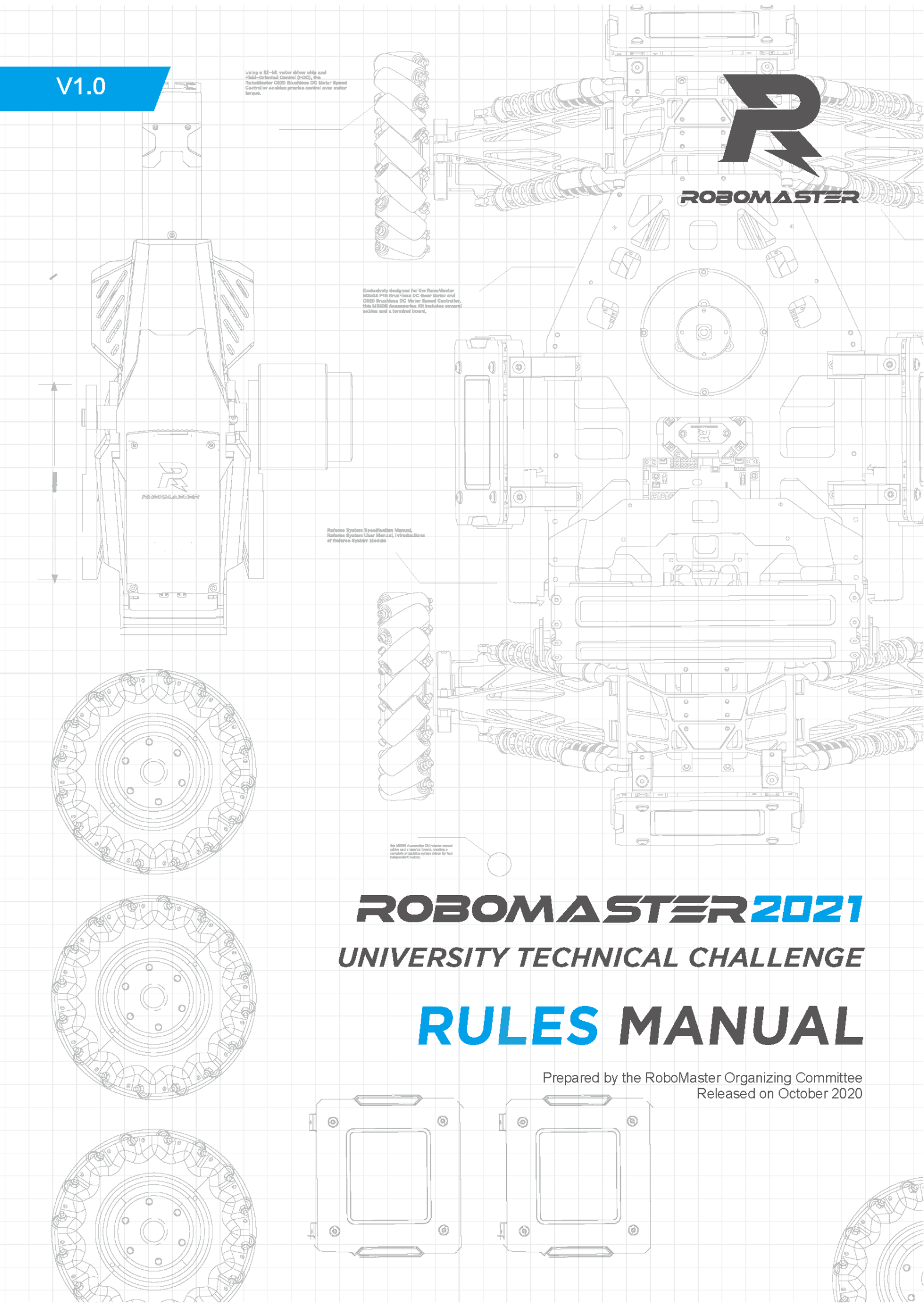
V1.0



ROBOMASTER 2021

UNIVERSITY TECHNICAL CHALLENGE

RULES MANUAL

Prepared by the RoboMaster Organizing Committee
Released on October 2020

Intellectual Property Statement

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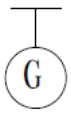
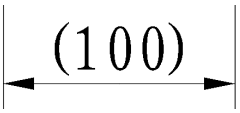
Reading Tips

