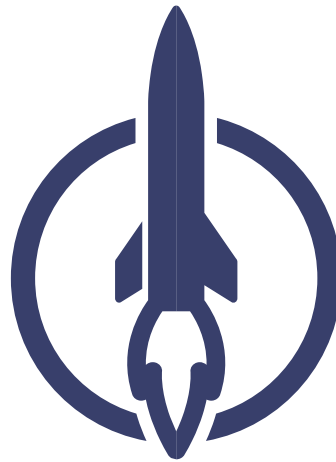




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EUROPEAN ROCKETRY CHALLENGE

LAUNCH OPERATIONS GUIDE



EUROC

EUROPEAN ROCKETRY CHALLENGE







European Rocketry Challenge – Launch Operations Guide

INTERNAL APPROVAL

PREPARED BY:

Álvaro Lopes, Portuguese Space Agency
Inês d'Ávila, Portuguese Space Agency
Manuel Wilhelm, Portuguese Space Agency
Paulo Quental, Portuguese Space Agency

Signature:

Date: 30/06/2022

VERIFIED BY:

Marta Gonçalves, Portuguese Space Agency

Signature:

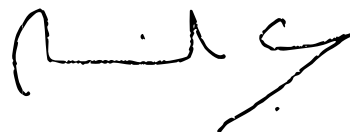


Date: 30/06/2022

APPROVED BY:

Ricardo Conde, Portuguese Space Agency

Signature:



Date: 30/06/2022



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1. INTRODUCTION

1.1. BACKGROUND

The Portuguese Space Agency – Portugal Space promotes the EuRoC – European Rocketry Challenge, hosted in the Municipality of Ponte de Sor, a competition that seeks to stimulate university level



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.

EuRoC 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.

Since EuRoC's first edition, in 2020, where 100 students were present to 2021, with 400 students participating, the growth of the competition within Europe is visible, and especially within Portugal, with an increasing number of interested teams applying to the competition. For the future, it is Portugal Space's goal to continue to foster the exchange of knowledge and international interaction inherent to the event, allowing more students to gain from the Challenge and, at the same time, contribute to it.

This document defines all procedures for the launch operations in EuRoC. Revisions of this document will be accomplished by document reissue, marked by the version number. The authority to approve and issue revised versions of this document rests with Portugal Space.

1.2. PURPOSE AND SCOPE

The Launch Operations Guide (LOG) aims at providing the overarching procedures for the launch activities to take place at EuRoC. This document focuses on practical information regarding operations and safety, among others, enabling teams to better understand what to expect and what teams should comply with, once arriving at the event.

The EuRoC organizers reserve the right to update the document whenever necessary, including with more detailed and precise information closer to the event, as well as adapt the document during launch operations to real world conditions.

Please note that all the pictures and schematics provided within this guide are merely indicative being subject to changes.

2. EVENT LOCATIONS

The EuRoC features two locations: the Paddock at Ponte de Sor Airfield and the Launch Site at Santa Margarida Military Camp.



2.1. ACCESS CONTROL

Teams can access the premises of the Airfield via the main gate. Teams will need to register at the EuRoC registration desk, at the paddock, during the morning of the first event day to obtain their EuRoC credentials to access the premises on subsequent days.

Teams can only access the launch site, via the main gate of the military camp, with the respective EuRoC credentials.

2.2. Paddock

The paddock is located at the Airfield of Ponte de Sor, about 125 km North-East of Lisbon.

The paddock will have the necessary infrastructures for teams to work and assemble the projects prior to the launch day. For loading/unloading purposes, it is expected that teams can temporarily access an unloading area closer to the paddock, to be checked prior with the EuRoC official present on site.



Figure 1: Paddock at Ponte de Sor Airfield

2.3. LAUNCH SITE

The launch site will be located at the Santa Margarida Military Camp, about 50 km North-West of Ponte de Sor Airfield where the paddock is located, reachable by car in approximately 45 min from there.

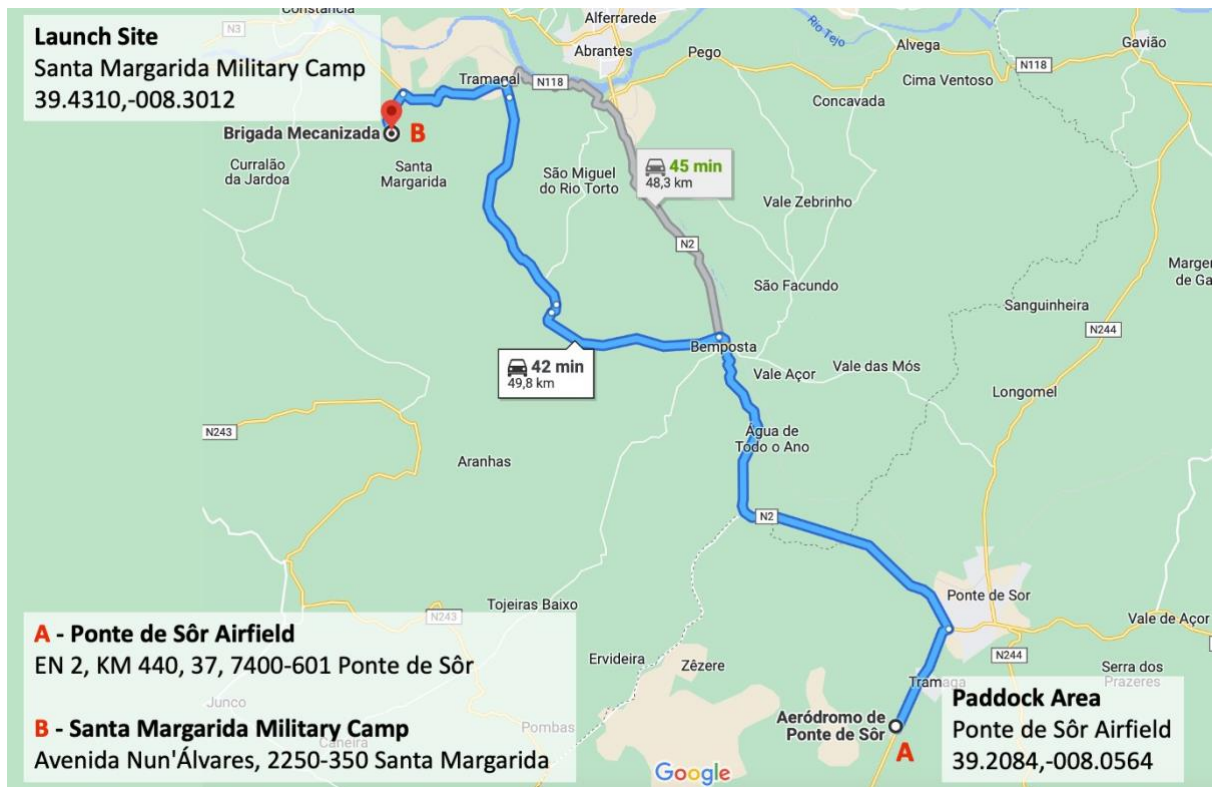


Figure 2: Paddock, Launch Site, and route in between.

