

# **Anatolian Rover Challenge**

2025 Manual



## Version Information

This file, ARC'25 Manual v.3, is the latest released version of ARC'25 manuals.  
For the planned updates, check Change in Rules and Delivery Dates.  
Written by the ARC Committee. Digitally distributed.

## Changelog

ARC'25 Manual v.1 release date: 15.12.2024.  
ARC'25 Manual v.2 release date: 15.01.2025.  
ARC'25 Manual v.3 release date: 15.02.2025.

## Information Channels and Contacts

The ARC website is the main source of information on the event.  
Questions about the rules can be submitted via the ARC website.

**The ARC Website:** [www.anatolianrover.space](http://www.anatolianrover.space)

**The ARC Mail Address:** info@anatolianroverchallenge.com

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# 1. Introduction

Anatolian Rover Challenge is an annual international rover challenge. In the scope of the challenge, the teams of students that are affiliated by academic institutions try to achieve the determined missions by their own "planetary exploration robots" called rovers. Teams must design, manufacture, and equip their rovers with the necessary abilities to complete all missions. The ARC event aims to create an opportunity for teams to show their abilities in solving difficult engineering and scientific problems.

The student teams that apply for the challenge go through a design report and video presentation process. After the evaluation, teams that qualify for the finals are announced and invited to participate in the field evaluation that takes place in Türkiye.

The finals are held in the carefully designed open field that is 40 meters in diameter and designed to resemble the surface of Mars and the Moon. During the finals, teams perform four mission scenarios. Scores are determined by judges based on score tables. ARC starts with a meetup day, followed by three days of competition, and ends with an award ceremony.

ARC awards are unique! In ARC'24, the winning team awarded a series of test runs at the moon regolith simulator of SpacePort Rostock, Germany. It provided an opportunity for the team to test in real conditions of harsh Moon dust, challenging their rover engineering to the limits! Meanwhile, ARC'23 offered the winner a launch to space! Team's photo now decorates the walls of the International Space Station as part of a commemorative postcard. On January 17th, 2024, Türkiye's first astronaut, Alper Gezeravcı, carried the postcard to the ISS during his Ax-3 mission. For more details about this mission and the competition, visit the ARC website. Godspeed!



ARC'23 Award: Postcard of Winner Team launched to International Space Station



ARC'24 Award: Test opportunity at Moon Surface Simulator at Spaceport Rostock



## 2. General Information

Anatolian Rover Challenge (ARC) 2025 will be held in July 2025. The challenge is organized by the ARC Organizing Committee (or the ARC Committee), which is a subcommittee of the Space Exploration Society (UKET) that was established to contribute to space studies in Türkiye.

### 2.1. Descriptions

**Supreme Board of Judges:** The responsible committee for the examination and scoring of the reports and missions throughout the challenge, which is established on transparent principles, with international participation.

**Organizing Committee/Organizer/The ARC Committee:** The ARC Organizing Committee is a subcommittee of the Space Exploration Society (UKET). It is the committee that conducts and manages all the organizational processes of the Anatolian Rover Challenge.

**Team:** A group of students affiliated with an academic institution who applied for the challenge. Each team must consist of at least two members and an academic advisor.

**Team Leader:** The responsible person for matters related to the team and the rover.

**Team Member:** A team member must be over 18 and a university student of all levels. Members can take part in only one team.

**Advisor:** The person with an academic title that guides the team.

**Prohibited Substance:** Substances that affect self-control, team members, and the rovers, such as alcohol, drugs, all kinds of weapons, etc.

**Finals:** The on-stage challenges (explained in the **Missions** section in detail) that are held in Türkiye. Only qualified teams (finalists) can participate in the finals. Teams that are not eligible for the finals or curious are encouraged to experience the challenge as visitors.

### 2.2. Participation Conditions

1. The application for the challenge is required to be submitted electronically using the online application system at the [Apply ARC | Anatolian Rover Challenge](#) address.
2. It is obligatory to participate in the challenge as a team; individual applications will not be accepted. There can be more than one team from a single institute.
3. In case of any changes in the information given in the application, the teams must notify the Organizing Committee.
4. Each team is required to have a Team Leader and an Advisor, whose descriptions are given in the **General Information** section.
5. The deadlines for the reports and events are specified in the challenge calendar. The Organizing Committee reserves the right to change the calendar.
6. Only the team members must be the authors of all the required documents that will be submitted.
7. An academic advisor is required for all teams. The teams may have more than one academic advisor.



## 2.3. Calendar

### 2.3.1. Milestones

An up-to-date calendar of the challenge and important dates is shown in the table below. The versions of the ARC Manual differ in terms of a few additional details. The missions will remain intact.

Date	Event
15.12.2024	Release of the ARC'25 Manual v.1
15.01.2025	Release of the ARC'25 Manual v.2
15.02.2025	Release of the ARC'25 Manual v.3
15.02.2025	Beginning of the Application Submission
01.03.2025	Beginning of the Report Submissions
15.03.2025	Early Application Due Date
16.03.2025	Beginning of the Late Application
15.04.2025	Report Submissions Due Date
15.04.2025	Late Application Due Date
20.05.2025	Announcement of the Finalists
01.06.2025	The last release of the communication protocol
23.07.2025	ARC'25 Orientation Day
24.07.2025	ARC'25 Day 1
25.07.2025	ARC'25 Day 2
26.07.2025	ARC'25 Day 3
27.07.2025	ARC'25 Award Ceremony

### 2.3.2. Details

1. The deadline for applications is the same as the report submission due date. After this date, applications will be invalid and will not be considered. Teams that apply early may be given priority in the challenge day timetable.
2. Registration for the finals will be performed on-site on the stated dates.
3. On the closing day, the teams' total scores will be calculated and announced, and awards will be given to the top teams.





4. The Organizing Committee will announce the first version of the timetable, which includes the exact time slots for each mission one week before the event. The final version will be announced on the first day of the challenge.
  - a. Each team is responsible for complying with this timetable. The Supreme Board of Judges reserves the right to reject any request for change in the challenge day timeline.

## 2.4. Emergency Handling

1. Necessary precautions and disaster plans have been made for the safety of the teams and the challenge area. Teams are expected to comply with the safety instructions from the ARC committee on site.
2. In case of any injuries, the first aid will be made by paramedics, and if necessary, the injured person will be sent to the nearest hospital by ambulance. By applying, teams agree to the ARC committee's emergency procedures.

## 2.5. Challenge Fee

The early submission fee is 125 US Dollars, which should be paid by 15.03.2025. For the applicants who submit their fee after this date until the last day of submission of applications, which is 15.04.2025, the late submission fee is applied, which is 150 US Dollars.

After the finalist teams are announced, teams that qualify for the finals must pay the challenge fee of 125 US Dollars. The payment details will be specified on the website.

## 2.6. Questions and Answers

A frequently updated Questions and Answers section is provided on the website. Teams are encouraged to ask questions through this section. The Q&A section overrides the ARC Manual. In addition, teams can also use the forum page (<https://www.anatolianrover.space/forum>) on the website to share with each other.

## 2.7. Change in Rules and Delivery Dates

The Organizing Committee reserves the right to extend the deadline for document submissions and make necessary but unavoidable corrections to the challenge regulations at any time. Teams are obliged to check the challenge website for any changes. Major changes in rules are stated through the versions of the manual:

- 15.01.2025 – the ARC Manual Version 2 (v.2.)
- 15.02.2025 – the ARC Manual Version 3 (v.3.)



## 2.8. Finalists

The finalist teams will be selected by the judges based on the reports submitted by the teams. Final qualification scores are calculated by combining Design Report and Video Presentation Score. The finalists will be announced on the date specified in the schedule.

## 2.9 World Rover League

The World Rover League (WRL) is a global space robotics league for university students, including all competitions and teams in the world to date organized by SPROS and UKET, in which teams conceptualize, design, develop, and operate an astronaut-assistive next-generation planetary rover in simulated conditions. ARC22-ARC25 scores will be listed on the WRL rankings on ARC website.



### 3. General Rules

The general rules are listed below:

1. All the teams present in the on-site challenge will be given a certificate of participation.
2. Rewards will be given according to the ranking of the scores collected from missions.
3. The academic advisor's job is to help students plan their projects, guide them academically, and support them mentally and emotionally. The awards to be given at the end of the challenge are only for the team members.
4. The teams are obliged to show the expected care for their surroundings and other teams while competing.
5. The "Waiver Form" will be read and signed by each team member before the challenge during the registration.
6. All team members are obliged to comply with the rules specified in this specification. If non-compliance is observed by the Organizing Committee, the relevant situation will be brought to the attention of the Supreme Board of Judges. As a result of the evaluation of the Supreme Board of Judges, individuals or teams may be disqualified from the challenge.
7. During the entire event, no rover or any part of the system of the rover may damage or interfere with other teams' systems. Any reports of such violations will be investigated independently by the judges or organizers, and any violation of this rule may result in the team's disqualification from the challenge. The Organizing Committee will not be held responsible for any of the damage caused to teams' systems.
8. Teams and members are fully responsible for any damage, accident, situations, events, etc., caused by their hardware/software. All the precautions and rules declared by the Organizing Committee must be strictly followed. Any violation of safety regulations and standards will result in the disqualification of the team from the challenge.
9. The use of any Prohibited Substance during the challenge is prohibited and constitutes a crime under the laws of Türkiye. Persons/teams who use and disturb the environment will be disqualified from the challenge.
10. In case of a dispute regarding the challenge, the decision of the Supreme Board of Judges will be considered binding.
11. In case of violation or cheating of the rules or specifications, judges will take action.
12. Teams must comply with the directions and instructions of the Judges/Organizing Committee.



## 3.1. Rover Design Requirements

To participate in the challenge, the general requirements specified in this file must be met. Teams have to indicate in their technical reports that they meet these requirements. In exceptional cases where teams are unable to meet the general requirements, they should contact the ARC Organizing Committee via website or e-mail before submitting the technical report. In the case of any violation in requirements, the organizer has the right to remove the team from the challenge.

### 3.1.1. Weight Limitation

The weight limitation applies only to the rovers and does not include fixed antennas, computers, and other equipment. The rover will be weighed at the start of each mission.

1. The rover's weight with installed systems should not be more than 60 kilograms.
2. Rovers over 60 kilograms will receive 5% penalty points for each kilogram weighing more than 60 kilograms.
3. The total weight of the rover and installed mission-specific hardware in all missions combined must not exceed 80 kilograms.

### 3.1.2. Size Limitation

The size limitation applies to the rovers including installed systems. The missions of the challenge are designed for a 1.5m x 1.5m x 1.5m vehicle, with at least 30 degrees of slopes, the large-scale rovers might not pass the expected passages in the missions, and might not complete the missions. If a rover cannot exit/enter the airlock, it can start from outside of the airlock for a 30% penalty, see **9. Evaluation**.

### 3.1.3. Cost Limitation

The total cost of the rover systems cannot exceed 20,000 US Dollars (see Cost Report).

### 3.1.4. Design Advice

Rover should be designed by considering the climate and environmental conditions of the region where the challenge is held. Any damage that may arise from environmental conditions is the responsibility of the relevant team. During the missions, rovers will work in the open field, and the challenge plan may be rescheduled in very windy, rainy, or foggy weather conditions. It is the teams' responsibility to design or maintain their vehicles and equipment in such a way that they will not be affected by environmental conditions during or before the challenge.

The challenge fields will be prepared by taking the surfaces of the planets on which the scenarios take place as examples. It is recommended that rovers be designed to perform the



missions given in ground conditions such as gravel, either loose or hardened soil, and fine particle sand. There will be cratered or sloped sections in the field.

Standard European type 220-230 V 50 Hz AC F type sockets will be provided to the teams at the bases. In addition, facilities such as tables, chairs, and extension cables will be provided at the base. Teams are encouraged to bring power plugs.

### **3.1.5. Rover Safety**

#### **3.1.5.1. Activity Light**

Rovers should be able to show their operational status to judges in proximity by turning a light green when remotely controlled, yellow when autonomously controlled, and red to indicate disarm. If the activity light is not turned on during the missions, the rover incurs a 10% penalty.

#### **3.1.5.2. Emergency**

Rovers must not cause electrical, thermal, or mechanical harm to people who might want to stop it or to the people around them. Teams are liable for damage caused by their rovers and activities while on and off the mission.

1. A red emergency button with a diameter of at least 3 cm should be available on the rover, and this button should be kept in a visible place; vivid colours like red or yellow are preferred. Otherwise, the teams will not be allowed to start the mission. The emergency button must stop the transmission of power to all the rover's moving systems. The rovers without an emergency button are subjected to a 5% penalty.
2. There is no limitation on the rover's cruising speed. Apart from the mission, the relevant teams must control their rovers, taking into account the safety of the living beings in the challenge area.

#### **3.1.5.3. Use of Flammables-Explosives**

When teams want to use pyrotechnic systems, they must contact the judge before the challenge and provide the associated MSDS documents.

### **3.1.6. Communication Equipment Usage**

Teams can communicate between the rover and the base using a radio link. It is necessary for the success of the challenge missions that the communication systems of the teams cover the challenge area.

In the challenge area, teams will set up their equipment in the base. They can place the antenna outside so that their communication equipment is next to the base. Teams will be settled in the bases, so at least 10 meters of cable will be needed for their communication antennas.