Legend

Prohibitions	Important notes	Hints and tips	Definitions and references

Legend for Battlefield Drawings

	
The plane on which the battlefield is located is its lowest plane	Dimensions are for reference only

Release Notes

Date	Version	Changes
October 15, 2020	V1.0	First release

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1. Introduction

The RoboMaster 2021 University Technical Challenge (hereinafter referred to as "RMUT 2021") consists of three components: Engineer Mining, Standard Racing and Smart Firing, as well as Dart Targeting.

1.1 Main Changes to New Competition Season

The RMUT 2021 has been updated with the following changes:

Challenge

- The 2V2 Confrontation has been removed
- The Engineer Projectile Obtaining challenge has been replaced by Engineer Mining

Robots

- Radars are allowed to enter the battlefield for Dart Targeting

Competition Area

- The Battlefield has been re-designed

1.2 Robot and Operator

Building specifications for robots can be found in the "RoboMaster 2021 University Series Robot Building Specifications Manual".

1.2.1 Robot Lineup

The robot lineup for the RMUT 2021 is as follows:

Table 1-1 Robot lineup

Challenge	Quantity of Robots on Battlefield	Backup Robots (optional)	Robot Numbering
Engineer Mining	1	Only one backup robot is allowed for each challenge. For Dart Targeting, each team is allowed to carry at most four backup darts.	Red 2
Standard Racing and Smart Firing	1		Red 3
Dart Targeting	1-2 (the Dart System must be deployed and must include four darts)		• Dart System: Red 8 • Radar: Red 9

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The Radar is optional. It can relay images back to the gimbal display in the Operator Room and provide a full view of the match.

1.2.2 Basic Robot Information

The basic robot information for the RMUT 2021 is as follows:

Table 1-2 Basic Robot Information

Robot Type	Initial Projectile Quantity (round)	Maximum Chassis Power Consumption (W)	Initial HP	Initial Firing Speed Limit (m/s)	Barrel Heat Limit	Barrel Cooling Value per Second	Projectile Launch Speed (round/s)	Initial Position
Engineer Robot	-	No limit	500	-	-	-	-	Starting Zone
Standard Robot	50	80	200	30	240	40	Refer to "3.2.2 Barrel Overheating and Cooling" for more details.	Starting Zone
Dart System	-	-	-	18	-	-	-	Dart Launching Station
Radar	-	-	-	-	-	-	-	Radar Base

- Robot chassis: A mechanism that carries and has been mounted with a robot propulsion system and its accessories.
- Chassis Power Consumption: The power propulsion system that enables a robot to move horizontally, not including the power used for special tasks (e.g., power consumption for functional movements such as moving the upper mechanical structure).
- Initial Firing Speed: The speed detected by the relevant modules of Referee System after a projectile or dart has completed its acceleration.
- Initial projectile quantity: The quantity of projectiles that a Pit Crew Member can load into the magazines of a robot before the start of a round.
- Barrel Heat: A mechanism for limiting the firing of projectiles by robots. For more details, please refer to "3.2.2 Barrel Overheating and Cooling".

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1.2.3 Operator Lineup

- An operator must be an Regular Member of a team in the current season.
- An operator can be substituted after each round.

The operator lineup is as follows:

Table 1-3 Operator Lineup

Robot Type	Robot Operated	Full Team Lineup Size
Ground Robot Operator	Standard Robot	1
	Engineer Robot	1
Aerial Gimbal Operator	Dart System, Radar	1

Ground Robots: The collective term for Engineer and Standard Robots.

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2. Operator Room and Projectiles

2.1 Operator Room

Each Operator Room shall be equipped with a corresponding number of computers, each connected to its corresponding official equipment such as a monitor, mouse, keyboard, USB hub and wired headset.