The launch site features the following areas:

- Public Area;
- Safety Tower;
- Teams Preparation Area;
- Pyro Preparation Area;
- Pyro Shop;
- Mission Control;
- Launch Pad;
- Liquids and Gaseous Propellants Storage Area.

In the public area, teams will find a roofed tribune, that will be open to the teams and public for leisure but will be cleared for launch. A spectator area in front of the tribune will be where all spectators can follow the launches. The safety tower is located near the tribune, where the range safety personnel will be stationed, including first responders in case of emergency. Please note that the launch site layout (see Figure 3) might be subject to changes.



Figure 3: Launch site layout.



Figure 4: View of the launch pad area and launch rails of EuRoC 2021.



3. LOGISTICS & ACQUISITIONS

3.1. PYROTECHNICIAN LICENSE

The local regulations demand that each team shall have at least one person holding a valid pyrotechnician license issued in Portugal to manipulate any explosives and pyrotechnics. This person shall be responsible for the setup of the rocket on the field or the one supervising the construction and project. This team member shall also be the EuRoC point of contact for all propulsion related matters.

The pyrotechnician license will only be valid during EuRoC where there will be a lead pyrotechnician on-site to overview all pyrotechnics manipulation and ease the process before the authorities.

For the EuRoC officials to fill out the pyrotechnician paperwork with the proper authorities, teams will be requested to provide the team member personal information (i.e., name, email, phone number, address and digital copy of the identification document). This information will be requested upon the filling of the Technical Questionnaire.

3.2. COTS SOLID MOTOR ACQUISITION

Only COTS solid motors from the official EuRoC Motors List and specified by the teams in the Technical Questionnaire are permitted at EuRoC. After submission of the questionnaire the EuRoC organizers will contact the teams to provide detailed information on the acquisition process, including ordering, transport, and payment.

When filling out the Technical Questionnaire teams should specify at least two backup choices in case the first option is not available, in this way avoiding back and forth communication with the organization and expediting the acquisition process.

When ordering the motors, teams shall order everything needed and verify what is included in the order, since some components might not be found in Portugal (e.g., US bolts). Teams should be aware that the motors have manufacturing tolerances and thus do not always fit in the casing. Thus, teams shall come prepared to accommodate all difficulties that may arise, having into attention that there will be no spares for the team's motor.

Teams intending to purchase multiple motors (e.g., staging, clustering) should contact the EuRoC organization immediately after the submission of the Technical Questionnaire.

3.3. SRAD SOLID MOTORS

Teams with SRAD solid motors are required to submit a SRAD Motor Technical Description and the Fuels



Material Data Sheets of their system as an appendix to the Concept Report. This must include motor technical details, details on fuels/oxidizers/propellants, equipment and supplies needed for preparation, and the preparation procedure.

After the submission of the Concept Report, the EuRoC officials will assess the SRAD Solid propulsion system case by case, after which it will contact the teams individually to clarify any doubts or concerns and discuss the best approach for each specific case. In order to have a timely and profitable discussion the information provided in the appendix should be as detailed as possible.

3.4. LIQUIDS & GASES ACQUISITION

Teams are required to indicate their fuel/oxidizer needs on the Technical Questionnaire. Liquid/gaseous propellants must be acquired through EuRoC, under no circumstances will a team be allowed to bring their own propellants. This is not applicable to any specific rubber/fuel for SRAD hybrid motors which the teams themselves supply and can be considered inert and as such non-dangerous.

Teams should ensure to order a sufficient amount of fuel/oxidizers, to account for possible mishaps or possible needs for additional launch attempts during the event days. No additional fuel/oxidizer will be on stock besides the amounts ordered by the teams on the Technical Questionnaire. After submission of the questionnaire, the EuRoC organizers will contact the teams to provide detailed information on the acquisition process, including ordering, costs and payment.

Please note that the bottle fittings might be different from the ones normally used by the team and shall take all necessary precautions to ensure the compliance with the EuRoC supplier products. The product sheets of the fuel/oxidizers will be made available to the teams, after the submission of the questionnaire.

Teams are responsible by having all the necessary equipment on site (e.g., cooling chamber, thermal protection, etc.).

3.5. ENERGETICS ACQUISITION

Energetics (e.g., black powder, e-matches, igniters, CO2 cartridges) can be acquired directly via EuRoC. Please note that for particular products, only CE marked products approved by the Portuguese authorities can be legally used at EuRoC.

Teams should provide all the information regarding their energetics needs on the Technical Questionnaire, including special requests for using SRAD systems or the possibility to manufacture it in Portugal. Upon submission of the questionnaire, teams will be contacted by the EuRoC officials in order not only to assess any special requests but also to provide more detailed information on the



products available and respective costs. Teams should not forget to account for spares. Several products will also be available, in limited quantities, at the Pyro Shop.

While the EuRoC organization will always work to provide the best solution, teams need to be aware that some products (e.g., black powder) might not be exactly the same as the team is used to.

Teams wishing to, will have the possibility to test their systems on the launch site in the earlier days of the event before the launch days.

3.6. IMPORT/EXPORT TO/FROM PORTUGAL

SRAD hybrid and liquid motors can generally be imported into Portugal in a neutral, non-dangerous state, nonetheless teams need to ensure on their own that all import requirements that might apply are fulfilled. The same applies to the inert propellants for hybrid motors, but once again teams shall ensure that all the import requirements are fulfilled and that they have the right documentation.

It is strictly forbidden for the teams to directly import SRAD solid motors into Portugal. Teams with solid motors should contact the organization, via info@euroc.pt, as soon as the delivery of the Concept Report.

When shipping via parcel teams need to ensure a timely shipping, be aware that there might be delays or customs complications that require some time to handle, causing at the limit a team inability to launch.

Teams shipping via parcel from outside the EU should refer to the EuRoC Temporary Admission Guide, available at the Teams Area in the EuRoC website, that contains useful information on this matter.

When preparing the shipping to Portugal, teams should also plan ahead the return of the project to the home country with special attention to used batteries, rocket parts, unused propellants and motors. COTS solid motors that remain unused by the end of EuRoC will be following for destruction unless teams find a way to ship it or another feasible alternative.

Closer to the event, the EuRoC organizers will provide a shipping address/contact to where teams should send all the parcels.

3.7. TRANSPORTATION TO/AT THE EVENT

Teams are responsible for their own transportation getting to and from EuRoC as well as getting around during the event. For loading/unloading purposes, it is expected that teams can temporarily access an unloading area both at the paddock and at the launch site, to be checked prior with the EuRoC official present on site. Nonetheless for the remaining time teams need to comply with the designated parking areas. Entrance at the Santa Margarida Military Camp will be restricted to authorized personnel only, so be sure to use the team's credentials, provided during the registration, at all times.



Transportation, from the storage site to the paddock, will be provided for the shipped parcels. Transportation of the teams' projects from the paddock area to the launch site will also be provided, this transport will take place the day before a team's launch. The specific time of this transport will be communicated to the teams at the event.