Teams will be shown a certain area near the base to put their antennas. Antenna masts cannot exceed 3 meters in height, and the area might not be supportive of masts that are not strongly anchored, as they are composed of loose soil.

During the challenge, teams are free to choose communication bands and equipment. For this reason, planning should be done, considering the field can be approximately 40 meters in diameter. It is recommended that the communication equipment can work in the same environment as the surrounding wireless devices.

During the challenge, the equipment can be used by the law numbered 5809 of the constitution of the Republic of Türkiye. For the frequency bands available for use, the table below is recommended to be examined.

<https://www.btk.gov.tr/uploads/pages/milli-frekans-plani.pdf>

It is the team's responsibility to operate the communication systems within the legal power and frequency limits.

### 3.1.7 Rover Technical Check-in

Technical check-in will be conducted on orientation day (the day before the missions). The rover must have the following features during team check-in. The judges will inspect the rover. This also helps the teams to check rovers before the mission day. The rovers must fulfill the technical check-in requirements :

1. The rover should move at least 5 meters, do a 360 turn and push a button on a panel.
2. The rover has an indicator light that works as stated in all modes.
3. The rover has a vertical cylinder 2-3 cm in diameter at least 1 meter above the ground level to attach the Mission Module via a provided bracket.
4. The rover shows it can be stopped remotely over RSCP communication
5. The rover shows it has an emergency button at least 3 cm in diameter on the rover.
6. The rover has to fit inside and be able to leave the airlock on its own.

### 3.1.8 ARC Equipment Mount

The rover must have a pipe as the connection point for **ARC Rover Mission Camera** and **RSCP Module**. The ARC Equipment Mount should;

1. Top and Front sides are mostly open, not fully obstructed by the rover parts.
2. The Pipe should be 25 mm in diameter and at least 10 mm long.
3. The Pipe must be able to carry at least 1 kg of load.
4. The pipe must be horizontal and at least 1 meter high from the ground.



## 3.2. Penalty Conditions

People or teams that do not comply with the conditions specified in the General Rules and Ethical Rules will be evaluated by the Supreme Board of Judges. If deemed necessary, individuals or teams are asked to defend themselves. As a result of the evaluation, penalties such as deduction of points, failure of the mission, or disqualification from the challenge may be given. On non-compliance, the Supreme Board of Judges can deduce the scores of the team.

## 3.3. Objection Process

1. The pre-challenge objection process works as follows:
  - Before the challenge, address venue or rules concerns in writing via the specified website; report evaluation objections should be submitted in writing to the Organizing Committee via the provided email, and the Organizing Committee will forward these to the Supreme Board of Judges for examination.
2. During the challenge, the objection process works as follows:
  - a. Teams are allowed to object to the decisions taken by the judges for review by the Supreme Board of Judges, consisting of all judges.
  - b. Video recordings taken by the Organizer during the challenge preparation and mission are used as evidence for objections.
  - c. Each team has a maximum of 3 objection rights.
  - d. Objections including possible proof must be delivered by the team leader via an email to the address: **rules@anatolianroverchallenge.com**.
  - e. The Supreme Board of Judges will announce the results of the objection evaluation at the latest before the challenge award ceremony.
  - f. Any questions during the challenge will be addressed by the relevant judge. Teams can not object to a third person.

## 3.4. Ethics

1. Any kind of inappropriate behavior will be noted by the Organizing Committee and related authorities will also be informed immediately if necessary. These behaviors can be summarized as follows;
  - a. Insulting, swearing, threatening, etc., actions against other teams, people, or organizations through social media or in the challenge area during the challenge period.
  - b. Physical, verbal provocation, etc., movements towards other competitors during the challenge.
  - c. Behaviors that may disturb other teams in and around the challenge area.
  - d. Being involved in fights in the challenge area.



2. Language, religion, belief, political opinion, race, age, and gender discrimination will not be tolerated in the challenge area, as well as behaviors and practices that may jeopardize equal opportunity.

## 4. Definitions

### 4.1. Challenge Area

The challenge takes place in two separate fields: Moon Field and Mars Field. The Mars Field is home to Science Mission and Night Mission, while the Moon Field is home to Autonomous Mission and Collaboration Mission.

### 4.2. Mission Fields

The areas where the missions will be performed in the challenge area will be referred to as the "mission field". During the challenge period, only the field crew of the relevant team, the rover of the relevant team, and the judges can enter the mission fields and interfere with the field and the rover. Besides, watching the mission fields while other teams are competing will not be allowed.

Mission fields will be overhauled for the next relevant team by the judges at the end of each mission. Judges can make changes to the field to ensure equality during the mission.

Weight and size checks are made near the field where the rovers begin their preparations for the mission.

There are two mission fields:

**Mars Field:** Includes Mars Base and resembles Mars surface by its color and features.

**Moon Field:** Includes Moon Base and resembles the Moon surface by its color and features.

### 4.3. Rover

Rover is a mobile device that can operate alone, without any wired connection with another system, and can be composed of various subsystems. The rover can only be commanded from the base or can move on its own (autonomous).

Each rover will have a unique license plate for identification provided by the ARC Organization Committee.

### 4.4. Bases

There are two base replicas in the challenge area, one on each mission field. Competing teams will control their rover within the bases during the missions.

They are closed areas that are located in the mission field and connected to the rest only by an "airlock". Only the base crew of the relevant team and the judges can enter the base. The





base crew can only control the rover remotely (via remote-wireless connection). During missions, the base crew will not be able to see the rover directly. The relevant team must install the necessary equipment and antenna connections to the base to control the rover before starting the mission. Before each mission, teams will be given some specified time for preparation according to the challenge timetable.

## 4.5. Base Crew

It is a crew, formed by a selection of team members, that is the only authorized and responsible crew to remotely control the rover in the base. The base team cannot communicate with the outside except the rover and judges during the mission. The base crew starts and finishes commanding the rover by the judges' directions to accomplish the mission. During the autonomous driving stages, the base crew must comply with the instructions and the directions of the judges. The base crew may decide not to continue the mission.

## 4.6. Field Crew

It is a crew consisting of two selected members of the relevant team who will be responsible for carrying the rover at the field in the beginning of the Science mission or during the intervention. It is forbidden for the field crew to speak during their mission, except in emergencies and interventions. The field crew stays at the base without communicating with the base crew. In case of intervention, the field crew, equipped with the astronaut costumes, leaves the base, gets the rover, and brings it to the airlock.

## 4.7. Judges

The judges are the most authorized officials in the challenge. It is essential to pay attention to and follow the instructions and directions of the judges. During the challenge, there will be at least one judge at each of the places, like the base, the field, and around the challenge area. The judges are responsible for the organization of the challenge and guiding/assisting the relevant team.

## 4.8. Intervention

During the mission, only the base crew can decide to intervene unless there is an emergency situation in the field. In cases where the safety of the people in the field is at risk due to a malfunction in the rover, the judges may decide to intervene by pressing the rover's emergency button. Mission time will not be paused when intervention begins. When the team decides to intervene, they must inform the judges. Then, the field crew carries the rover to the airlock without communicating with the base crew. For each intervention, scores are deducted from the relevant team for that mission, as indicated in the Score Table. During a mission, the rover can be interfered with at most 3 times. When the 4th intervention is performed, it is assumed that the team has



decided not to continue the mission but is allowed to use the time remaining for testing purposes. As long as rovers drive and enter the airlock by themselves, the base crew can fix their rovers without getting an intervention. This does not count as an intervention.

## 4.9. Field Onboarding

The day before missions begin, judges will tour the teams in groups. Judges will explain each mission step to the team members and will answer their questions firsthand on-site.

## 4.10. Skipping

Teams can skip the steps they want by informing the judge. They are not penalized by time or scores for the steps they skip; in case of skipping, mission time will not be paused. If a team does not use their right to skip, they must take each mission step in order, without skipping. In case of a skip, the judge can make the necessary changes on the field and the rover, such as the arrangement of the position, so that the next mission steps are not adversely affected. While the judge makes the necessary changes, it is forbidden to touch or intervene in the vehicle by any team member, and it is going to be considered intervention unless specified in the rules. The skipping rules specific to missions are as follows:

**Science Mission:** Skipping applies. The teams can decide to try the skipped step again.

**Night Mission:** Each step can be skipped. However, if a step is skipped, it cannot be retried.

**Autonomous Mission:** Each step can be skipped. However, if a step is skipped, it cannot be retried.

**Collaboration Mission:** Skipping rules applies to Sensor Task. Rest of the steps can be retried until the team completes it.

## 4.11. Field Dimensions

Mars Field and Moon Field are approximately 40 meters in diameter. Both sites have a circular shape. Coordinates of the center point of the fields will be provided before the missions.

## 4.12. Coordinate System

EGM96 coordinate system, and (Lat: dd.dd., Long: dd.dd. Altitude: meters) format will be used when locations are given or requested. Ex: (41.100276, 29.020975, 53.96).

## 4.13. Border Violation

If the rover goes off-site, the intervention rules apply, and the field crew brings the rover back into the field. Teams will be provided with center coordinates of the two fields and highly encouraged to implement fencing algorithms.



## 4.14. Criteria for “Reaching Target”

Measurements will be used to score points in mission steps that include expressions such as “goes/returns near the target”. The distance between the outer surface of the target object and the rover’s closest point to this surface is measured. If it is less than the requested distance (2 meters for Autonomous Mission and 1.5 meters for remaining unless otherwise stated), the rover is considered to approach or arrive. For example, to go near/reach the base, it is accepted that there is a part of the rover within the specified distance from the outer surface of the base.

## 4.15. Mission Module

The mission module consists of a 360-degree camera and an RSCP communication module. This module will be connected prior to each mission. Make sure to have a long enough RS-232 cable with a D9-SUB connector to connect the module.

# 5. Documentation

## 5.1. Application Form

Every team must complete the challenge application form on the official ARC website. Teams must provide team information that includes “team name”, “list of the team members”, and “the contact information of the team leader and the team advisor” to the Organizing Committee. Teams that do not present the complete team information before the design report submission is due will not be allowed to participate in the challenge. After the application is completed, all team members must join the ARC Community Discord server. During the competition, all communication will happen through Discord (See [discord.com](https://discord.com)).

## 5.2. Reports

### 5.2.1. Design Report

To become a finalist and participate in the challenge, the candidate teams must report their work and electronically send the report together with the video they prepared, as specified on the challenge website, within the dates specified in the challenge calendar. The Design Report will be uploaded for public view after finalists are announced. The report must be prepared using the template provided on the ARC website. Expected contents and scoring parameters are stated in the Score Table. This score, combined with the video presentation score, will be used to rank the teams to select finalists.



No	Title	Description	Detail	Score
1	Team Info	Team Name	Name of the team and, if applied, name of the rover.	1
2		Contact	Contact information and social media links of the team	1
3		Academic Institution	Name and address of the affiliated academic institution.	1
4		Academic Consultant	Name, affiliated academic institution, and contact information of academic consultant.	1
5		History of the team	A paragraph of team history including foundation date, attended competitions, and experience.	5
6		Active Members List	A table of active members including the following information: Name (or initial letters), University Major, and duty in the team.	2
7		Team Photo	A photo/screenshot of the whole or part of the team.	1
8	Management	Work Calendar	Explain the work on the project using a Gantt chart. Include 10-15 items in the Gantt chart.	10
9		Team Formation	How is the team workforce structured? (2-3 sentences) Include a graphic to explain the structure as well.	5
10		Workplace	How does the team design, build, and test the rover physically? Explain the workplace. (2-4 sentence) Include a photo/screenshot of the workplace.	3
11		Funding	How much are the project funds at the time of submission of this document?	2
12			How much spending is expected for the development costs? How much spending is expected for the travel costs?	2
13			What is the team's plan in an insufficient funding situation by the competition date?	2
14		Logistics	What is the team's plan to package and bring the rover to the competition site by July? (4-6 sentences)	4
15	Rover Design	Mobility system	What is used? Describe the system (3-5 sentences)	10
16			Why is the system chosen? What are the considerations? What are the weaknesses and strengths? (3-5 sentence)	
17			Unique points and inspirations (3-5 sentences)	
18			Visuals of the system (2 photos/screenshots), 3D model of the rover should be provided	
19			Technical Specifications, including mass and size (3-5 sentences)	
20			Discuss the system's adequacy for its role in competition	



			missions. (3-5 sentences)	
21	Electronics and power system		What is used? Describe the system (3-5 sentences)	10
22			Why is the system chosen? What are the considerations? What are the weaknesses and strengths? (3-5 sentence)	
23			Unique points and inspirations (3-5 sentences)	
24			Visuals of the system (2 photos/screenshots)	
25			Technical Specification,s including mass and battery duration (3-5 sentences)	
26			Discuss the system's adequacy for its role in competition missions. (3-5 sentences)	
27	Manipulation system		What is used? Describe the system (3-5 sentences)	10
28			Why is the system chosen? What are the considerations? What are the weaknesses and strengths? (3-5 sentences)	
29			Unique points and inspirations (3-5 sentences)	
30			Visuals of the system (2 photos/screenshots)	
31			Technical Specifications, including mass, max payload, and size (3-5 sentences)	
32			Discuss the system's adequacy for its role in competition missions. (3-5 sentences)	
33	Science Payload		What is used? Describe the system (3-5 sentences)	10
34			Why is the system chosen? What are the considerations? What are the weaknesses and strengths? (3-5 sentence)	
35			Unique points and inspirations (3-5 sentences)	
36			Visuals of the system (2 photos/screenshots)	
37			Technical Specifications including mass and sensors (3-5 sentences)	
38			Discuss the system's adequacy for its role in competition missions. (3-5 sentence)	
39	Ground station equipment and communication system		What is used? Describe the system. (3-5 sentence)	10
40			Why is the system chosen? What are the considerations? What are the weaknesses and strengths? (3-5 sentence)	
41			Unique points and inspirations (3-5 sentences)	
42			Visuals of the system (2 photos/screenshots)	
43			Technical Specifications including resilience to noise and communication range (3-5 sentences)	