An Operator Room is not provided with additional power supply.

2.2 Projectiles

The parameters and scenarios of use for projectiles in the competition are as follows:

Table 2-1 Projectile Parameters and Scenarios of Use

Robot Type	Appearance	Color	Size	Weight	Shore Hardness	Material	Scenarios of Use
17mm projectile	Spherical	Yellow-green	16.8 mm ± 0.2 mm	3.2 g ± 0.1 g	90 A	Plastic (TPU)	Standard Racing and Smart Firing

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3. Competition Mechanism

3.1 Robot Status and Buff Types

Robots will display the following statuses during the competition as shown below:

Table 3-1 Robot Status

Status	Description
Survive	Robot's HP is not zero.
Defeated	Where a robot's HP drops to zero after its Armor Module has been attacked or hit; it has exceeded its Chassis Power Consumption limit, Initial Firing Speed limit or Barrel Heat limit; its Referee System module has gone offline, etc.
Ejected	Where a robot is ejected directly by the Referee System as a penalty after being issued with a Red Card or having accumulated 8 violation points.
Offline	Where a robot is disconnected from the server.

After a robot is defeated or ejected, the Referee System will cut off power supply to the robot (except for the Mini PC).

3.2 HP Deduction Mechanism

The HP of robots may be deducted in any of the following situations: the Barrel Heat limit, Initial Firing Speed limit or Maximum Chassis Power Consumption of a Launching Mechanism is exceeded; an Armor Module is struck in a collision; an important module of the Referee System goes offline; as a penalty for violation of rules; etc.

The Referee System will round down the HP deduction and keep the integer when calculating the HP.

3.2.1 Initial Firing Speed Exceeds the Limit

Set the Initial Firing Speed limit as V_0 (m/s), the actual initial speed detected by the Referee System as V_1 (m/s).

When $V_1 > V_0$, the Deducted HP = Maximum HP * L%. The value of L% is correlated to the margin of excess. The larger the margin of excess, the greater the value of L%.

Table 3-2 Penalty Mechanism for Exceeding Initial Firing Speed Limit

17mm projectile	L%
$0 < V_1 - V_0 < 5$	10%
$5 \leq V_1 - V_0 < 10$	50%

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17mm projectile	L%
$10 \leq V_1 - V_0$	100%

3.2.2 Barrel Overheating and Cooling

Set the Barrel Heat limit as Q_0, the current barrel heat as Q_1, For each 17mm projectile detected by the Referee System, the current barrel heat Q_1 is increased by 10 (regardless of its initial speed) The barrel cools at a frequency of 10 Hz. The cooling value per detection cycle = cooling value per second / 10.

A. and when $Q_1 > Q_0$, the first-person-view (FPV) visibility of the client screen is reduced. The FPV will only return to normal when $Q_1 < Q_0$. The FPV for the client is as follows:

Figure 3-1 FPV of Client

B. When $2Q_0 > Q_1 > Q_0$, the deducted HP for every 100 ms = $((Q_1 - Q_0) / 250) / 10$ * Maximum HP. After the HP deduction, the barrel cooling will be calculated.

C. When $Q_1 \geq 2Q_0$, the immediate deducted HP = $(Q_1 - 2Q_0) / 250$ * Maximum HP. After deducting HP, set $Q_1 = 2Q_0$.

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The below shows the HP deduction and cooling logic when the Barrel Heat limit is exceeded:

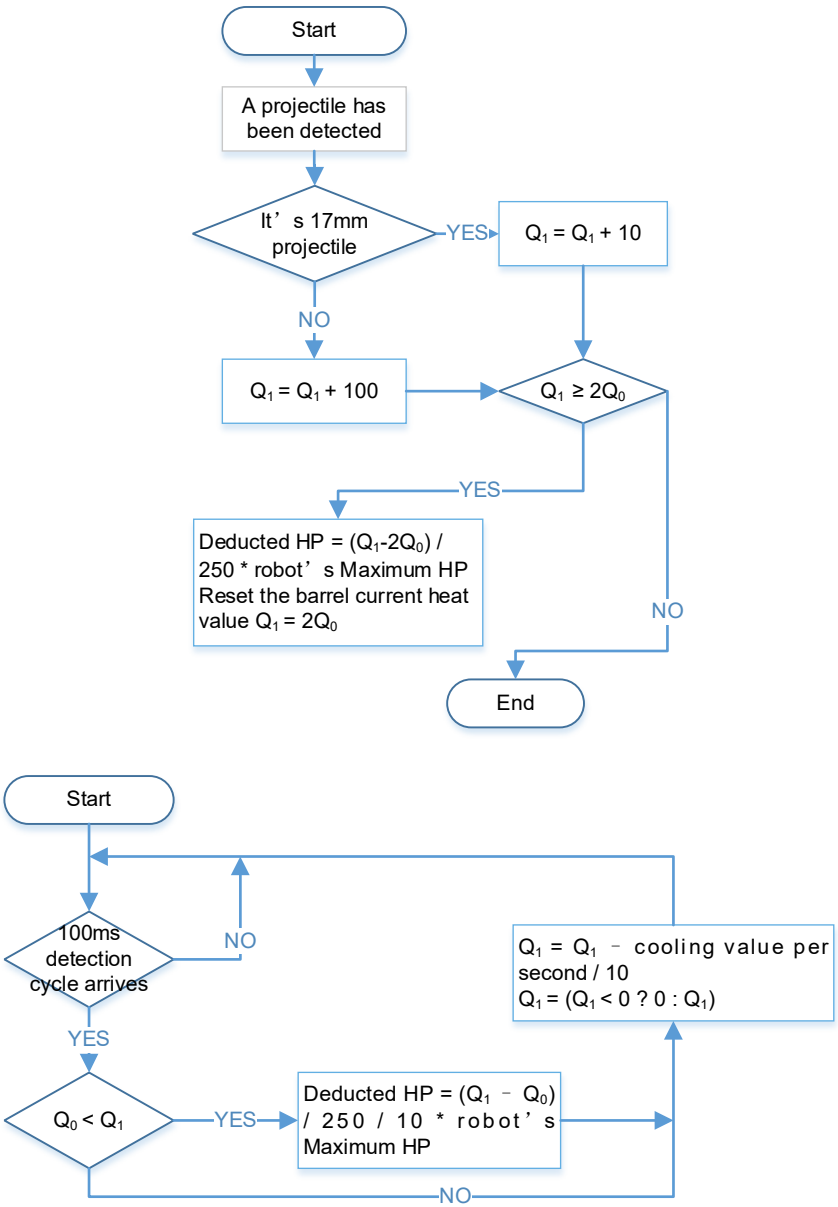

Figure 3-2 (Above) HP Deduction logic and (Below) cooling logic when Barrel Heat limit is exceeded

3.2.3 Exceeding Chassis Power Consumption Limit

The Chassis Power Consumption of robots will be continuously monitored by the Referee System, and the robot chassis needs to run within the chassis power consumption limit. Considering it is difficult for a robot to control instantaneous output power when in motion, a buffer energy (Z) has been defined in order to avoid the penalty that accompanies. The buffer energy of a Standard Robot is 60J.

After buffer energy has been exhausted, if the Chassis Power Consumption of a Standard Robot exceeds the limit, the deducted HP for each detection cycle = Maximum HP * N% * 0.1.

The Referee System monitors Chassis Power Consumption at a frequency of 10Hz.

Excess Percentage: $K = (P_r - P_l) / P_l * 100\%$, where P_r is the instantaneous Chassis Power Consumption output and

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P_I is the power consumption limit.