4. LAUNCH SITE ORGANIZATION

4.1. ROLES AND RESPONSIBILITIES

To ensure launch operations as well as an overall successful event, the EuRoC officials are structured in several primary areas headed by the responsible officer which counts with various deputies in order to fulfil the respective responsibilities. At EuRoC teams will find the following officers:

- Technical Evaluation Board (TEB) Head;
- Mission Control Officer (MCO);
- Launch Control Officer (LCO);
- Range Safety Officer (RSO);
- Preparation Officer (PO);

During the event, when in need to reach out to the organization, teams should streamline the contacts according to the respective roles and responsibilities, in this way guaranteeing the most accurate and timely response. Teams can find below more detailed information on each officer's responsibility, to better understand what to expect and who the team should contact in the various cases once arriving at EuRoC.

The TEB Head, with the help of the deputies, will oversee and orchestrate the overall paddock operations. It will coordinate with the Preparations Officer on the outcome and Action Items of the Flight Readiness Review (FRR). The TEB Head will oversee the overall scheduling at the paddock area as well as the FRR schedule. Teams will only be able to perform the launch rail fit check after authorization of the TEB Head. All paddock related matters/questions shall be discussed with the TEB Head.

The MCO, with the help of the deputies, will oversee and orchestrate the overall launch operations. It will oversee the teams in the mission control area and teams wanting to proceed to the Launch Pad shall do so only with the authorization of the MCO. In accordance with the various moments of the launch operations the MCO will set the Launch Site Status. Mission Control personnel is also responsible for assuring that the flight predictions are within the safety limits, thus, teams shall provide the most up to date simulations and make the officials aware of any chances made to the rocket. The MCO will orchestrate and conduct the countdown, being also responsible for managing the rocket tracking and the coordination of the Recovery Team.

The LCO, with the help of the deputies, will oversee and orchestrate the launch pad operations. It will manage the setup and operation of the launch rails, the handling and loading of liquids and gases, as well as the overseeing of the installation and test of ignition systems on the launch pad. The LCO will



oversee and assist the teams with launch pad integration, and it will conduct a final safety inspection on the launch rail.

The Range Safety Officer (RSO), with the help of the deputies, will ensure that the launch site operations are in accordance with regulations and standards while also overseeing and orchestrating operations in the public area and media area. To assure that everyone, at all times, is aware of the safety measures put in place during EuRoC, the RSO will conduct safety briefings and drills. Launch site inspections will be performed to ensure adequate hazard mitigation measures in all areas, if at any moment a team identifies a potential hazard it should report it to the RSO in order to be taken appropriate measures. The Range Safety officials manage the airspace clearance, also monitoring the meteorological conditions. The RSO will oversee the access control to the launch site and manage the launch site clearance according to the range status. The RSO is responsible for coordinating the emergency response. If a team needs medical assistance, it shall request aid to the emergency authorities available on site, to assure a timely response. If at any given moment a team feels there is a safety breach of any kind, it shall contact immediately the RSO.

The Preparation Officer (PO), with the help of the deputies and the pyrotechnics team, will oversee and orchestrate operations in the preparation and pyrotechnics area. It will coordinate with the TEB Head and control and help with the resolution of Action Items issued in the FRR, while also conducting the Launch Readiness Reviews (LRR) and issuing the Flight Card. The PO will oversee the launch scheduling thus, questions regarding LRR, overall schedule, launch slots, scrubbed flights shall be directly communicated to the PO. The Preparation Area officials will manage the preparation and integration of pyrotechnics and motors. After launch and recovery teams shall be prepared for the PO to conduct the Postflight Review (PFR) and fill the Postflight Record.

4.2. LAUNCH SITE OPERATION REGULATIONS

The launch site dimensions are oriented on NFPA 1127 for complex rockets (e.g., multi-stage, clustered motors) with a maximum allowable altitude of 10000 m.

The EuRoC launch site (see Figure 5) has a circular diameter of 5000 m (radius of 2500 m) with the launch pad at its centre and a minimum spectator distance of 610 m from the launch pad. Only essential launch personnel may be allowed as close as 305 m to the launch pad with explicit permission by the RSO. All event areas, including mission control, are set up outside of the 610 m radius.

Teams shall only be permitted to launch if a nominal flight is projected to touch down downrange well within the launch site radius of 2500 m.

The launch corridor is in the form of a circle segment with a +/- 10° arc with a length (radius) of 11500 m downrange.

The launch site is located at Santa Margarida Military Camp, consequently EuRoC operation regulations will be subject to and in-line with the camp regulations. During launch operations, the access to the military camp may be restricted.

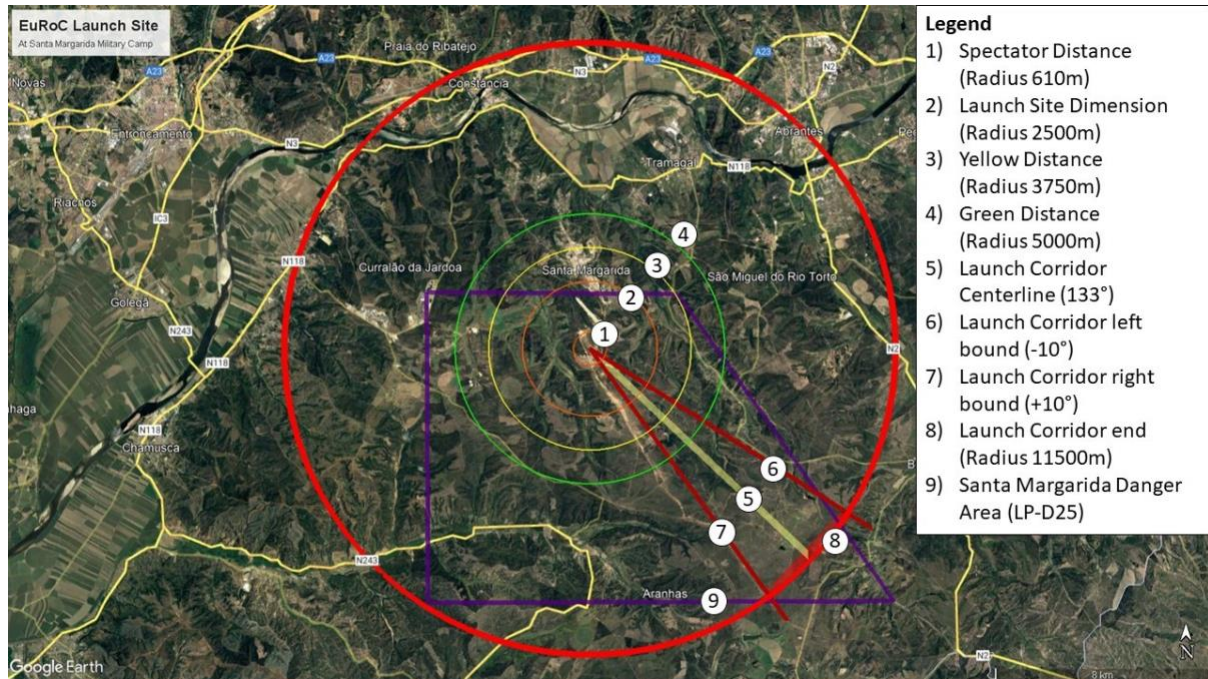


Figure 5: EuRoC launch site at Santa Margarida Military Camp.

4.3. LAUNCH PAD LOCATION AND LAUNCH DIRECTION

Nominal launch direction is 133° from North azimuth, roughly towards the South-East. The wind direction will be monitored, and the launch direction may be adjusted accordingly.