44			Discuss the system's adequacy for its role in competition missions. (3-5 sentence)	
45		Software System and Architecture	What is used? Describe the system. (3-5 sentence)	10
46			Why is the system chosen? What are the considerations? What are the weaknesses and strengths? (3-5 sentence)	
47			Unique points and inspirations (3-5 sentences)	
48			Visuals of the system (2 photos/screenshots)	
49			Technical Specifications including connections, protocols, speed of processing (3-5 sentences)	
50			Discuss the system's adequacy for its role in competition missions. (3-5 sentence)	
<b>TOTAL</b>				<b>100</b>

### 5.2.2. Video Presentation

Participating teams should prepare a video in which they show their rover's readiness for the challenge. The video link must be uploaded to the challenge website together with the reports at the latest on the report submission date. The video must be shared by the participating team publicly on YouTube. The purpose of the video is to show the team and the rover's compliance with the challenge regulations and how ready they are to obtain scores from the missions. The judges will score the uploaded videos according to the criteria stated below. **The suggestion of the ARC Organization Committee for the content duration is 6 minutes, and it can be up to 10 minutes.** Additionally, teams must add timestamp markers in their YouTube video descriptions to indicate key sections. Recommended content in the video and scoring is stated in the table below. Also, the rovers in the video must fulfill the requirements in the **3.1.7 Rover Technical Check-in** and **3.1.8 ARC Equipment Mount** sections. Video Presentations from previous challenges can be found on the ARC Website's "Participants" section.

No	Title	Description	Detail	Score
1	Team Info	Team Name	Name of the team and if applied, name of the rover.	8
2		Academic Institution	Name of the affiliated academic institution.	
3		History of the team	The team's history including foundation date, attended competitions, and experience.	
4		Team Visual	A photo/screenshot/video of the whole or part of the team.	
5		Astronaut	What is your team's training plan for your astronauts?	



6	Management	Workplace	How does the team design, build and test the rover physically? Explain the workplace.	2	
7	Rover Design	Mobility system	What is used? Describe the system.	6	
8			Technical Specifications including mass and size.		
9			Why is the system chosen? What are the considerations?		
10			Visuals of the system to show mechanisms.		
11			Demonstration of the system with ARC'24 mission objectives in mind.		8
12			What is used? Describe the system.		4
13		Technical Specifications including mass and size.			
14		Why is the system chosen? What are the considerations?			
15		Visuals of the system to show mechanisms.			
16		Demonstration of the system with ARC'24 mission objectives in mind.	6		
17		Manipulation system	What is used? Describe the system.	6	
18			Technical Specifications including mass and size.		
19			Why is the system chosen? What are the considerations?		
20			Visuals of the system to show mechanisms.		
21			Demonstration of the system with ARC'24 mission objectives in mind.		8
22			What is used? Describe the system.		6
23		Technical Specifications including mass and size.			
24		Why is the system chosen? What are the considerations?			
25		Visuals of the system to show mechanisms.			
26		Demonstration of the system with ARC'24 mission objectives in mind.	8		
27		Ground station equipment and communication system	What is used? Describe the system.	4	
28			Technical Specifications including mass and size.		
29			Why is the system chosen? What are the considerations?		



30			Visuals of the system to show mechanisms.	
31			Demonstration of the system with ARC'24 mission objectives in mind.	6
32		Software Architecture	Detailed flowchart of the software systems	8
33		Whole Rover	Demonstration of the system with ARC'24 mission objectives in mind.	10
34	Video Clarity		Quality of the content and presentation	10
<b>TOTAL</b>				<b>100</b>

### 5.2.3. Science Report

The Mars field will be designed based on the Solis Planum (33°S, 271°E) on the surface of Mars. From the given Mars coordinate, a scientific question should be determined and investigated. This hypothesis should be explained in the science report. A landing point on the given challenge area sketch should be specified to test the hypothesis. This landing point is the position where the relevant team's rover will start the Science Mission during the challenge. While determining this starting point, two essential points should be considered. The landing point should be coherent with the scientific hypothesis as well as it should be a suitable terrain for the rover to drive.

The Mars field sketch representing the given coordinates will be shown in the Science Report Template. The teams should interpret the structures on the sketch based on the orbiter images of the Solis Planum and by reviewing the literature. The selected structures from the Solis Planum indicated in the sketch will exist on the Mars field during the ARC finals. The structures in the Mars field will not be scaled versions of the real structures in the Solis Planum. It should be noted that the maximum depth or height of the structures in the area can reach 2 meters, and the slopes of the structures can be 30 degrees.

The report should also include which experiments were selected to check the scientific hypothesis that was determined. These experiments should be significant in terms of checking the scientific hypothesis. Randomized experiments that do not contribute to the scientific hypothesis will not yield scores.

In this report, teams should indicate which scientific hypothesis they will test at the designated area, what kind of sample they aim to collect, what experiments are planned to be performed on the sample, and what is expected to be found as a result of these experiments. The hypothesis planned in the science report should be taken into account during the challenge. The points of the Science Mission will be affected by the Science Report. Following a hypothesis different from the one stated in this report during the challenge will result in a score break. The report must be prepared using the template provided on the ARC website.





### 5.2.4. Cost Report

Teams are obliged to write a report on the cost of their rover. The total cost of the rovers cannot exceed 20000 US Dollars. The cost report template will be shared with teams on our website. All the details on the template should be fulfilled by the teams, and there should be at least 30 expense items of the rover. All the provided information must be provable with official documents on the challenge day upon request. The financial report is mandatory for participation in the final stage of the competition. In addition, the reports will be scored, and the team with the best report will be awarded.

### 5.2.5. Technical Collaboration Presentation

The teams must prepare a presentation for their approach on the collaboration mission. This presentation should detail their approach to the task, the criteria they use for selecting their astronauts, the readiness of their rover for the mission, the communication methods they plan to employ with their team members in ground control, and the teams they will collaborate with as well as the details of this collaboration. Teams will select and train an astronaut (see **7.1.4. Collaboration Mission**) to fix rover problems alone. Presentation should include the team's approach to their training program. The presentation must be prepared using the template provided on the ARC website. The presentation will be a part of the mission score (see **7.1.4. Collaboration Mission**).

Teams will present their Technical Collaboration Presentations on the competition day.



## 6. Background of the Missions

### 6.1. Mars Story

In the vast expanse of Solis Planum, Mars, researchers face a challenge to unlock the region's secrets. From capturing panoramic images of landscapes to analyzing subsurface samples, the Science Mission invites teams to explore their hypotheses about Martian science. The mission tests their creativity and technical skill by diving into the planet's surface.

As darkness falls, the teams must navigate rugged terrain to retrieve and power up WISE (Water Ice Subsurface Extractor) and ensure its operation. Then, the rover moves WISE in place to excavate the Martian subsurface water ice. Upon reaching the intended location, the rover goes back to bring the power unit that has depleted. The rover then returns to base, waiting for the good news, namely "water". With precision at every step, this challenge presents a real-world planetary exploration, inspiring a new era of scientific discovery.

### 6.2. Moon Story

The first permanent lunar base region began to be established through the collaboration of various space agencies. The mission involved setting up an antenna location to maintain communication, as well as researching potential fuel sources for spacecraft. Autonomous robots were tasked with exploring suitable regions for the mission and investigating a lava tube. Once appropriate areas were identified, the necessary equipment was deployed.

Over the years, the base was expanded and eventually evolved into an international mission hub. Now, the lunar base requires maintenance and repair operations. These tasks necessitated the cooperation of robots from different space agencies. This mission marked a milestone as robotic systems from multiple nations worked together to fix problems. The successful collaboration of these diverse space agencies signaled the dawn of a new era in space exploration.

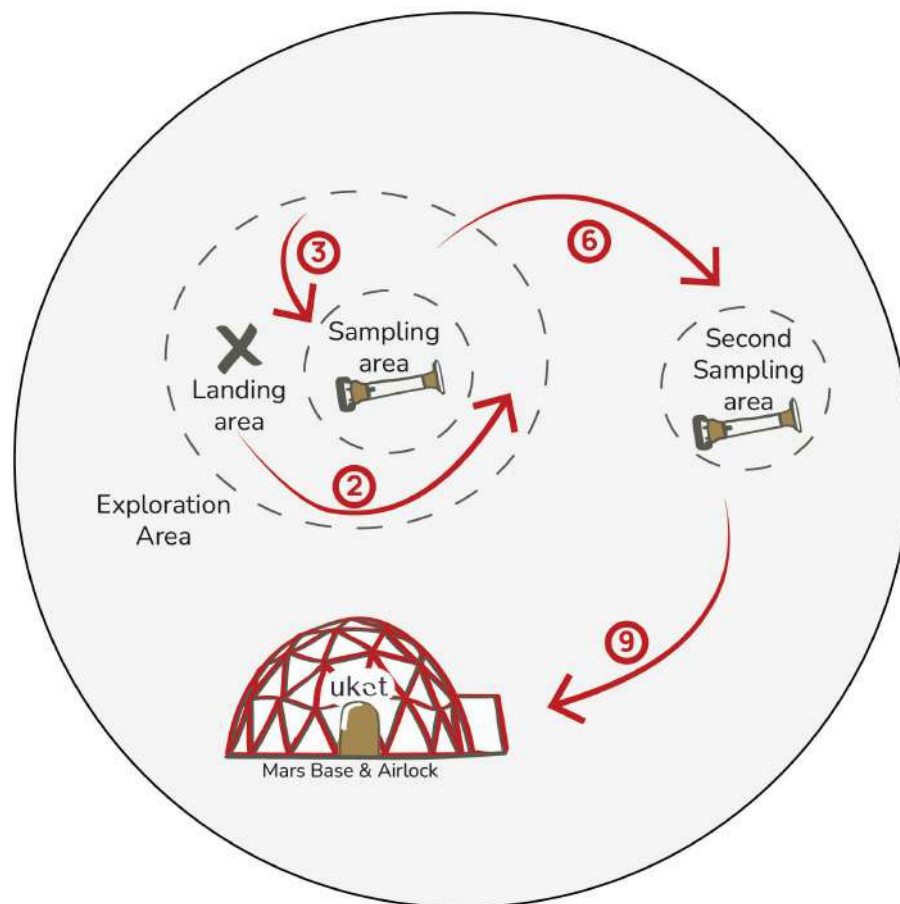
## 7. Missions

### 7.1. The Final Stage Missions

#### 7.1.1. Science Mission:

**Time Limit:** 30 minutes + 10 minutes + 10 minutes

**Mission Field:** Mars



#### 7.1.1.1. Steps

This mission consists of 3 main parts:

##### Part 1 | Landing & Exploration (30 min)

1. **Start at the landing area.**  
The landing area is identified in the science report by the teams.
2. **Survey the area.**



The rover should take panoramic/stratigraphic pictures. The purpose of this image is to observe all the structures in the area.

**3. Navigate to the sampling area and collect a sample.**

The first sampling area is the location indicated by the teams in the science report. The sample should be taken using a drilling system at a minimum depth of 5 cm and a minimum weight of 5 g.

**4. Conduct onboard measurements.**

Measurements must be recorded. If there is a system developed such as a spectrometer or an onboard experiment kit, that will be evaluated as onboard equipment. If a sensor mounted, that will be evaluated under onboard sensor category.

**5. Preserve the sample in a closed and sealed container.**

Samples that are in non-sealed containers will not be evaluated.

**6. Navigate the second sampling area.**

The second sampling area is identified on the sketch. The sample should be taken using a drilling system at a minimum depth of 5 cm and a minimum weight of 5 g.

**7. Conduct onboard measurements.**

Rover has to identify related chemical or physical properties of soil with an onboarded chemical or physical analysis method. Measurements must be recorded. If there is a system developed such as a spectrometer or an onboard experiment kit, that will be evaluated as onboard equipment. If a sensor mounted, that will be evaluated under onboard sensor category.

**8. Preserve the sample in a closed and sealed container.**

Samples that are in non-sealed containers will not be evaluated.

**9. Return to the airlock.**

The rover should navigate back and enter the airlock so that no part of it is left outside.

**10. Hand over the samples to the judges.**

During the delivery, the samples must be in a sealed container.

**Part 2 | Laboratory (10 min)**

**1. Astronaut scientists conduct their experiments.**

Based on the hypothesis that teams come up with in the science report, each science team can prepare an experiment set that supports their initial hypothesis. Teams have to complete all experiments within 10 minutes. There is no stretch on the timeline.