Table 3-3 Penalty Mechanism for Exceeding Chassis Power Consumption Limit

K	N%
K ≤ 10%	10%
10% < K ≤ 20%	20%
K > 20%	40%

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The logic graph for Chassis Power Consumption detection and Deducted HP for a Standard Robot is shown below:

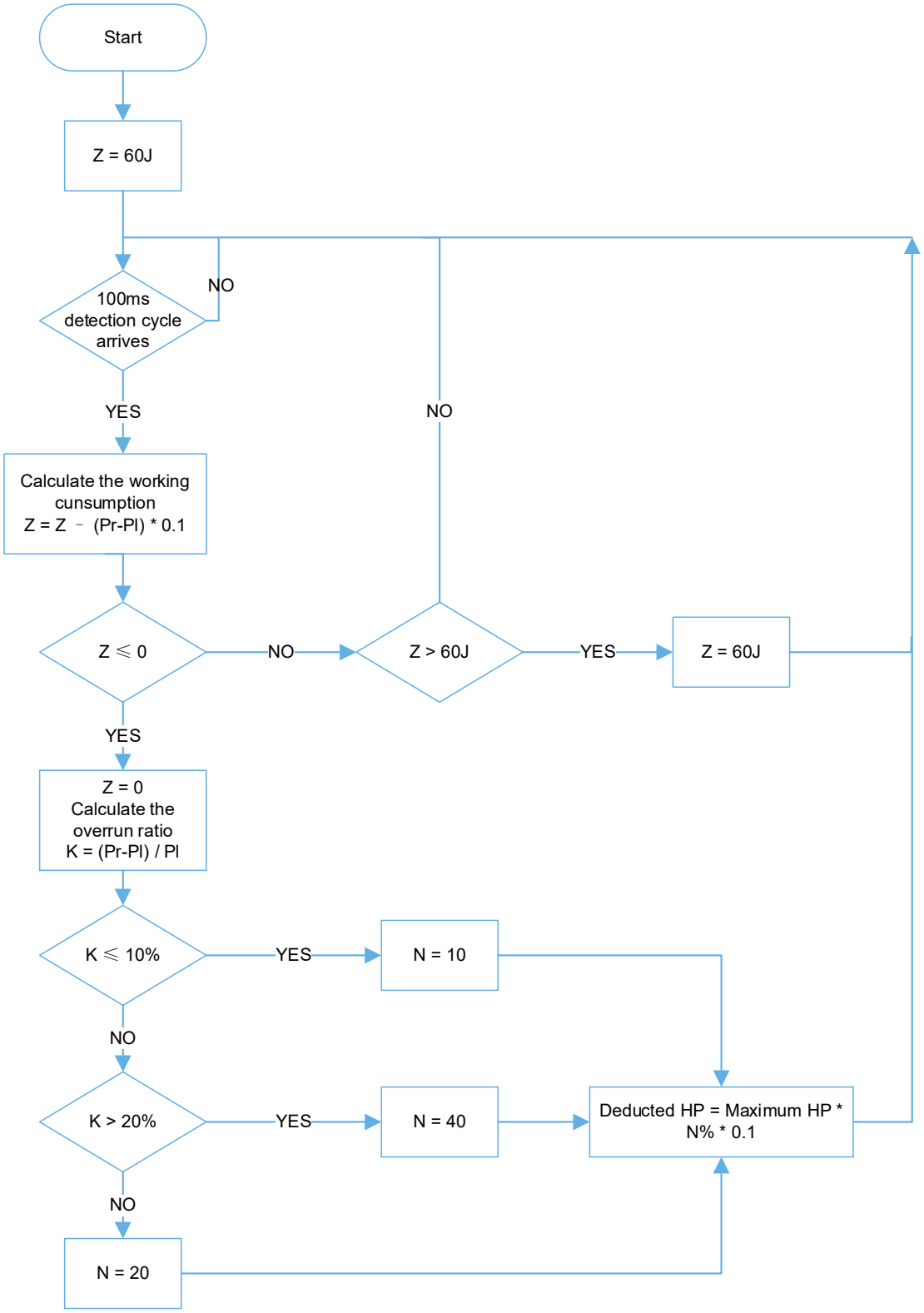

Figure 3-3 Chassis Power consumption detection and HP Deduction Logic of Standard

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3.2.4 Attack Damage

⚠ In an actual match, the normal speed of a projectile that touches the Armor Module attack surface is different from its initial firing speed due to the projectile's speed decay and its incident angle not being normal to the Armor Module attack surface. Damage detection is based on the normal component of the projectile's speed upon contact with the Armor Module attack surface.