The maximum inclination of the launch rails is $84 \pm 1^\circ$. Launch rail inclination may be lowered by the event organizers if they see fit to further increase the safety margin.

Table 1: Launch Pad Details.

Latitude of Launch Pad	39°23'22.92"N
Longitude of Launch Pad	8°17'20.27"W
Elevation of Launch Pad	160 m above mean sea level
Nominal Launch Direction	133° from North azimuth
Nominal Launch Rail Inclination	$84 \pm 1^\circ$ from horizontal

4.4. VEHICLE OPERATIONAL REGULATIONS

In accordance with the EuRoC Design, Test & Evaluation Guide, the minimum rocket take-off velocity off the launch rail is 30 m/s, the minimum static stability margin off the launch rail is 1.5 calibres, and the maximum permitted impulse of the rockets is 40,960 Ns.



4.5. AIRSPACE

The national airspace authorities need to clear the airspace for the event. There will be dedicated launch windows within which the 3000 m flight category rockets may be launched. For high-flying rockets in the 9000 m flight category, special short duration launch windows with dedicated air space clearance are requested prior to the event (typically 10 min) which must be maintained and strictly followed.

4.6. METEOROLOGICAL CONDITIONS

The meteorological conditions are assessed via forecasts, meteorological data, and a launch site weather station. For launch operations to commence, the maximum allowable wind speed on-ground is 8.7 m/s.

The ascent trajectory needs to be free of clouds. In case of thunderstorm or lighting in the area, launch operations will be suspended immediately.

4.7. LAUNCH SITE STATUS

The launch site status will be indicated visually via a coloured flag (green-yellow-red) near the mission control, and in addition via Public Announcement. The following four statuses may be raised, each with increasing restrictiveness.

- **Green Flag Status:** A green flag indicates that no direct launch operations are on-going. Only non-hazardous preparatory work is underway. Teams and staff are free to move on the launch site, respecting and keeping clear of teams' and staff's direct work areas. Visitors are free to move on the spectator area. However, visitors may not enter the teams' areas, except if by explicit invitation by a team or staff and shall be accompanied at all times.
- **Yellow Flag Status:** A yellow flag indicates that launch preparations are on-going. Potentially hazardous tasks are underway, such as handling of motors, pyrotechnics, and propellants in the pyro preparation area, on route to the launch pad, and at the launch pad. Teams and staff may remain in these areas and shall be aware of the on-going activities. Personnel not directly involved in hazardous tasks shall stay clear of them. In addition, the team and staff areas in their entirety are off-limits to spectators.
- **Red Flag Status:** A red flag indicates that launch preparations are in their final stages. Additional, potentially hazardous tasks are underway on the launch pad, such as connecting of igniters, arming of electronics, and removal of safety pins. Only essential personnel may be at the launch pad (within the 610 m safety radius). The team and staff areas in their entirety are clear of all non-essential personnel. Essential personnel may also include team members in need to perform critical tasks on their vehicle to ensure launch readiness for their launch slot



later during the launch day. All personnel must be in high alert, immediately ready at all times to move to the spectator's area as soon as the final launch status signal sounds.

- Final Launch Status: A final announcement together with an acoustic signal indicates that launches are imminent. No additional flag will be raised, the red flag remains up. The team and staff areas in their entirety are clear of all personnel, and remaining personnel is to move to the spectator area. Only launch control personnel may be within the 610 m safety radius at the forward mission control. All other personnel are either at the mission control or at the spectator area. Movement to, from, and on the launch site may be restricted.

Category \ Area	Preparation & Pyro Area	Mission Control	Forward Mission Control	Launch Pad	Spectator Area
1 - Spectators	by invitation only				
2 - General Teams/Staff					
3 - Essential Teams/Staff					
4 - Launch Control					

Personnel of group [Category] can be at [Area] during ...

Green Flag

Yellow Flag

Red Flag all times

... but must leave once the status is raised.

Figure 6: Access rights according to Launch Site Status.

4.8. LAUNCH RAIL PENNANT

Each launch rail shall have its own red pennant to be fixed visibly on the rail to indicate any potentially hazardous activity, for example an on-going propellant loading or arming process, or a potentially hazardous state, for example the presence of a loaded rocket or a pressurized tank.



5. SCHEDULING

5.1. SCHEDULING PROCESS

The EuRoC scheduling process follows a first-come, first-served principle for the FRR, LRR, and launch time slots. In addition, for the launch timeslots, technical considerations such as target altitude, propulsion type, hybrid/liquid pressurization considerations are taken into account.

EuRoC provides several slots for the teams, thus the responsibility to find a suitable combination of timeslots lies with the team.

Teams shall apply for a timeslot for the FRR during their registration at the event on the event's first day. After the FRR, if the status is "Nominal" or "Provisional", teams shall apply for a LRR and Launch timeslots with the EuRoC staff.

5.2. BACKUP LAUNCH SLOTS

Timeslots selected by the teams may be subject to changes due to unforeseen issues or force majeure (i.e., weather). In such cases, a backup possibility for the team may be attempted, prioritizing launch slot selection according to the table below (see Table 2).

In all cases, EuRoC is reserving the right to alter the launch slots/launch order if necessary.

Table 2: Launch Slot Prioritization.

Priority given in launch slot choice			
Original Slot	Was this the launch slot originally chosen by the team?	If yes, priority is ...	1
Backup Slot	Is there a readily available open launch slot later on the launch day, not interfering with any other planned launches?		2
	Is this the team's first (second, third, ...) launch attempt?		3
	Was the team's launch attempt scrubbed due to a third party?		4
	Was the team's earlier launch scrubbed due to force majeure?		5
	Was the team's launch attempt scrubbed due to the team itself?		6

Despite the best efforts, events related to force majeure are out of the control of the EuRoC organizers. Therefore, a general guarantee that teams can launch at the event or will have a backup launch slot under all circumstances cannot be given.

5.3. EVENT DAYS

As an example, for an 8-day event, the event days will be scheduled as follows:

Day 1 and 2: Preparation Days.



Paddock and launch site open and preparations start. Teams will register and welcome and safety briefings will be held. Teams will perform their jury pitch on the Jury Day. Registration for FRR shall be made, afterwards registration for the LRR and Launch Slots will be open.

Day 3 to 7: Launch Days.

Beginning of launch operations, with Launch Readiness Reviews, launches, recoveries and postflight reviews. Transportation of teams' rockets and equipment will be performed to/from the launch site from/to the paddock.

Day 8: Wrap up.

Postflight Highlights and Award Ceremony.

5.4. SETUP TIME

The baseline for an efficient and safe setup is a well-trained and independently acting crew. Good training can be achieved prior to the competition via static firing tests.

Teams should train, drill, improve, and organize, focusing on becoming more efficient, for example taking the lessons learned to design ground support equipment for efficient use. Some target setup times are included below for reference (see Table 3).

Table 3: Example target setup times for typical launch preparation activities according to propulsion type.