**Part 3 | Presentation (10 min)**

*Teams should be consistent with their Science Report. Science Report points will apply to this part.*

**1. Explain the mission area.**

The geology of the area is explained using photographs. Science team members should interpret the observed geomorphological structures.



## 2. Explain the stratigraphy of the region.

The relative age relationships of morphological structures are explained. The age relationship of the unit from which the sample is taken with the surrounding units is expected to be specified.

## 3. Explain the hypothesis and the selected locations.

The hypothesis indicated in the previously submitted report is expected to be explained. The selected locations in the area should also be described. These locations are previously stated in the science report. It should be clearly explained why these locations are chosen for the test and what types of elements were considered, e.g., vitality, aquatic, or geological.

## 4. Explain the sampling location and photos gathered during the mission.

Teams show visual data to support their hypothesis. The location, where the sample is taken, should be photographed with a scale.

## 5. Identify the samples.

## 6. Explain the onboard measurement/experiment set and logic of design.

All experiments that are chosen in the science report must be correlated with hypotheses.

## 7. The results based on all onboard measurements/experiment sets should be explained.

The science team must provide a clear explanation of onboard equipment (including sensors). It must be clarified how it works, what the design parameters are, and provide a comparative data set on the accuracy of data that is collected from the sample. Any unnecessary sensor/equipment usage which is unrelated to the experiment set will not be granted.

### 7.1.1.2. Scores

No	Section	Parameter	Score
1	Exploration - Selected Area	Taking photographs of the sampling site	5
2	Exploration - Selected Area	Taking panoramic photograph	3
3	Exploration - Selected Area	Measurements with onboard equipment	7
4	Exploration - Selected Area	Measurements with onboard sensors	2
5	Exploration - Selected Area	The depth of sample site min 5 cm with drill	8
6	Exploration - Selected Area	Amount of sample size min 5 g	4
7	Exploration - Given Area	Navigating to given sampling area	2
8	Exploration - Given Area	The depth of sample site min 5 cm with drill	8
9	Exploration - Given Area	Amount of sample size min 5 g	4
10	Exploration - Given Area	Measurements with onboard equipments	5
11	Exploration - Given Area	Measurements with onboard sensors	2
12	Exploration - Selected Area	Carrying sample to the airlock with closed and sealed container	1



13	Exploration - Given Area	Carrying sample with a closed and sealed container	1
14	Exploration	Reaching Mars base after sampling	2
15	Exploration - Selected Area	Delivering sealed container to judge inside Mars base	1
16	Exploration - Given Area	Delivering sealed container to judge inside Mars base	1
17	Presentation	Explaining mission area	6
18	Presentation	Explaining the selection of the sampling area	6
19	Presentation	Showing photographs during the mission	2
20	Presentation	Showing photographs of the site sampling area	2
21	Presentation	Explaining photographs of the sampling area	2
22	Presentation	Showing panoramic photographs	2
23	Presentation	Explaining panoramic photographs	2
23	Presentation	Explaining the stratigraphy of the mission area	4
24	Presentation	Identifying sample	2
25	Presentation	Explaining sample	2
26	Presentation	Suitability of onboard equipments for sampling area	5
27	Presentation	Suitability of experiments for sample	2
28	Presentation	Suitability of area and sample relationship	2
29	Presentation	Showing onboarded sensor results in table with screenshots	2
30	Presentation	Explaining sensor results with frame of experimental results	3
<b>TOTAL</b>			<b>100</b>

### 7.1.1.3. Details

#### Laboratory Rules

During the laboratory part, every team should follow the lab rules:

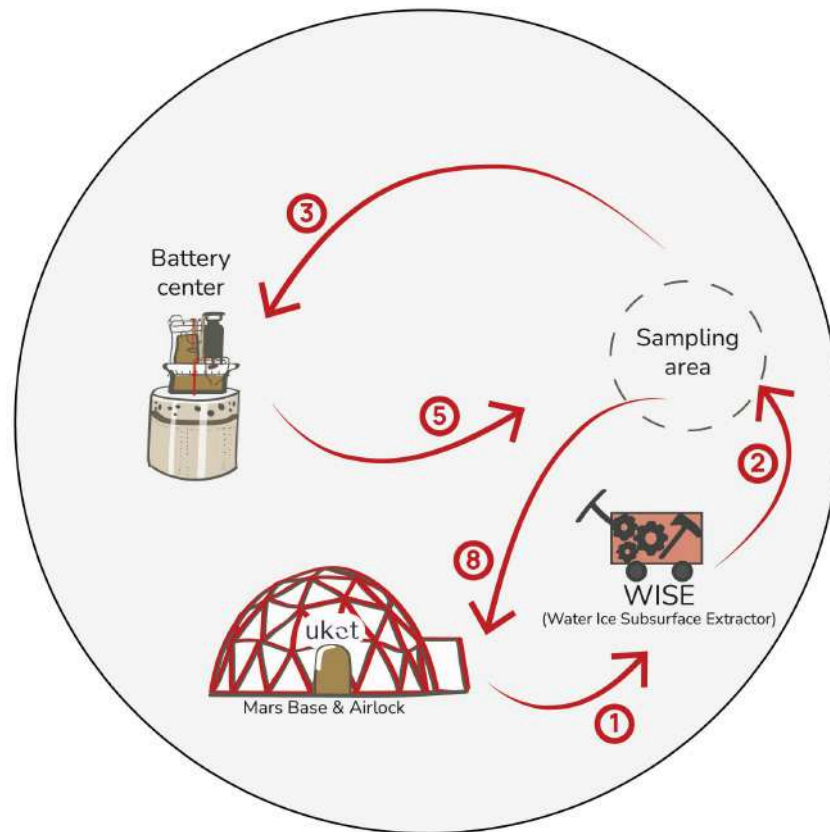
- Teams are not allowed to bring heat installing (electrical, gas, or portable), and there will be no support for any heating activity (including kettle)
- Teams are not allowed to bring flammable chemicals.
- Strong chemicals (pH < 4 or pH > 12) are not allowed to bring more than 10 ml.
- All chemicals and devices that will be used during the competition should be declared with a science report, if teams do not confirm their setup and chemicals before the competition, they will not be used during the competition.
- Each team must bring a chemical declaration form before starting experiments. This declaration will be signed by a judge and science team member.
- Each team has to collect disposals before they leave the experimenting area.

## 7.1.2. Night Mission

**Time Limit:** 15 Minutes

**Mission Field:** Mars

**Mission Time:** After sunset



### 7.1.2.1. Steps

1. **Reach to WISE (Water Ice Subsurface Extractor).**  
The rover starts by exiting the airlock and heads to WISE.
2. **Move WISE to the sample site.**  
WISE (4-wheel cart with towbar) is moved or towed to the sampling site.
3. **Reach the battery center.**  
The rover reaches the battery center.
4. **Pick up a charged battery.**  
The indicator lights will show battery capacity. The rover picks a charged one up.
5. **Place the battery near WISE.**  
Upon arrival at WISE, it safely places the battery near WISE.
6. **Connect the battery to WISE.**  
The rover forms a cable connection using a magnetic power cord.



### 7. Energize the battery.

The rover powers WISE by pressing the power button on the battery.

### 8. Return to the airlock.

The rover should enter the airlock so that no part of it is left outside.

#### 7.1.2.2. Scores

No	Parameter	Detailed Explanation	Score
1	Reach to WISE	Rover reaches WISE.	10
2	Move WISE to the sampling site.	WISE was brought near the sampling site. (see 4.14)	20
3	Reach the battery station.	Rover reaches the battery center.	5
4	Pick up a charged battery.	The rover picks up the charged battery and leaves the area.	15
5	Place the battery near WISE	Rover safely places the battery near WISE.	20
6	Connect battery to WISE	The rover connects the cord securely.	20
7	Energize the battery	The rover fully presses the battery's power button.	5
8	Return to the airlock	The rover should enter the airlock so that no part of it is left outside.	5
<b>TOTAL</b>			<b>100</b>

#### 7.1.2.3. Details

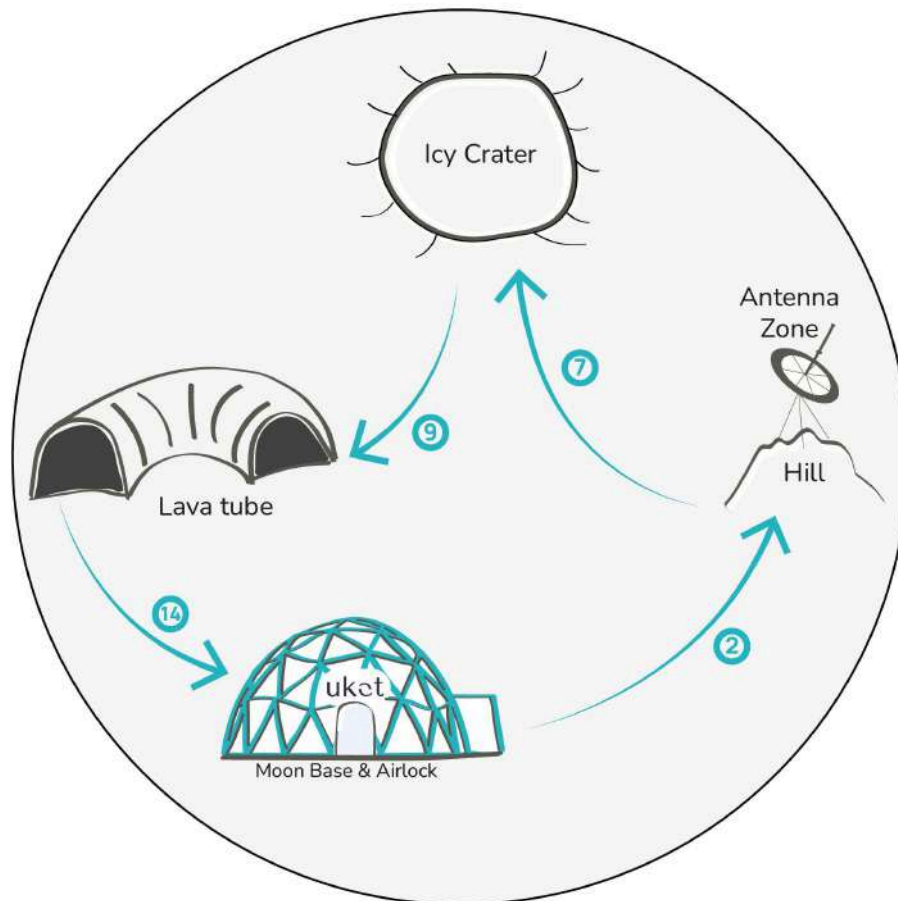
- The mission will be performed in the dark. Therefore, rovers should be prepared for night operations.
- Battery weight is less than 5 kg.
- Power cord's one end is already connected to WISE, and the other end is magnetic. It can easily be attached to the battery terminal.
- Teams are encouraged to explore the route that WISE will be moved along early in the mission.



### 7.1.3. Autonomous Mission

**Time Limit:** 30 minutes

**Mission Field:** Moon



#### 7.1.3.1. Steps

**1. Use activity light correctly for the whole mission.**

The rover must indicate its transition to autonomous mode by activating a yellow light.

#### Antenna Installation

**2. Move out of the airlock.**

The rover is equipped with an antenna while being prepared for the mission at the lunar base. The team members will place the rover inside the airlock at the lunar base. If the rover's dimensions do not comply with the specified limitations, the team will skip this step and begin the mission from the airlock's exit point.



- 3. Reach the antenna area.**

The rover autonomously moves to the specified coordinates (See **4.12. Coordinate System**).
- 4. Find the peak of the antenna area.**

Scan a circular area with a 10-meter radius to find the peak of a hill. After finding the suitable height, this is the antenna area. The rover must come to a complete stop.
- 5. Install antenna to the peak.**

The rover begins the mission with this antenna. The rover will autonomously proceed to the specified coordinates and drop the antenna at the peak.
- 6. Send coordinates of the peak.**

Transmit peak coordinates over RSCP.

### Ice Search

- 7. Reach the “Icy Crater” area.**

The rover will autonomously proceed to the center of the 10-meter-diameter Icy Crater’s coordinate.
- 8. Locate the coldest point and send the coordinates.**

Locate the coldest surface within the Icy Crater and transmit its coordinates via the communication protocol.

### Lava Tube Exploration

- 9. Reach the provided coordinates of the lava tube entrance.**

The rover will autonomously approach the entrance of the lava tube.
- 10. Enter the lava tube.**

Rovers are required to navigate to the lava tube entrance, either by using custom detection algorithms or by detecting the two Aruco markers placed at the entrance of the lava tube.
- 11. Measure the length of the covered (roofed) section.**

During its exploration, the rover must use its onboard sensors and cameras to measure the length of the tunnel’s covered section.
- 12. Exit the lava tube and transmit the covered section length.**

After completing the measurement, the rover will exit the lava tube and, using the RSCP communication protocol, send a message reporting the length of the covered section in meters.

### Return to the Base

- 13. Reach the airlock.**

After receiving the “return” message, the rover must navigate back to the airlock while avoiding obstacles. The route to return to the airlock is entirely at the rover’s discretion, except for the restriction of not re-entering the lava tube.