An Armor Module detects projectile attacks using the pressure sensor combined with the armor's vibration frequency. A Dart Target Module detects dart attacks using the Armor Module combined with the phototube. The time interval required for the detection of a dart attack by a Dart Detection Module is 1 second.

The minimum detection gap for an Armor Module is 50 ms.

The projectile needs to come into contact with the impact surface of the armor module at a certain speed in order to be successfully detected. The velocity range for the detection of different projectile types by an armor module is as follows:

Table 3-4 The velocity range for the detection of different projectile types by an armor module

Armor Module	17mm projectile
Large Armor Module, Small Armor Module	No less than 12 m/s
Triangular Armor Module	Not detected

A robot will experience damage when its Armor Module is hit in collision.

The table below sets out the HP deductions for different armors assuming no buff points are received:

Table 3-5 HP Deduction Mechanism for Attack Damage

Damage Type	HP Damage Value
Collision	2
Dart	1/2 of the Maximum HP of Base or Outpost

3.2.5 Referee System Going Offline

According to the latest version of the "RoboMaster 2021 University Series Robot Building Specifications Manual", robots must be mounted with their corresponding Referee System modules, and each Referee System module must have a stable connection to its server throughout the competition. The Referee System server detects the connectivity of each module at a frequency of 2 Hz. If important Referee System modules such as a Speed Monitor Module, Positioning System Module or Armor Module goes offline due to design or structural problems, then the HP of the corresponding Ground Robots will be deducted.

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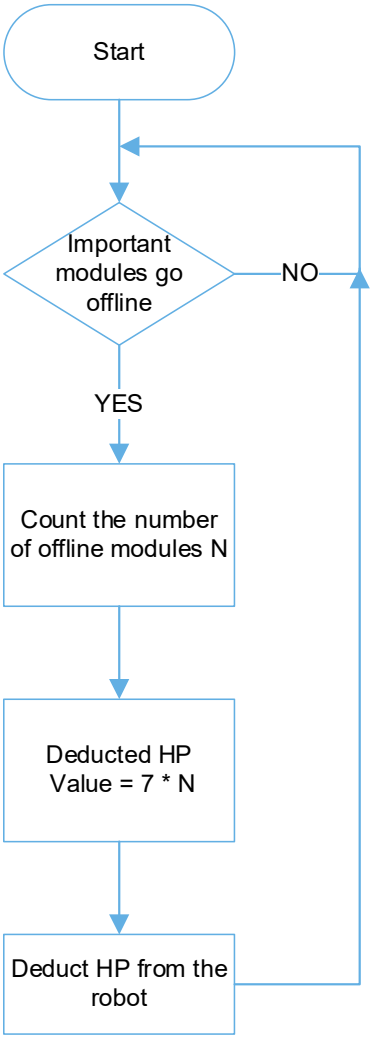

Figure 3-4 HP Deduction Mechanism for Important Referee System Modules Going Offline

3.3 Revival Mechanism

For the Standard Racing and Smart Firing challenge, the Revival Mechanism is as follows:

- Revival Mechanism: In each round, a Standard Robot can be revived twice at any location of the Battlefield. Upon revival, its HP will be restored to its Maximum HP.
- Time Required for Revival: It takes 10 seconds for a Standard Robot to be revived after being defeated.