Activity	Solids	Hybrids	Bi-liquids
Mission Control setup	30 minutes	30 minutes	30 minutes
Launch Pad equipment setup	30 minutes	45 minutes	60 minutes
Rocket on rail and rail erected to launch angle	15 minutes	15 minutes	15 minutes
Power-up, telemetry and checkouts (*)	15 minutes	30 minutes	30 minutes
Propellant loading, including pressurization (*)	N/A	30 minutes	60 minutes
Igniter loading (*)	10 minutes	10 minutes	10 minutes
Pyrotechnics arming, final check (*)	5 minutes	5 minutes	5 minutes
Total (serial vs. parallel)	115 / 60 minutes	180 / 120 minutes	210 / 165 minutes

(*) Actions that cannot be carried out in parallel.

6. PRE-LAUNCH PREPARATION

6.1. PREPARATION AT THE PADDOCK

In the paddock, teams will carry out the final preparations before the launch day. Teams can expect to find tables, chairs, and a power outlet in the respective booths. Teams are expected to bring their own



tools, supplies, power extension/multi cords, desk lights, and whatever else they might need. Teams may conduct smaller mechanical and electrical work within their booths (e.g., hand drilling, soldering) on appropriate working pads/boards they should carry with them. Any potentially dangerous work, especially associated with a substantial amount of heat release (e.g., angle grinder, welding) shall be conducted outside the paddock tent in a dedicated area.

It is not permitted, under any circumstances, to conduct tests involving propellants, explosives, or energetics in or around the paddock area. Teams wanting to conduct tests, shall do it so at the launch site on the day prior to the first launch day with explicit approval of the Preparation Officer and with assistance of the Preparation Officer Deputy in conjunction with the Pyrotechnics staff.

The working hours of the paddock are 08:00 to 24:00.

6.2. FLIGHT READINESS REVIEW (FRR)

The Flight Readiness Review is a complete technical review of the teams' project performed by the Technical Evaluation Board. It is a major milestone that gives the team the clearance to transfer the vehicle from the paddock to the launch area to start the dedicated launch preparations.

Within the FRR, the TEB goes through a detailed FRR checklist (see Appendix C of the Design, Test & Evaluation Guide), for which teams must be prepared. The rocket shall be disassembled at the joints and nosecone, and access to the recovery system (including parachutes), avionics, and payload should be granted.

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 team to FAIL the FRR and will not be allowed to launch their vehicle. If any single criterion is scored "yellow", while no criterion is "red", the overall flight status is "Provisional" (please see further details in DTEG). Any criterion that is scored "yellow" in the FRR will result in an Action Item which is 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 Preparation Officer or Deputy during LRR.

The Preparation Officer (PO) and Range Safety Officer (RSO) shall be informed by the TEB of the outcome of the FRR, especially regarding any criticalities and action items that might require further discussion.

6.3. LAUNCH RAIL FIT CHECK

The Launch Rail Fit Check is part of the FRR where teams need to demonstrate that their vehicle fits and can be safely mounted on the respective launch rail, event-provided or team-provided, for which teams shall coordinate with the TEB. Teams shall have the launch lugs readily available at the paddock.



When bringing their own, teams need to ensure that the rocket fits the launch rail. On the launch site, the LCO or Deputy will check again that the vehicle is mounted properly on the launch rail for all teams.

6.4. LAUNCH RAIL SETUP

EuRoC provided launch rails will be set up by the event organization, while team provided launch rails shall be set up by the team. Transport of team launch rails to the launch pad shall be organized by the team – please note that the road is very rough and uneven including some big boulders.

Teams can set up their launch rails on the launch pad on the first days, before the launch days. Teams should bring all the tools and equipment needed to do so. Teams launch rails should be set up all the way to the side of the launch pad, and then moved to the final position in the morning of the launch day when they are needed. The final position of the launch rails shall be coordinated with the event staff. Independently of what launch rail teams use, teams should have a dedicated and trained launch rail crew. Teams using the EuRoC launch rails can train during the preparation days.

Teams are responsible to and for any damage that bad utilization of the launch rails may impose to equipment and people.

6.5. COTS SOLID MOTORS PREPARATION

Teams that have ordered a COTS solid motor shall go to the launch site during the preparation days and check with the EuRoC staff if everything is in order.

Some COTS solid motors need more elaborate preparation, (e.g., parts needing to be glued and to cure) which needs to be done during the preparation days by the team in conjunction with the EuRoC staff.

EuRoC staff can provide support, teams shall communicate early if needing support.

6.6. HYBRID & LIQUID ROCKETS PREPARATION

The main points in hybrid & liquid rocket preparation are checking if all bottles are complete, if the bottle fittings are appropriate, setting up the loading station, and testing the loading station.

During the preparation days, there is the possibility to set up the liquid loading station on the launch pad, then move it towards the left side of the launch pad. The loading time is critical during launch day operations (see DTEG for more details).

Please note that the bottle fittings may vary from the ones teams normally use and thus, adaptors might be needed. On the Teams Area of the EuRoC website teams can find all the necessary information on the bottles that will be available at EuRoC. It is the team full responsibility to come prepared with the necessary adaptors, no adaptors will be provided at EuRoC.



6.7. SRAD SOLID MOTORS PREPARATION

For SRAD Solid Motors, please see Sections 3.3. and 3.6.

6.8. ON-SITE TESTING

Testing should be done prior to the event. Potentially hazardous testing, especially involving black powder and energetics for the recovery system, cannot be done at the paddock. Teams may conduct tests at the launch site, for example tracking/telemetry, ignition system, or remote filling station.

Any tests at the launch site shall be conducted before the actual launch days. Teams shall limit the number of people on the launch site to the necessary minimum to ensure smooth preparation. Support will be provided by the EuRoC staff.

7. LAUNCH DAY OPERATIONS

7.1. A SAMPLE LAUNCH DAY

In the table below, a sample launch day is shown for a team (in example) in the first launch window.

Table 4: A sample launch day.

07:00	Arrive at launch site, check if everything needed is at the launch pad, start preparations
08:00	Morning Briefing
08:30	Install Motor
09:30	LRR
10:00	Move to the Launch Rail
10:30	Install igniters
11:00	1 st Launch window opens - launch
12:00	1 st Launch window closes - recovery
12:30	LRRs other teams, rocket found and returned
13:00	Other teams moving to the launch pad
13:30	Install igniters
14:00	2 nd Launch window opens



15:00	2 nd Launch window closes - recovery
15:30	Postflight review commence
16:00	3 rd Launch window opens
17:00	3 rd Launch window closes - recovery
18:00	Postflight reviews completed
19:00	Launch Range Closed

Independent from the launch window the team will launch at, some ideal reference times can be found below.

- Time from arriving at the Launch site in the morning to being ready for LRR: 1-2 h;
- Time from LRR to launch rail: 15 min;
- Time at the launch pad to get ready for launch: 15 min;
- Hybrid and liquid time for loading: max. 90 minutes including pressurization (See EuRoC Rules & Requirements);
- Time between launch window closes and recovery: ASAP, teams shall have the recovery team (2-3 members) ready to go;
- Time between recovery and postflight review: ASAP, but other teams' LRR and launch preparation have priority;
- Cleaning of the launch site and packing up: after the postflight review.

7.2. MORNING BRIEFING

The morning briefing aims at synchronizing all the involved in the launch operations, run through the plan for the day, address criticalities and questions.

The morning briefing is mandatory for the team leader with the option of one more team member for support (max. 2 persons per team will be allowed). Teams should take this opportunity to raise any questions, concerns or to pro-actively address any issue or concern that might impact the team's readiness to launch or that could be potentially relevant for safety.