#### 14. Enter the airlock.

Once the rover enters the airlock, the mission is considered complete.

#### 7.1.3.2. Scores

No	Section	Parameter	Score
1	Antenna Installation	Use activity light correctly for the whole mission	10
2	Antenna Installation	Move out of the airlock	4
3	Antenna Installation	Reach the antenna area	10
4	Antenna Installation	Send correct coordinates of the peak	30
5	Antenna Installation	Install antenna to the peak	12
6	Ice Search	Reach to the "Icy Crater" area	10
7	Ice Search	Locate the coldest surface and send coordinates	30
8	Lava Tube Exploration	Reach the provided coordinates of lava tube entrance	10
9	Lava Tube Exploration	Enter lava tube	16
10	Lava Tube Exploration	Exit lava tube	16
11	Lava Tube Exploration	Measure and Send the correct length of covered (roofed) section	30
12	Return to the Base	Reach to airlock	10
13	Return to the Base	Enter the airlock fully	12
<b>TOTAL</b>			<b>200</b>

No	Penalties	Detailed Explanation	Amount
1	Detection of remote control	No scores can be taken from the mission.	-100%
2	Remote Stop (to stop rover over RSCP communication)	Remote stop does not count as an intervention. Teams are encouraged to request a remote stop early whenever their rover malfunctions, goes off site or crashes to prevent a forced intervention.	-5%

#### 7.1.3.3. Details

Teams are prohibited from communicating with their rovers, including the issuance of start and stop commands. Prior to the beginning of the mission, the ARC crew will provide a communication module to the competing rover. This module is exclusively for the ARC crew's use to relay instructions to the rovers. Consequently, all mission directives will be transmitted via this module. Any movement made before receiving the assigned tasks for the next stage will result in a forced Remote Stop by the judge and, therefore, penalized. The rovers will operate without their own antennas, requiring teams to detach any antennas from the rovers at the mission's onset.



During the preparation time, the ARC judge will evaluate the rovers and may request teams to remove any system that resembles an antenna. In the preparation phase, teams are allowed to link their rovers to the Rover Satellite Communications Client Module (RSC-CM) using the RS-232 connection, as detailed in section **7.1.3.3.1. The RSC-CM** operates using a unique message format named the Rover Satellite Communications Protocol (RSCP).

#### **7.1.3.3.1 Rover Satellite Communications - Client Module (RSC-CM)**

The RSC-CM will be equipped with a 9-hole DB9 female socket and will use RS-232 communication protocol. It will operate at a baud rate of 115200 bps, have 1 stop bit, and will not use parity or additional stop bits. The RSC-CM module will employ the RSCP framing protocol for data transmission to and from the rovers. This protocol includes various message types, like "NavigateToGPS" and others. The RSC-CM module will operate independently without needing an external power source, as it will have its own internal power supply. It will weigh less than 1kg and will be roughly the size of a credit card. For information on mounting, see **3.1.7 Rover Technical Check-in**. For detailed information, please refer to the external documentation available in the GitHub repository.

#### **7.1.3.3.2 Message Format: Rover Satellite Communications Protocol (RSCP)**

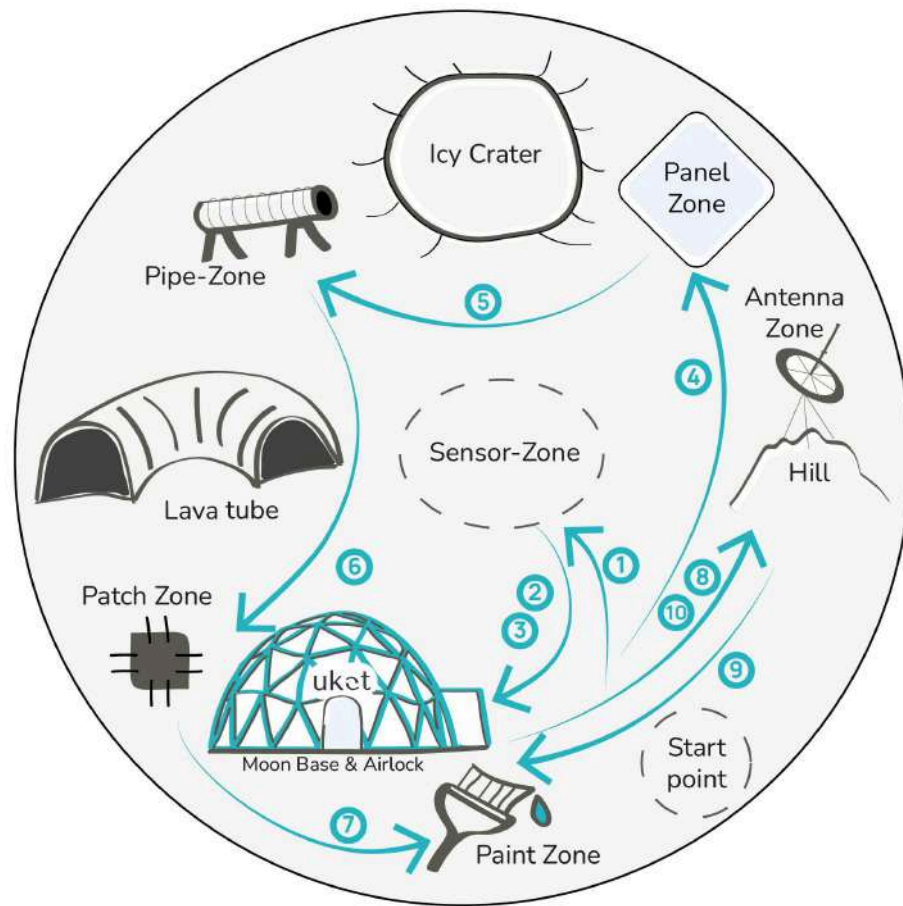
RSCP is a specialized protocol designed for communication with rovers over a serial connection during the ARC mission. The RSCP protocol is crucial for coordinating and instructing the rover's actions throughout the mission. The RSCP protocol serves as the primary means of communication between the mission control center and the participating rover teams during the ARC. It facilitates the transmission of mission directives, status updates, and control commands to the rovers, ensuring smooth mission execution.

The detailed technical aspects, including the frame structure and Python/C++ code examples, will be available in the external documentation for reference. Teams are advised to refer to this documentation for a deeper understanding of the RSCP protocol's inner workings. Teams can access the documentation using the link on the ARC website along with the ARC Manual. This link will lead to a GitHub repository of the ARC'25. Teams must follow the updates in this repository until the date specified in section **2.3.1. Milestones**, as this documentation, will also include crucial message timings, example communication flows and sequences, message structures and units which will be mandatory for the execution of this mission.

## 7.1.4. Collaboration Mission

**Time Limit:** 2 hours

**Mission Field:** Moon



### 7.1.4.1. Steps

#### Sensor Task (single rover only)

1. **Navigate to the sensors**  
Rovers start the mission near the base and reach their assigned "Sensor Zone".
2. **Transport the Recorder**  
Disconnect cables from a data recorder unit at the Sensor Zone and deliver the device to the base. The recorder has a carry handle and uses a USB type-A connector.
3. **Collect Sensors**  
Gather the disconnected sensors from Sensor Zone and deliver them to the base. Sensors are partially buried in the ground.



### Infrastructure Task (for groups of min. 2 rovers)

4. **Reset the instrument panels.**

An instrument panel is located in the Panel-Zone. The panel has a display on the front side and numpad on the backside. A pin code for a factory reset is shown. Press the numpad to enter the correct pin to reset the panel. Multiple pin code entries will be required.

5. **Install the fuel pipe.**

Carry and install a fuel pipe by connecting it to the end of the pipeline at Pipeline-Zone. Pipe ends will have handles.

6. **Repair the base with a patch.**

Seal a damaged area at Patch-Zone using a hook and loop tape retrieved from the base. The seal must cover the entire spot without gaps.

7. **Apply protective paint to the base.**

Apply protective paint to the indicated area at Paint-Zone using the brush and paint from the base provided.

### Antenna Task (for groups of min. 3 rovers)

8. **Set the antenna's tripod.**

Set up the antenna's tripod in the Antenna Zone. To do this, take the tripod from the base and move it to the Antenna Zone. Then unlock it (the astronaut can hand it to the rovers as in the **technical drawing** section), extend its legs, the height of the tripod must be at least 80 cm, lock it, place it upright in the required position and mount the antenna on top of it. (All the necessary instructions are given in **8.11 Antenna's Tripod - Collaboration Mission**).

9. **Carry the Dish antenna.**

Drag the Antenna dish from the Antenna-Zone to near the base. The parabolic-shaped dish antenna is heavy, but ropes are available at the base.

10. **Stick the Yagi antenna.**

First, the Astronaut needs to prepare the glue. Epoxy resin and hardener will be provided in the base. The astronaut will mix the adhesive in a container that the rover can hold easily. Then the rover taking the container should pour the adhesive, which can remain in gel form for about 5 minutes, on the pole in the antenna area. Then, the antenna from the base will be placed horizontally on the pole where the glue has been applied. The antenna should be kept there for a while (about 5 minutes). The antenna must stay on its own while in place when released.



### 7.1.4.2. Scores

No	Parameter	Detailed Explanation	Step Score
1	Report Score	Technical Collaboration Presentation score of the team	10
2	Navigate to the sensor area	Reach assigned Sensor-Zone.	5
3	Transport the recorder	Deliver recorder to the base without any cables.	10
4	Collect sensors	Bring all the sensors to the base.	5
5	Reset the panels	The instrument resets after entering the force reset code.	10
6	Install the pipe	Connected fuel pipe and secured to the pipeline with outer sleeve.	10
7	Attach Patch	The seal covers without any gaps.	10
8	Apply Paint	Paint the indicated area without any gaps.	10
9	Install Tripod	Set the tripod to height and mount the antenna at the spot.	10
10	Carry Antenna Dish	The antenna dish is brought near the base. (see 4.14)	10
11	Stick the Yagi Antenna	The sticked antenna doesn't fall and is acceptably horizontal.	10
<b>TOTAL</b>			<b>100</b>

### 7.1.4.3. Details

- All teams will employ their robots at the same time to upgrade the lunar base. Teams will complete some of the steps as groups. Groups can be formed or dissolved dynamically by teams' initiative for each step.
- Teams may complete the tasks in any order they choose and retry unlimitedly. However, Sensor Task steps are to be completed in order as defined in the "4.10 Skipping" section.
- All teams will install ground stations in a larger base called "mission control." It is near the fields, but it does not have field visibility. Mission control will include a "Mission Commander" that coordinates teams and assigns teams to zones.
- The Moon base will be inhabited by 'Astronauts', who are individuals responsible for the maintenance of the rovers. Each team can send only one thus, their number is limited, therefore, they are encouraged to work collaboratively and indiscriminately to fix the rovers. Astronauts can communicate visually and verbally over the radio with the mission control.
- Rovers can be modified anytime, but only while inside the base. Teams might perform tool changes to achieve better results. An intervention will only allow them to carry the rover to



the base. Astronauts are allowed outside only to carry the rovers back to base. These interventions do not cost teams a penalty.

- All mission steps have a specified zone. If a zone is occupied, entry requires a permit from “Mission Commander”, otherwise it leads to intervention penalties. Zones can be occupied at most for 20 minutes per group except Sensor Task. Teams that exceed the duration of 20 minutes must carry their rovers to airlock. Penalty rules apply to collisions and zone violations can escalate to disqualification. (except for **Navigate to the sensors** task which every team will have their separate zones)
- Points would be awarded for each of the teams in a group for completed steps.

## 7.2. Off-Field Missions

### 7.2.1. Challenge to Shine

**Time limit:** 10 minutes with each judge

This challenge is a presentation challenge of the ideal rover design of the team to experts in their fields. The presentations made in this challenge are evaluated separately and will not be included in the general challenge score. The fields of the experts are science, autonomous driving and control, robotic arms, driving in difficult terrain, team structure, etc. Team members will have 10 minutes to present their approach to the stated fields during this challenging process to the judges in different rooms. The presentations will be evaluated, and the judges will choose the winner of each field. Prizes will be given to the winning teams. Each field can only have one winner.

### 7.2.2. Fun Challenges

During challenge days, there will be fun activities that are not a part of the ARC missions. These challenges are a set of games and mostly require rover-teammate and multi-rover interaction. All the winners will get special awards. The ARC Committee has the right to make changes to fun challenges until the competition day. They are planned to be held on the last day of the competition.

#### 7.2.2.1. Rover's Mystery Canvas

Step into Rover's Mystery Canvas, where every stroke holds a surprise waiting to be discovered. Rovers will use the given paints to uncover the unknown and create memorable memories.





#### **7.2.2.2. Victoria's Rover**

Teams decorate their rovers with clothes and accessories of their design using the materials we provide or bring their own. Rover takes a tour of the runway. Traditional clothing is encouraged.

#### **7.2.2.3. Disco Rover**

Teams will play their chosen song and dance their rovers to specific rover dance figures. The team that executes the best figures wins the rover game.

#### **7.2.2.4. Rover Jenga**

Rovers and, optionally, teammates will play with rover-sized Jenga pieces. It can also be played by the participants optionally. They should be careful and precise so as not to drop the blocks.