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4. Challenge

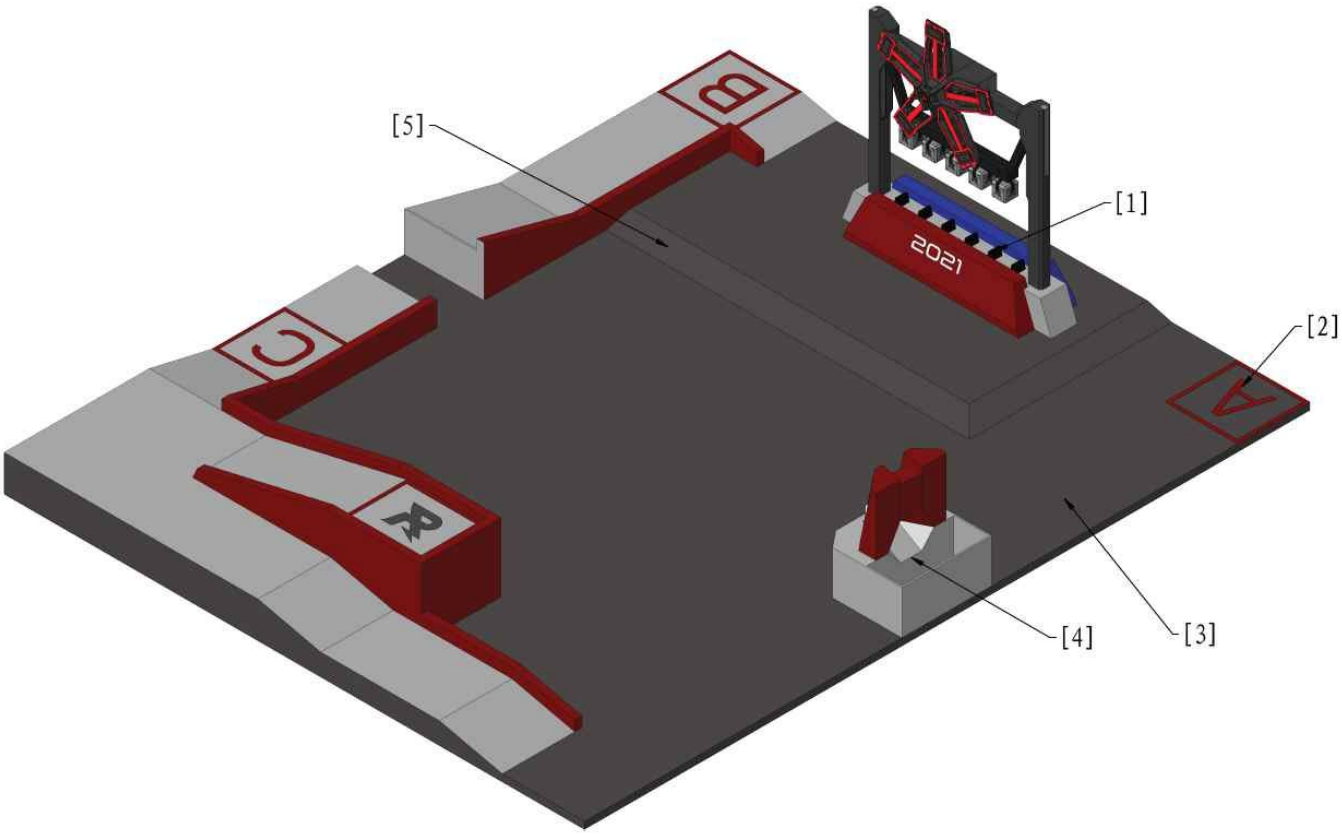
4.1 Engineer Mining

In each round, teams are given 1 minute to prepare for and 3 minutes to complete the Engineer Mining challenge.

The Engineer Robot leaves the Starting Zone, obtains minerals at the Resource Island, and redeem them at the Exchange Station. The Engineer Robot will be scored and ranked based on the quantity of minerals procured and the time taken to complete the task.

4.1.1 Competition Site

The site is 10m long and 8m wide. It consists of the Starting Zone, Resource Island and Exchange Station.