7.3. LAUNCH DAY PREPARATION

Launch operations start with the collection of the launch vehicle from the transportation truck, followed by settling into the already assigned preparation tent to do all the preparation towards the LRR. Teams shall also start preparing all the necessary mission control equipment.



If a team gets clearance from the LRR, they will be assigned a Team's Mission Control tent, to where teams shall move all the previously prepared mission control setup.

All the ground segment at Launch Pad and Mission Control must be ready and operational before the launch windows start.

7.4. LAUNCH PAD PREPARATION

Teams must prepare the launch pad setup after being assigned a launch rail. Teams using their own launch rail, must have the rail set during the preparation days, to move it to the designated area on the launch day. EuRoC launch rails will be operational on their respective area.

The loading station setup can be done during the preparation days on a designated area of the launch pad and then moved to the assigned launch rail. Teams should consider the uneven terrain and prepare themselves with solutions to keep their setup levelled and balanced to ensure the correct operation of all equipment.

7.5. ENERGETICS

The Pyrotechnics Team, under coordination of the PO, will supply the teams with black powder, electrical igniters or other pyrotechnics components that cannot be brought by the teams. The EuRoC team will supervise, review and support the teams with the application of igniters or other pyrotechnical devices, under approval of the PO or Deputy. These materials are stored and delivered on the launch site. Teams are permitted to install pyrotechnics and energetics only in the morning prior to their launch.

7.6. MOTOR INSTALLATION

The PO Deputy will support the teams with solid motor installation in the vehicle. The team will need to obtain the PO approval on the Flight Card that the solid motor (or solid part of the hybrid motor) has been installed correctly. With this signature, the teams are then eligible to move to the Mission Control Area, but not yet to the Launch Pad. At Mission Control, the MCO will coordinate further operations.

7.7. LAUNCH READINESS REVIEW (LRR)

The Launch Readiness Review will be conducted at the launch site on the day of the launch. Teams will be able to sign up for their preferred LRR time prior to their launch day on a first come, first served



basis. The earlier teams can schedule the LRR, the more time and less pressure they will have for final launch preparations afterwards.

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

- The team has completed the FRR 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 site 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 LRR, 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 LCO will conduct the following steps:

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

Teams need to be ready on time for the LRR. The rocket should be as ready as possible. To increase efficiency, teams should have a list of action items ready. If there are action items that would require showing “internal” parts of the rocket, teams may document the resolution of these items by pictures and videos, like that, teams can already largely assemble their rocket for LRR.

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 that 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 to the team certifies that the LRR has been passed successfully. With the Flight Card, teams will go to mission control, where they can get approval of the MCO to move their vehicle to the launch pad. Teams should ideally be ready to move to the launch pad within 15 min after the LRR.

7.8. LOADING OF PROPELLANTS

In the morning of the launch day, teams will coordinate with the LCO about their need to get the liquid propellants. These are stored in a storage container near the launch pad. With that, the LCO will initiate preparations to load gaseous/liquid propellants on the Launch Pad. Teams will then prepare the loading process themselves.

After the vehicle is mounted on the Launch Rail, the LCO or its Deputy will oversee and support the loading of the gaseous/liquid Propellants onto the vehicle at the Launch Pad. Teams will carry out the loading themselves. Teams are required to share any relevant technical information with the LCO to



ensure a safe and quick loading of the vehicle. Teams are required to bring any tools and equipment necessary for loading of propellants for their specific vehicle.

The vehicle will remain in a “safed” state throughout the loading process. The LCO will inform the MCO about the status of the loading process. The LCO or Deputy will confirm on the Flight Card the proper and successful loading with propellants.

7.9. FLIGHT CARD

When arriving to the launch site for the launch day teams shall fill out the Flight Card with their respective information (e.g., flight category, propulsion type, launch rail, CONOPS, frequency details, etc.). EuRoC officials will acknowledge that the motor is installed correctly, that a team has successfully passed the LRR and has the final inspection complete through the signature of the Flight Card, that once fully completed and signed shall be delivered to the MCO.

7.10. WEATHER CHECK

EuRoC requires that cloud cover shall not mask the ascent, thus for cloud covered sky the launches will be suspended. Low hanging cloud cover may allow 3 km launches, but not permit 9 km launches.

The wind speed and direction on ground will be monitored by a weather station by the EuRoC staff. The weather information is passed on to the teams to consider for the updated flight simulation.

7.11. UPDATED FLIGHT SIMULATION AND TRAJECTORY ANALYSIS

Any open questions about the flight simulation should be addressed as early as possible, at the latest at the FRR. Teams must provide flight simulation data representing real-world launch conditions (vehicle launch configuration, wind direction, wind speed) in an OpenRocket format to MCO after Flight Card issuance to ensure that the stability and trajectory are compliant with the operation regulations before the launch.

Along with the flight simulations, teams must provide a motor thrust curve for the final flight configuration. The last version of the file must include all the physical modifications and weight improvements made after FRR and LRR. If instructed, after LRR, teams must show and explain their project changes to the MCO or its Deputy at mission control to explain and check their final flight simulation setup.



7.12. TRANSPORT OF THE ROCKET TO THE LAUNCH PAD

With the signature of the LCO or Deputy on the Flight Card, the teams are eligible to move to the Mission Control Area, where they will inform the MCO that they are ready to move to the launch pad.

The MCO will give its oral approval once the appropriate operational conditions are given, which must be confirmed with the RSO and LCO as well as other officials. Only then are teams permitted to move to the Launch Pad.

Teams will move their vehicle by foot. Transport of the vehicle is only permitted with the vehicle in a “safed” state. The vehicle should always be pointed away from any personnel towards an open area.

7.13. MOUNTING ON THE LAUNCH RAIL

Once the vehicle arrives at the Launch Pad, the LCO (or Deputy) will guide the team to their respective Launch Rail and instruct the team about the mounting of the vehicle on the Launch Rail. The LCO will inspect the Launch Rail prior to mounting to ensure its mechanical stability and readiness.

For team provided launch rails, the team will oversee the mounting of the vehicle, with support of the LCO. For event-provided launch rails, the LCO (or Deputy) will oversee it.

7.14. IGNITION SYSTEM

Details on the ignition system can be found in the EuRoC DTEG – be aware that for COTS Solid motors the use of the EuRoC provided ignition system is mandatory.

Teams can set up their own ignition systems (SRAD motors) at the team mission control. Teams may run connecting wires to the launch pad or use wireless. For wireless systems, teams should test it again at launch day to ensure no RF-interference with all the other teams present.

7.15. ESTABLISHING LAUNCH READINESS

Before final launch preparation, all non-essential personnel are removed from the Launch Pad and must exit the specified Launch Site Safety distance (610 m).

Once all preparations have been concluded, excluding only those preparations that need to be completed immediately before launch due to the specifics of the vehicle (e.g., for liquid/hybrid vehicles), the LCO (or Deputy) will conduct a final visual inspection of the vehicle to ensure its launch readiness. The LCO will confirm on the Flight Card the final inspection.