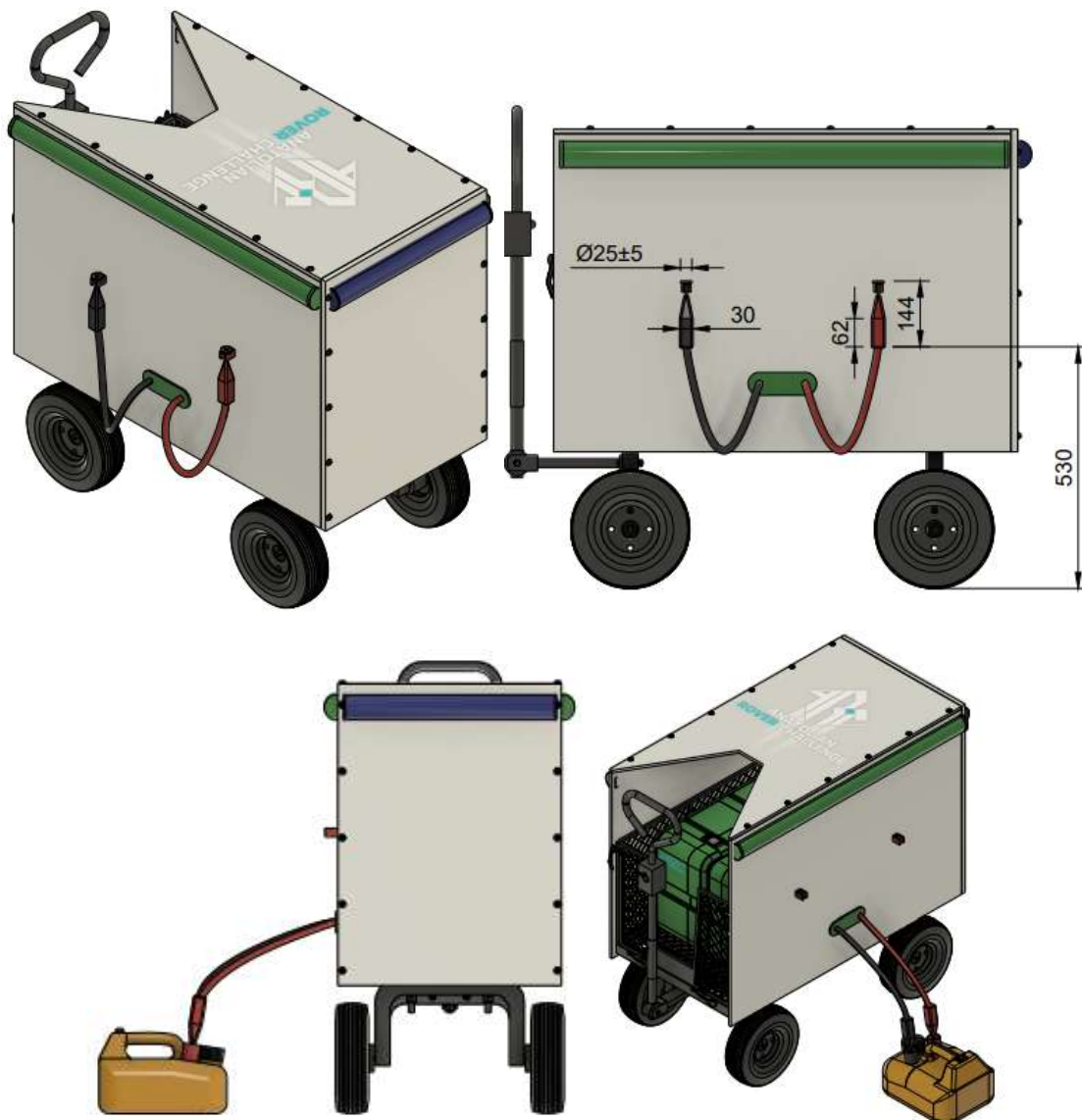
#### **7.2.2.5. Tug of Challenge**

Two teams play tug-of-war, with only team members or only rovers. Rovers can pull the rope tied.

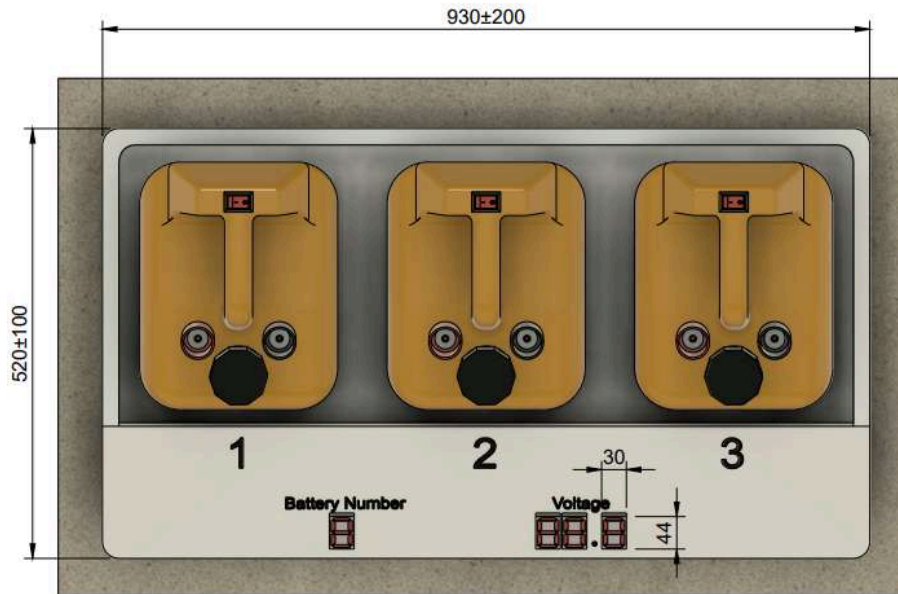
## 8. Technical Drawings

All measurements are given in millimetres.

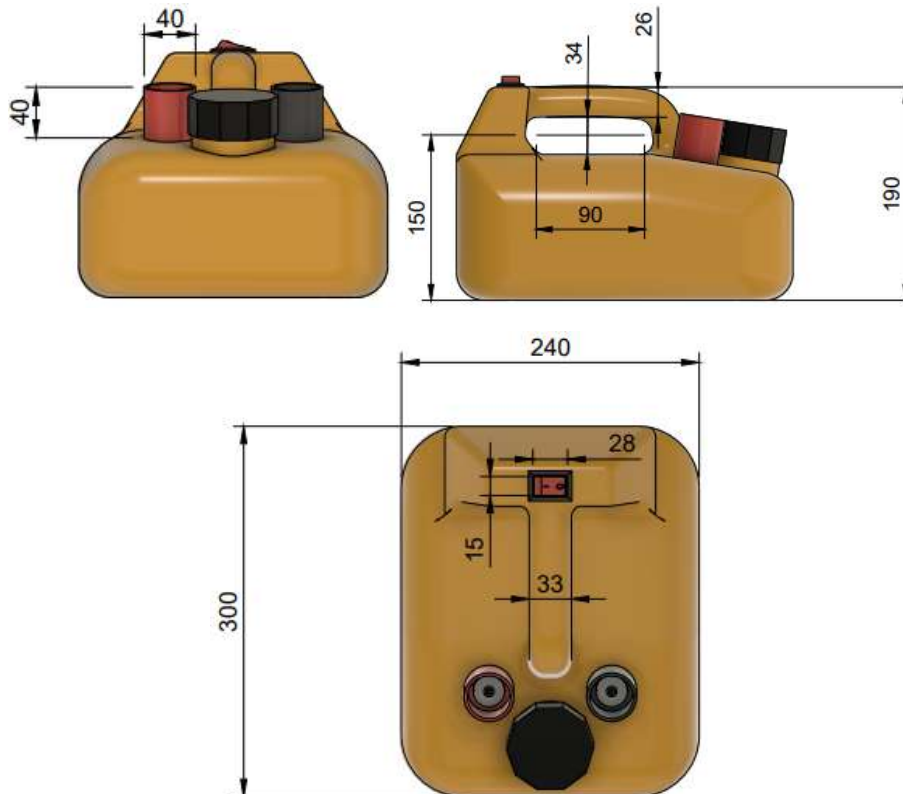
### 8.1. WISE (Water Ice Subsurface Extractor) - Night Mission



