthoughts" to the intended system)
			Overall system compliance with all expectations set by the EuRoC Design, Test, & Evaluation Guide

CRITERION	MAX. POINTS	RELATIVE	DETAILS
Strategic Design Decisions	60	20%	Demonstration of a clear, achievable strategic vision for how challenges were selected to advance strategic goals, mirrored by the project's design implementation
			Degree of strategic consideration given to the design and inclusion of COTS and SRAD in the project, also in regard in keeping in line with the teams' articulated strategic vision

			Manufacturing methods used in SRAD aspects of the project, such as additive manufacturing for example, are generally appropriate for the intended use and well understood by the team. Understanding extends not only to how the method works, but also its impact on project timelines, cost, and physical performance.

CRITERION	MAX. POINTS	RELATIVE	DETAILS
Design Challenges	60	20%	Selection and implementation of a challenging and novel design feature in one or more particular aspects, either to enhance the team's understanding of that subject, or to develop technology necessary for achieving a longer-term performance goal (e.g., active control, guidance)
			Selection and implementation of a novel or challenging propulsion and/or staging system, and development of the technology necessary for achieving a successful implementation

CRITERION	MAX. POINTS	RELATIVE	DETAILS
Payload	60	20%	Is the payload developed in conjunction with or completely by a third party?
			Is the payload independent, removable, and conform to both form-factor and mass requirements?
			Is the payload functional, e.g., a purposeful device such as an experiment or a technology demonstrator?
			Is the payload functionality being carried out during flight, so that useful data can be gathered?
			Is the payload active during flight, e.g., powered or energetic, to support and/or carry out its purposeful function?
			Is the payload deployed during flight?

TEAM EFFORT

Table 14: Team effort grading criteria

CRITERION	MAX. POINTS	RELATIVE	DETAILS

Deliverables (correct, complete, timely)	60	30%	Entry Form
			Academic Institution Participation Letter
			Student University Identifications
			Deposit Fee
			Technical Questionnaire
			Video Presentation
			Technical Report
			Technical Poster
			Proof of Insurance
			Waiver and Release of Liability Form

CRITERION	MAX. POINTS	RELATIVE	DETAILS
Organization, Operation, Communication	80	40%	Clear, open, honest, reliable, timely, and efficient communication in written and spoken word prior and during the event
			Organization and Reliability of the Team, e.g., team is present in time at the start of the event, team is reliable and in time for scheduled briefings and meetings (excluding spontaneous "snap-meetings"), clear responsibilities and roles within the team, clear points of contact towards the event officials
			High quality, clarity, and competency of poster presentation of the team towards the jury and the public
			Efficiency and preparedness of the team in prior to launch-site operations, including launch rail fit check, timely preparation for the scheduled launch readiness review without delays, timely transfer of equipment to the launch site
			Efficiency and preparedness of the team for launch-site operation, including dress-rehearsal of operations on launch day, general team readiness and preparedness for operations at the launch site, and preparedness towards unforeseen events ("Plan B")

CRITERION	MAX. POINTS	RELATIVE	DETAILS

Sportsmanship and Team Spirit	60	30%	Going above and beyond to assist fellow teams and the event organizers to assure the EuRoC is a productive, safe, and enjoyable experience for all involved, e.g., making themselves available to lend-a-hand whenever and however they can (whether they are asked to or not), being positive role models for their fellow teams, and generally being a "force for good" in every activity in which they involve themselves.
			Proverbial (or literal) smiles on their face, a school flag in their hand, and never lets either waiver throughout the event, show great pride in their work, learn from their mistakes, remain positive when things do not go their way, engage members of the public with respect and enthusiasm, and show respect for invited guests.

FLIGHT PERFORMANCE

Table 15: Flight performance grading criteria

CRITERION	MAX. POINTS	RELATIVE	DETAILS
Actual Apogee	240	80%	See section on 10.9 for details.

CRITERION	MAX. POINTS	RELATIVE	DETAILS
Recovery	60	20%	Competition officials will visually inspect the launch vehicle upon its return to the designated basecamp area to determine the success of the recovery operation. A recovery operation is considered fully successful if the damage to the launch vehicle is minimal, in essence if the systems intended consumables were replenished, it could be launched again safely. A recovery operation is considered to be of average success if the vehicle has experienced only little damage that could be fixed within a couple of days, e.g., replacing exchangeable fins. A recovery operation is considered unsuccessful, if the vehicle has experienced major damage and could only be flown after significant repairs taking more than a couple days.