The LCO shall inform the MCO and the RSO about the readiness of the vehicle and wait for their approval to continue with the “arming” process. For this, the MCO and RSO will transfer the launch



site into a Launch Ready state. Once the LCO has confirmed launch readiness with the MCO and the RSO, the vehicle is ready to be “armed”.

7.16. ARMING

Once launch readiness has been established, the essential team personnel will check if the recovery system is ready to be armed. Once this is confirmed, they will request the LCO permission to arm the recovery system.

All ground-started propulsion system ignition circuits/sequences shall not be "armed" until all personnel are at least 15 m away from the launch vehicle.

Personnel that are no longer required at the launch pad thereafter shall urgently leave the Launch Pad to the spectator area.

7.17. CONNECTING IGNITERS

Once arming is completed, the LCO may authorize the essential team personnel to proceed with the installation of the event-provided ignition system or team-provided ignition system, under supervision of the pyrotechnics team.

With the pyrotechnics team supervision, the team will keep the LCO informed about the status of the ignition system installation process. The LCO will inform the MCO and RSO about the ignition system installation process.

After installation of the igniters, all remaining essential personnel is to leave the launch pad with urgency to the forward mission control.

Note: Exceptions are made for the arming/connecting igniters sequence if igniters cannot be installed as a last step, e.g., for upper stages.

7.18. GO/NO-GO CALL

After arming, installation of igniters and retrieval of all personnel from the launch pad the Go/No-Go call will be managed by the MCO, which is in direct contact with the Team Mission Control and the pyrotechnics team. Teams will adhere to this call to confirm readiness for launch.

All deputies are managed internally by the officers, namely the MCO, PO, LCO and RSO, which shall go through the respective checklists and assure all safety conditions are undertaken. If at any moment, any of the officers has safety concerns the call will be interrupted.



7.19. COUNTDOWN

The MCO will rely the control to initiate countdown either to (1) pyrotechnics team, for EuRoC provided ignition system or (2) to team lead, for team provided ignition system. Countdown will be initiated down from 10 to 0, while 0 is “ignition”, voiced loudly and relayed via the PA system.

The RSO, MCO or pyrotechnics team/lead can interrupt the countdown at any time if necessary.

7.20. LAUNCH

The success of a mission is not defined by lifting off the launch rail but spans all the way until the recovery. Teams shall remain focused during the whole duration of the mission and best save celebrations for touchdown.

Once the rocket is launched, the main task for the team mission control and the EuRoC Launch operation team is to continuously monitor the flight trajectory and status. Therefore, a high focus should be kept at throughout the whole flight. The teams’ mission control should continuously and openly communicate with the MCO the status of the flight, especially if it is nominal or not. If an anomaly is detected that is potentially safety critical, this needs to be communicated immediately.

To ensure clear communication, chatter should be kept down until the mission is completed.

7.21. MISHAP

A launch mishap occurs when a flight attempt results in any potentially unsafe condition. Anybody (especially also teams mission control) who detects such a condition is obliged to immediately communicate to the nearest officer.

The RSO will orchestrate the immediate actions according to their assessment of the situation, especially the observed severity of the mishap, specifically instructing the spectators in the spectator area via PA and using the resources at their disposal to respond to the mishap, including the emergency response services if necessary.

The LCO will monitor the condition from the forward mission control, especially monitoring the trajectory. The LCO will communicate via radio to the RSO if there is any indication that the trajectory might be up range towards the spectator area.

The MCO will close the loop with the team at mission control and monitor via tracking the trajectory of the vehicle. The MCO will communicate via radio to the RSO if there is any indication that the trajectory might be up range towards the spectator area.



If touchdown can be confirmed visually, the RSO will monitor the point of impact for fires and orchestrate the fire fighter response if necessary.

If a mishap results in an uncontrolled high altitude/long range drift of any part potentially leaving the launch site, the RSO will immediately inform and coordinate with the airspace authority the appropriate response, aided by the distributed surveillance posts. For this, all available tracking data will be collected by the MCO and relayed to the RSO.

7.22. CONTINUATION OF SALVO

Once safe touchdown has been confirmed and no fires are spotted, the RSO will give clearance for the continuation of the launch salvo.

7.23. RECOVERY

For the recovery phase, teams shall have a Recovery Team composed by 2-3 members to be ready immediately after the launch window closes to join the EuRoC Recovery Team on the search for the vehicle. After RSO's clearance and MCO instructions, the recovery teams can start the operation.

Teams must have a recovery plan, to ensure they are prepared for this operation. GPS tracking system should be tested exhaustively before the launch day. Range and "hide-and-seek" tests are highly recommended.

Teams shall also prepare bags or boxes to transport the rocket fragments, in case of recovery system failure. For possible damaged LiPo batteries, all teams are required to have a dedicated container with the following features:

- Non-metallic inner packaging that completely encloses the cell/battery;
- Inner packaging made of a non-combustible, non-conductive, and absorbent cushioning material;
- Outer packaging that may be made of metal, wood, or solid plastic.

7.24. POSTFLIGHT REVIEW & POSTFLIGHT RECORD

After recovery, a Postflight Review will be conducted by EuRoC officials, upon the team arrival to mission control. If recovery is not successful, the Postflight Review will take place at the end of the day after launch operations. This review aims at assessing the success of the flight and recovery operations.

Teams must have, at least, gloves, masks, and goggles to handle the vehicle. If needed, teams can use working tools to open the rocket to access obstructed compartments. Any hot work with tools must be coordinated with the EuRoC officials conducting the review.



Before any action, the vehicle must be in a safe state: propellant tanks shall be empty, remaining, or unburned solid propellants removed, recovery electronics shall be “safed” and energetics shall be “safed” and removed.

During the review teams shall communicate the mission’s success, by assessing it with the EuRoC officials, e.g., the mission progress and status, rocket integrity, data collected, touchdown coordinates, payload mission and status, etc. Teams shall also communicate to the EuRoC officials if any rocket part is still missing.

After the Postflight Review, teams shall download, to the possible extent, altitude logging/tracking data, especially from the official altitude logging and tracking device and upload it to the Teams’ Area in the EuRoC website, together with the last flight simulation, including the estimated touch down point.

If available, at any point of the event, teams shall download any data from the payload experiment and upload it to the Teams’ Area in the EuRoC website.

Teams must document the Postflight Review via the Postflight Record, that shall be delivered to the EuRoC officials and where it will be recorded the success of the flight and recovery, and the data transfer.

7.25. LAUNCH SITE MAINTENANCE AND CLEANING

If any equipment is required to be scrapped or dumped (e.g., batteries, chemicals leftovers), the team is responsible for its correct disposal process. Avoid at all costs leaving unnecessary trash at the launch site.

APPENDIX A: ACRONYMS AND ABBREVIATIONS

CONOPS	Concept of Operations
COTS	Commercial off-the-shelf
SRAD	Student Researched and Developed
LRR	Launch Readiness Review
FRR	Flight Readiness Review
RSO	Range Safety Officer
MCO	Mission Control Officer
LCO	Launch Control Officer
PO	Preparation Officer
DTEG	Design, Test and Evaluation Guide



PA Public Address



APPENDIX B: LAUNCH SITE EQUIPMENT

B.1. EUROC MISSION CONTROL

In the EuRoC Mission Control teams will find the following basic support equipment:

- 1-phase 230VAC CEE 7/3 “Schuko” power outlet at each tent;
- Light tower for working after dusk.