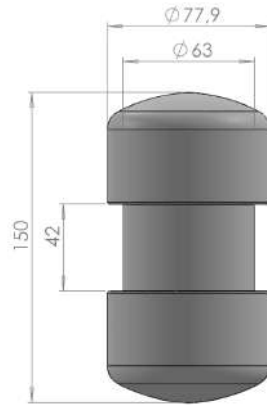
## 8.2 Battery Center - Night Mission



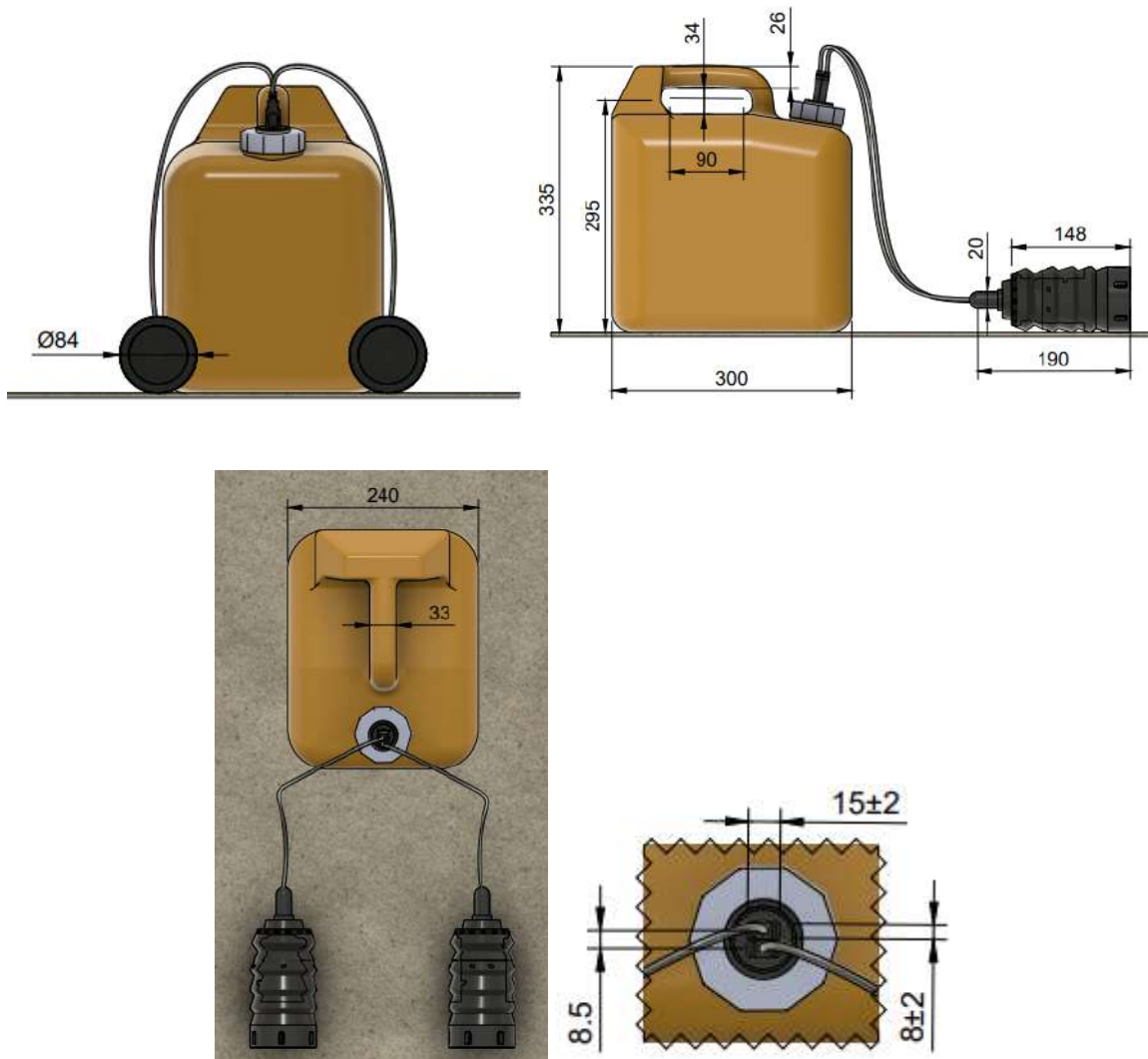
## 8.3 Battery - Night Mission



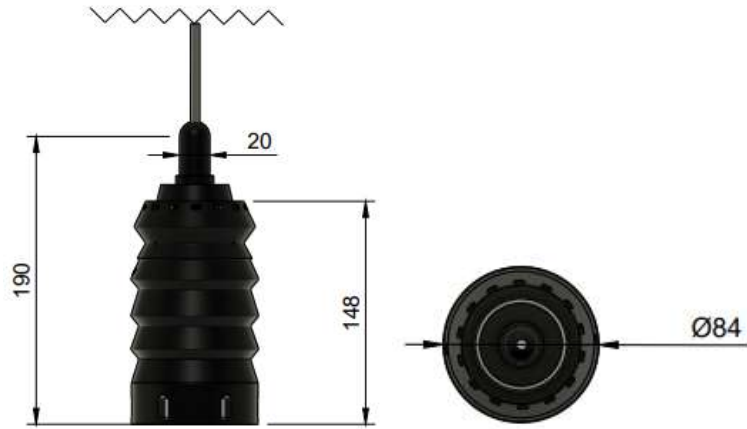
### 8.4 Antenna - Autonomous Mission



### 8.5 Recorder - Collaboration Mission

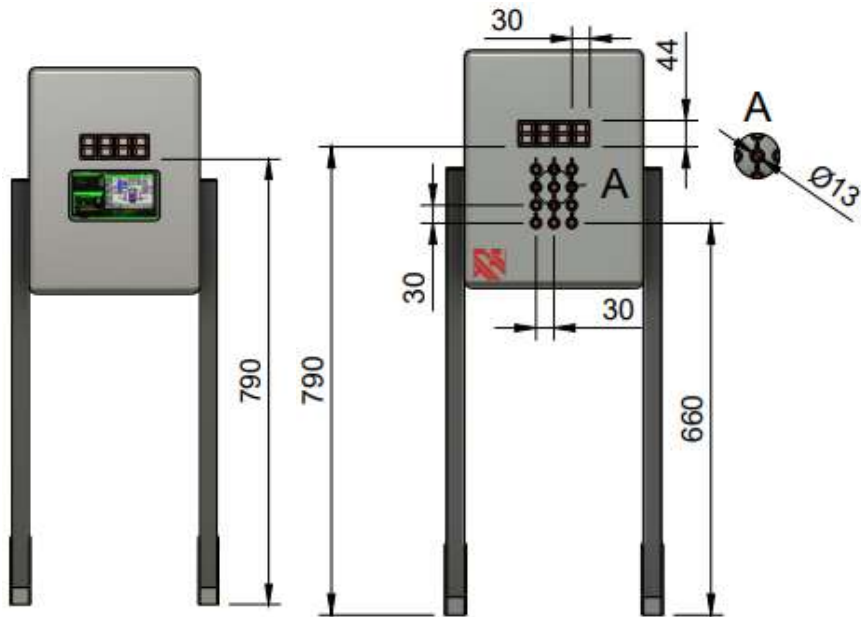


## 8.6 Sensors - Collaboration Mission



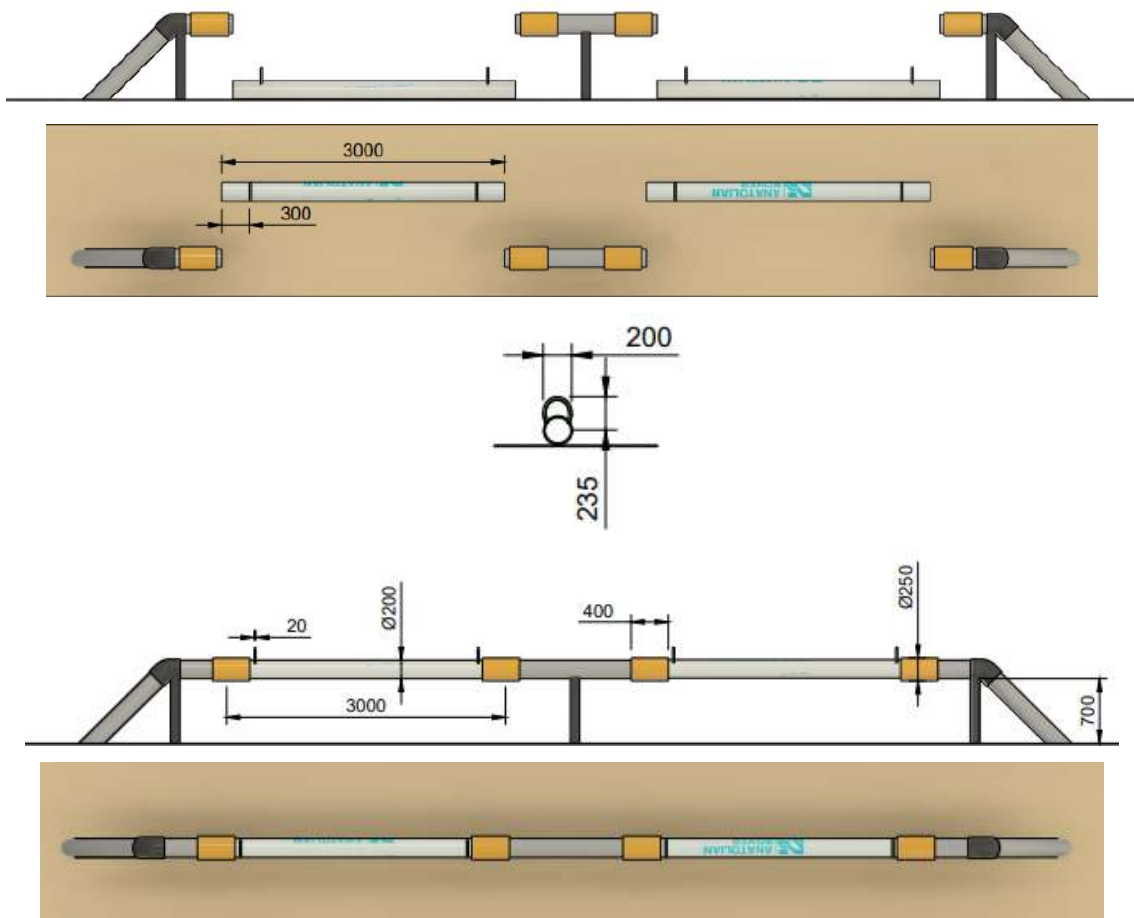
## 8.7 Panel - Collaboration Mission

Front and backside of the panel is shown.

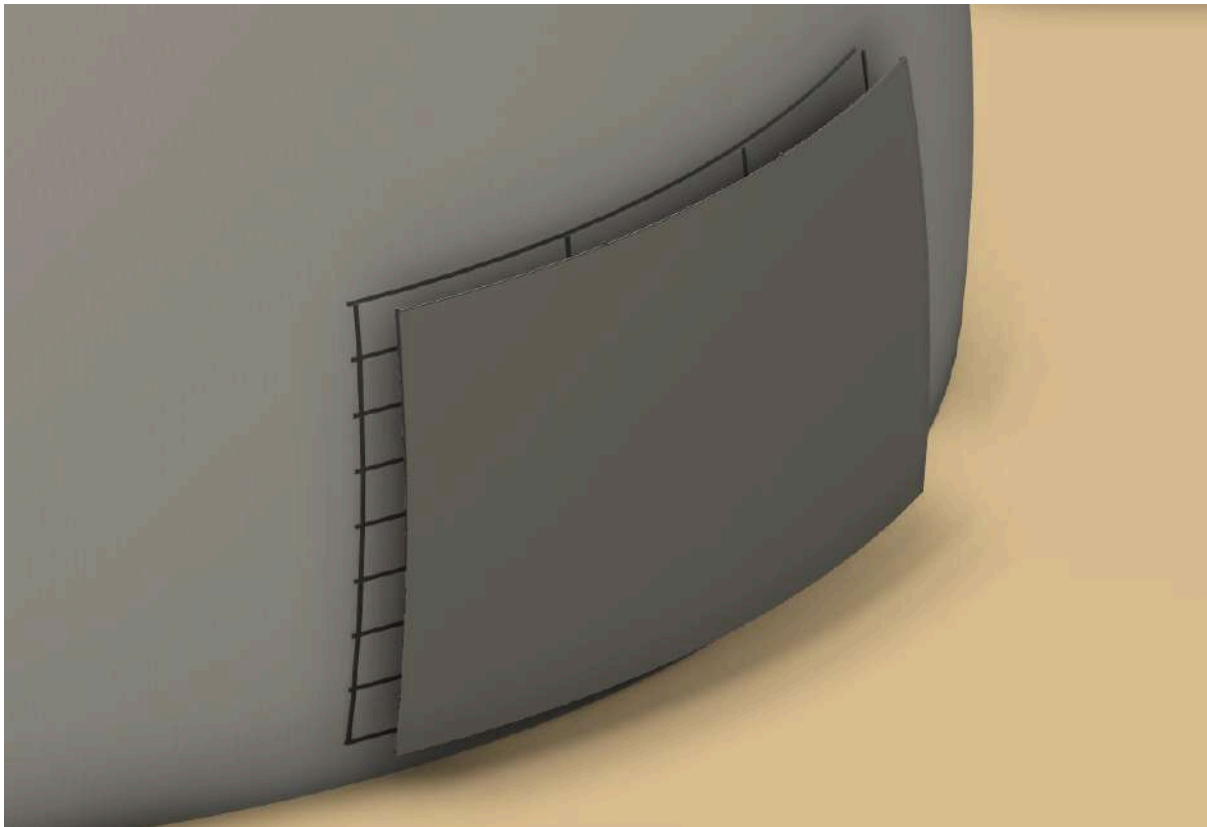
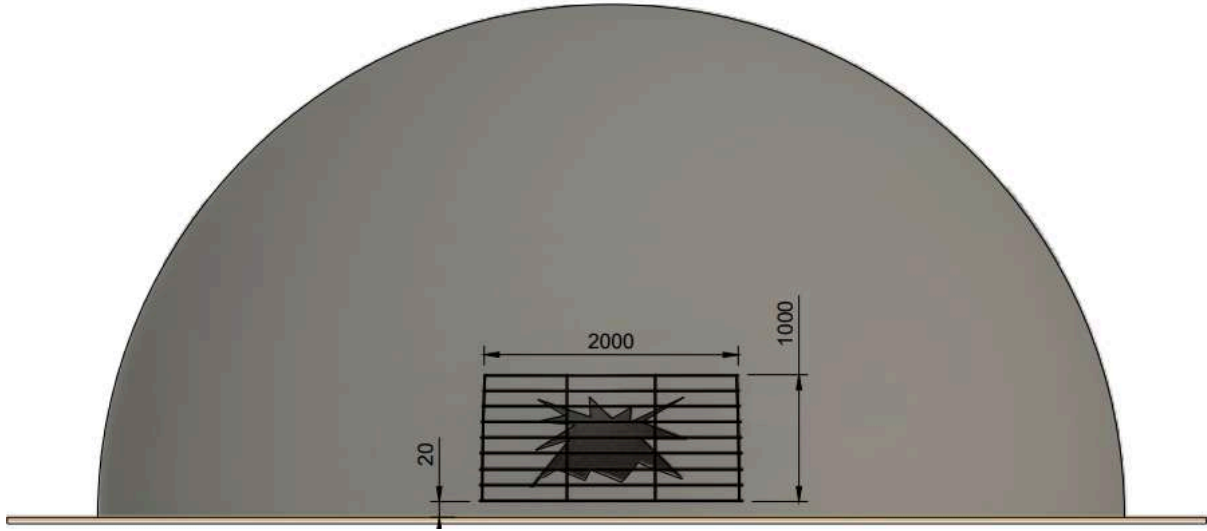




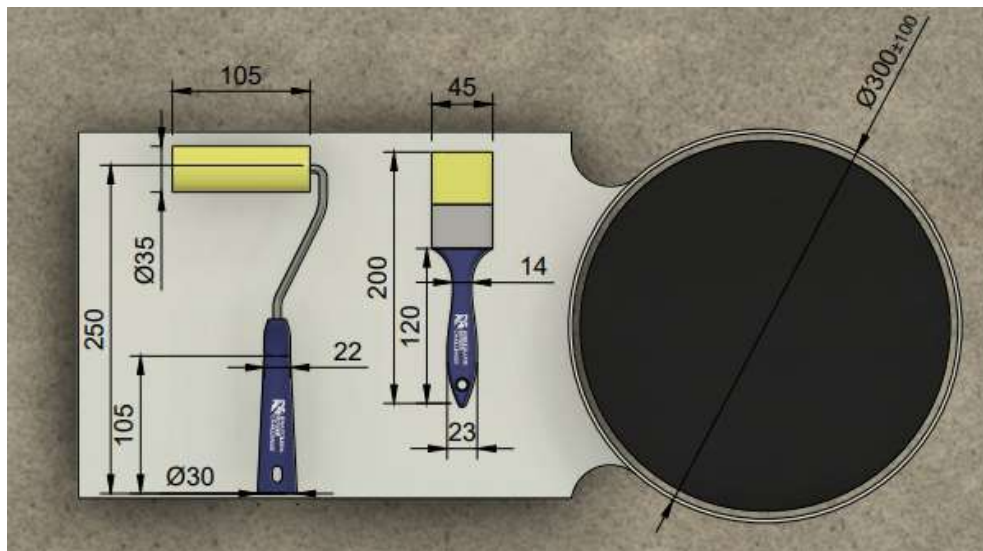
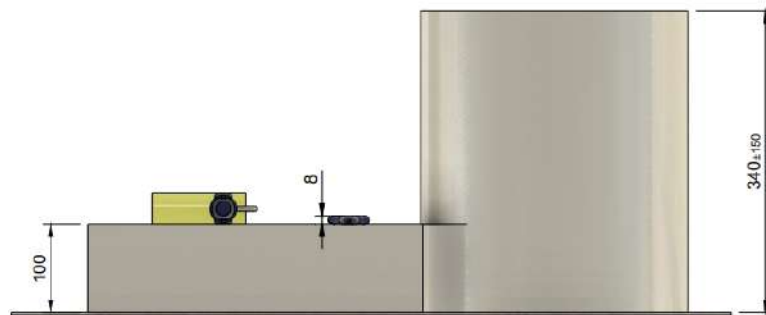
### 8.8 Pipes - Collaboration Mission



## 8.9 Patch - Collaboration Mission

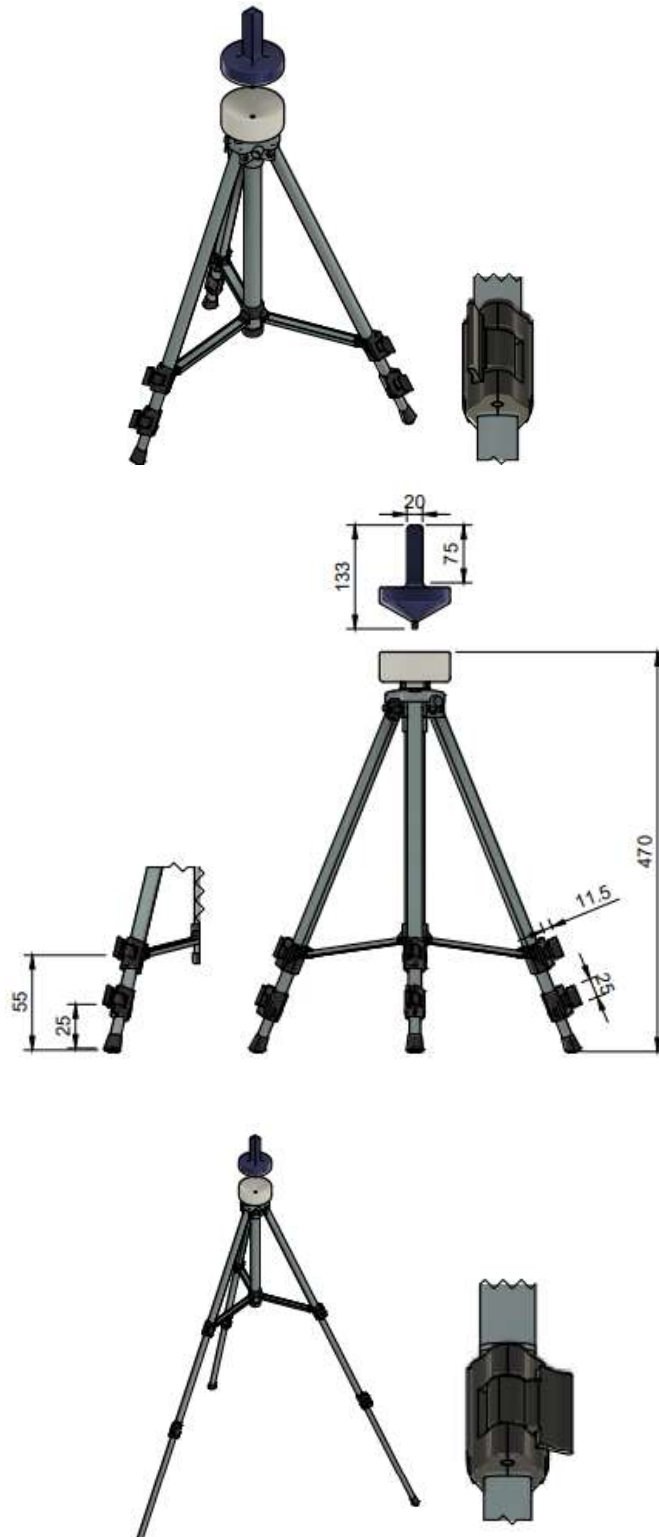


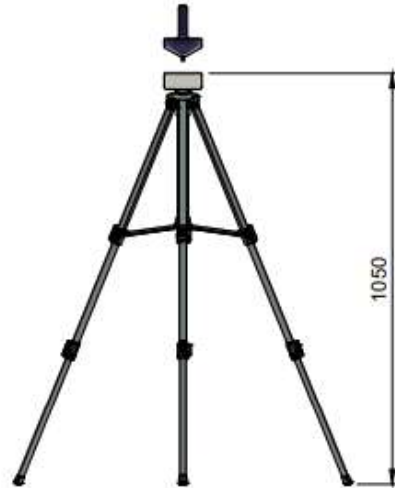
## 8.10 Brush and Paint - Collaboration Mission



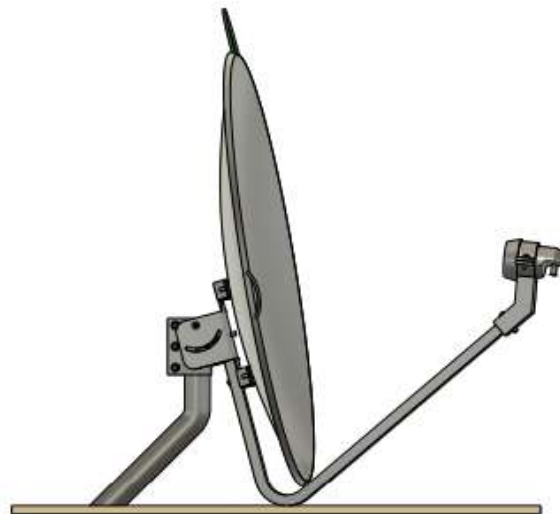
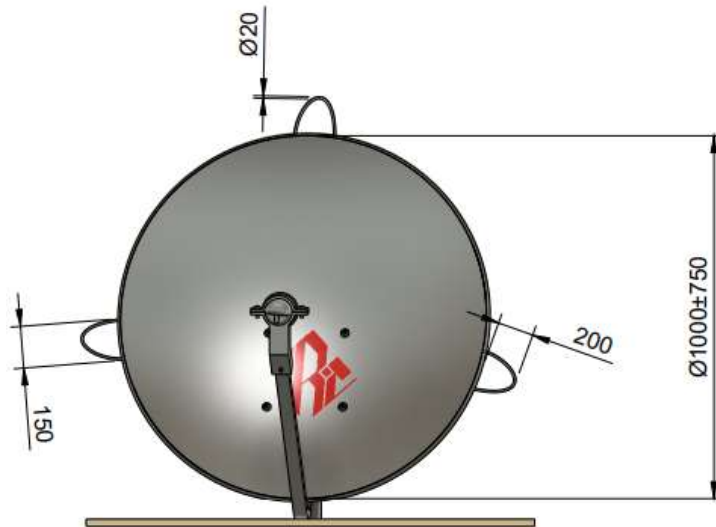


## 8.11 Antenna's Tripod - Collaboration Mission

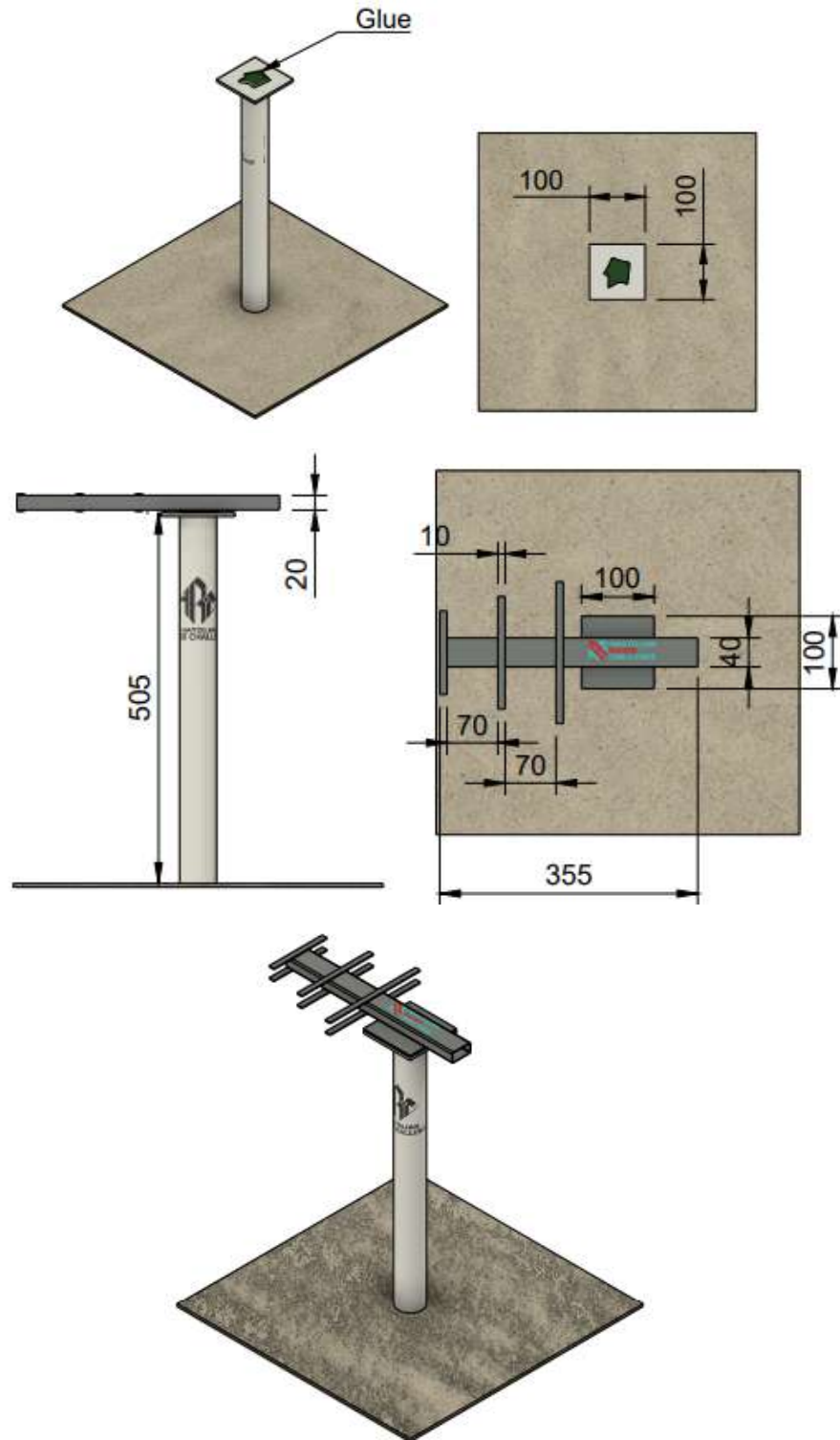




### 8.12 Antenna - Collaboration Mission



### 8.13 Stick Antenna - Collaboration Mission



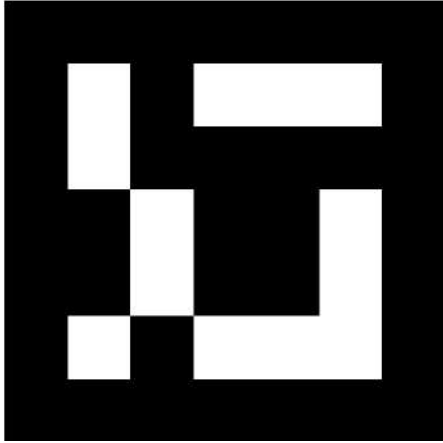


## 8.14 Marker

All the markers are of the size 20x20 cm.

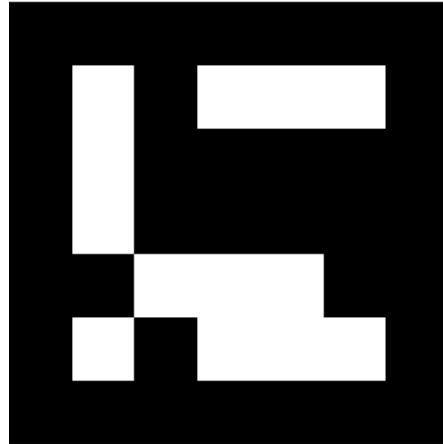
### 1.M1

The marker placed on the right and left hand side of the Airlock



### 2. M2

The marker placed on the right and left hand side of the entrance of the lava tube





## 9. Evaluation

The challenge scores are stated in the tables in the relevant mission section. Each mission is worth 100 points, and all missions are worth 400 points. At the end of the challenge, teams are evaluated using the sum of all mission scores. The top three teams with the maximum overall points will be selected as winners and awarded, respectively. In addition to mission points, there are general scoring rules for all missions, as stated in the table below.

No	General Scoring Rules
1	Teams can make a maximum of 3 interventions. (limitless in Collaboration Mission)
2	One intervention deducts 15% of the mission score. (no deduction in Collaboration Mission)
3	Two interventions deduct 40% of the mission score. (no deduction in Collaboration Mission)
4	Three interventions deduct 70% of the mission score. (no deduction in Collaboration Mission)
5	Pressing the emergency button is considered an intervention.
6	Judges can invoke an intervention in case of a security problem or going off-field.
7	During skipping, touching other than moving counts as an intervention during skipping.
8	Mission time will continue during Skipping or Intervention.
9	Not turning on the activity light deducts 10% of the mission score.
10	Not having an emergency button on the rover deducts 5% of the mission score.
11	If a rover cannot exit/enter the airlock, it can start from outside of the airlock for a 30% penalty.
12	Causing any damage to the placed items on the field deducts 10% of the mission score.