Note: Teams must bring their own extension cables and socket rails/cable drums, etc., to be able to use the power outlet supplied.

B.2. EUROC LAUNCH PAD

In the EuRoC Launch Pad teams will find the following basic support equipment:

- 1-phase 230 VAC CEE 7/3 “Schuko” power outlet at each launch rail;
- 3-phase 400VAC IEC 60309 (16A) power outlet at each launch rail; • Two light towers for working after dusk, are expected to be available.

Note: Teams must bring their own extension cables and socket rails/cable drums, etc, to be able to use the power outlet supplied.

APPENDIX C: LAUNCH DAY ESSENTIALS

C.1. PLANNING

“Plan the Flight, Fly the Plan” is what makes a successful launch day. All the launch processes must be known in detail and proper checklists will speed up the procedures and ensure nothing is missing.

All tasks and respective responsible must be clearly defined, so everyone know what their responsibilities are and who is doing what, when and where. Schedule a plan with (indicative) time and locations, to guide the team throughout the day.

Table 5: Checklist example.

T-24h Procedure			
Location: Paddock			
To be done the day before launch day.			
1.0	TASKS	D ONE?	RESPONSIBLE
1.1	Confirm SD cards are formatted and clear for onboard cams.		Camera Deputy
1.2	Perform full balance charge on 2S LiPo.		Electronics Deputy



1.3	Perform full balance charge on 3S LiPo.		Electronics Deputy
1.4	Fully charge 1S LiPo for AIM XTRA.		Electronics Deputy
1.5	Fully charge 1S LiPo for EasyMega.		Electronics Deputy
1.6	Remove all upper panels.		Flight Director
1.7	Remove aft cone.		Flight Director
1.8	Remove bottom 3 panels.		Flight Director
1.9	Verify flight software is uploaded to Stack flight computer.		Software Deputy
1.10	Install flight fins.		Flight Director

C.2. LAUNCH SITE INFRASTRUCTURE

In the teams' preparation and mission control area, field tents will be provided to the teams. These will include electricity, lighting, tables, and chairs. In the pyrotechnics preparation area, there will be a pyrotechnics storage truck and field tents to prepare the solid motors and recovery system energetics, including electricity, lighting, tables, and chairs.

The launch pad is rectangular with an approximate dimension of 125 m x 20 m, providing enough space to place both EuRoC and team provided launch rails. Electricity (both 1-phase 230V and 3-phase 400V) and lighting will be provided, however the total power at the launch pad is limited and teams should indicate their individual power needs prior to the event.

About 60 m to the side of the Launch Pad Area, a gas bottle storage will be setup, however space is limited, and the teams should indicate their storage needs prior to the event.

C.3. ENVIRONMENT

Santa Margarida Military Camp features an extremely dry and dusty environment. Most of the terrain is uneven and hilly, with overgrown dry vegetation and a light forest towards the launch corridor.

The wild fauna of this dry area is composed mostly by insects and birds, with the occasionally appearance of foxes. There are also some dangerous animals, namely ticks, scorpions and salamanders, that despite not so common still require attention and carefulness.

Regarding the weather conditions, the launch site area offers no shade in the field, making the sun exposure continuous while walking and working outside the tents. The sunlight during October is still strong with high intensity UV radiation.

Typical temperatures in Santa Margarida in October are in the following range:

- Average low 12°C (min 7°C);
- Average high 21°C (max 30°C).

Details can be found on the [Portuguese Institute for Sea and Atmosphere](#) (IPMA) website.



C.4. COMMUNICATION AND VISIBILITY

The communication between the teams and EuRoC organization should be made, preferably, through the Team Leader or an assigned Point of Contact, who should visibly wear the identification provided.

The Point of Contact must know who needs to reach, as different people can help with different matters. All communication regarding teams' status is always welcome, if the team is ready earlier, running late, needing something, or having concerns, no matter what, communicate the team status to the organization.

Be on time at the morning briefing, as this is the most adequate moment for communication before operations start.

Emotions are flying high during launch day, especially when the team is stressed, stay respectful and helpful towards other teams and the organizers.

C.5. RADIO COMMUNICATION AND FREQUENCIES

All teams are encouraged to obtain a number of decent quality license-free PMR radios for internal team communication, communication with EuRoC staff/mission control, ad-hoc coordination, etc.

A suitable supply of expendable spare batteries or battery chargers is highly recommended.

C.6. CLOTHING & BASIC NEEDS

All team members are encouraged to come prepared with a suitable "field/day pack", which is kept close at hand (or worn) during launch days.

Due to the unpredictability of the weather in October, teams are highly encouraged to check the weather forecast before departing to Portugal. Despite that, teams shall come prepared for all eventualities, being it strong sunlight and high temperatures or heavy rain and low temperatures. Below you can find some provisions intended to get teams through a EuRoC day or to enable teams to continue efficient operation after loss of daylight.

- Sunscreen, sunhat/umbrella and sunglasses;
- Practical footwear for both dirty and muddy conditions;
- Drinking water. Please note that there is no accessible water at the launch rails, nor mission control;
- Snacks, biscuits and other non-perishable energy supplements;
- Headlamp/head-torch;
- Backup clothing, covering exposed arms and legs. Even during warm weather after loss of daylight it may result in a sudden and significant drop in ambient temperature. Also, coverage of arms and legs is recommended for the recovery operations that might take place in thorny terrain.



C.7. PERSONAL PROTECTION EQUIPMENT

All teams must bring any Personal Protection Equipment (PPE) required for all preparation and launch activities. EuRoC does not have a supply of spare PPE. PPE includes, but is not limited to, safety goggles, gloves, safety shoes, hardhats, ear protection, cryo-protection, etc.

C.8. EQUIPMENT TRANSPORTABILITY

All the equipment brought to the event is under each team's responsibility, meaning that all equipment brought to the event must also travel back with the team.

The launch pad is located 650 m away from the other event areas and can be reached via a dirt road, however this road is only open to teams' vehicles prior to and after launch operations and closed to teams' vehicles during operations. Therefore, teams should be prepared to gap this distance by foot.

All heavy equipment and transportation boxes should be designed/upgraded to be easier to transport on the dusty and uneven terrain of Santa Margarida Military Camp.

C.9. EQUIPMENT RUGGEDIZATION

All teams are encouraged to upgrade the equipment to endure harsh environments. Dust and shockproof electronics are highly advised to work on the launch site, as the fine powder will find its way onto any device and to ensure the equipment can absorb any potential fall or hit.

All mechanisms as joints, hose connectors, gears, etc., are also subject to dust and their maintenance should be adapted to this environment. Make sure everything is cleaned before connecting parts and for parts lubrication use dry lube instead of grease if possible.

C.10. SELF-SUFFICIENCY

All teams must bring the necessary technical equipment for the respective project. This includes everything from tools, electronic and electrical equipment to other specific solutions for their project's needs (e.g., a cooling chamber for gases, power strips and extensions). Every phase of the competition requires specific tools, from preparation to recovery. Planning each phase separately will help teams to not miss a thing.

Be prepared for the unexpected, all equipment and tools brought to the competition should be planned in advance. Smart packing and packing lists are highly encouraged.