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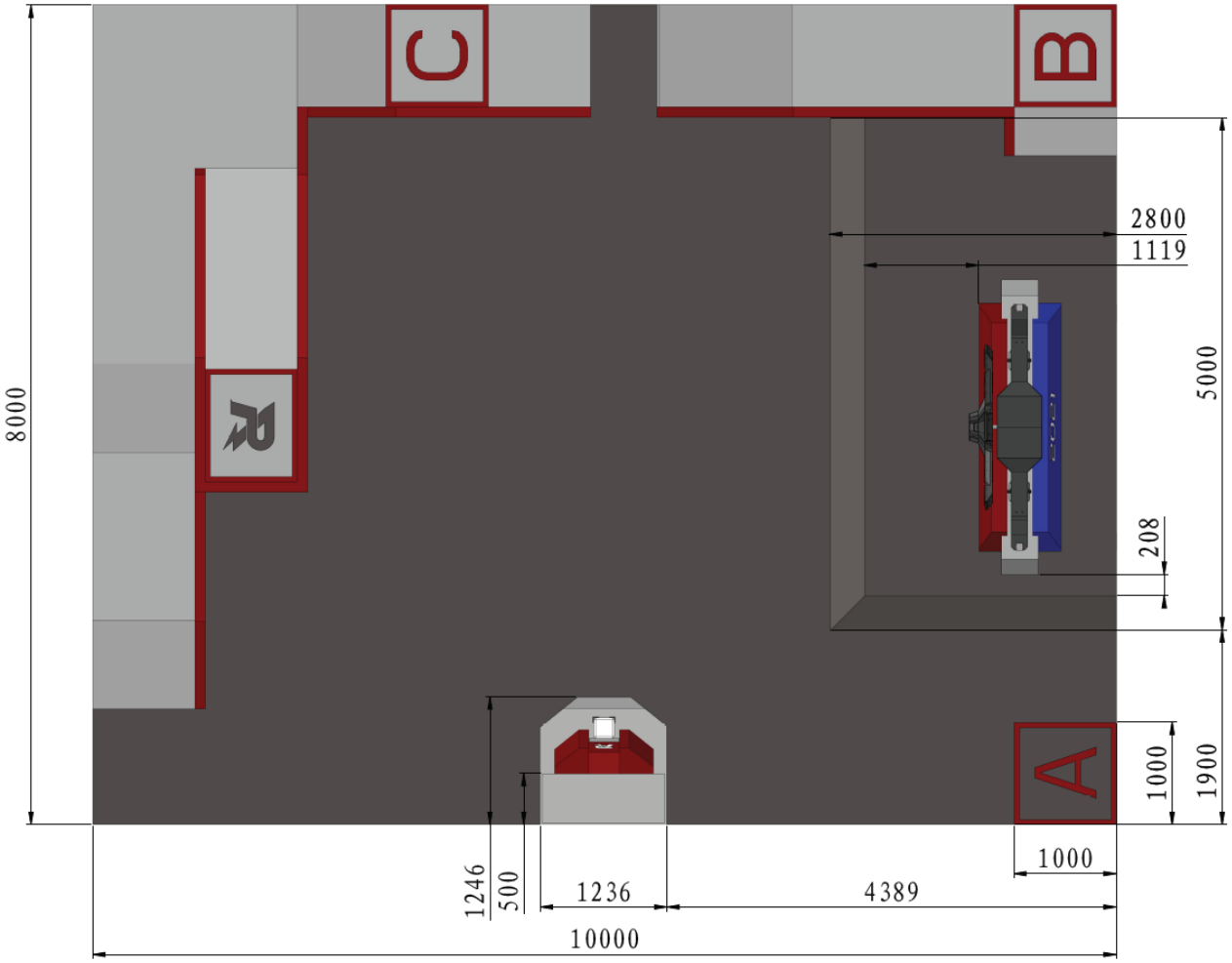

[1] Resource Island [2] Starting Zone (Zone A) [3] Ground [4] Exchange Station [5] 15° slope

Figure 4-1 Battlefield Components Involved in Engineer Mining

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4.1.1.1 Resource Island

There are 5 minerals on the Resource Island.

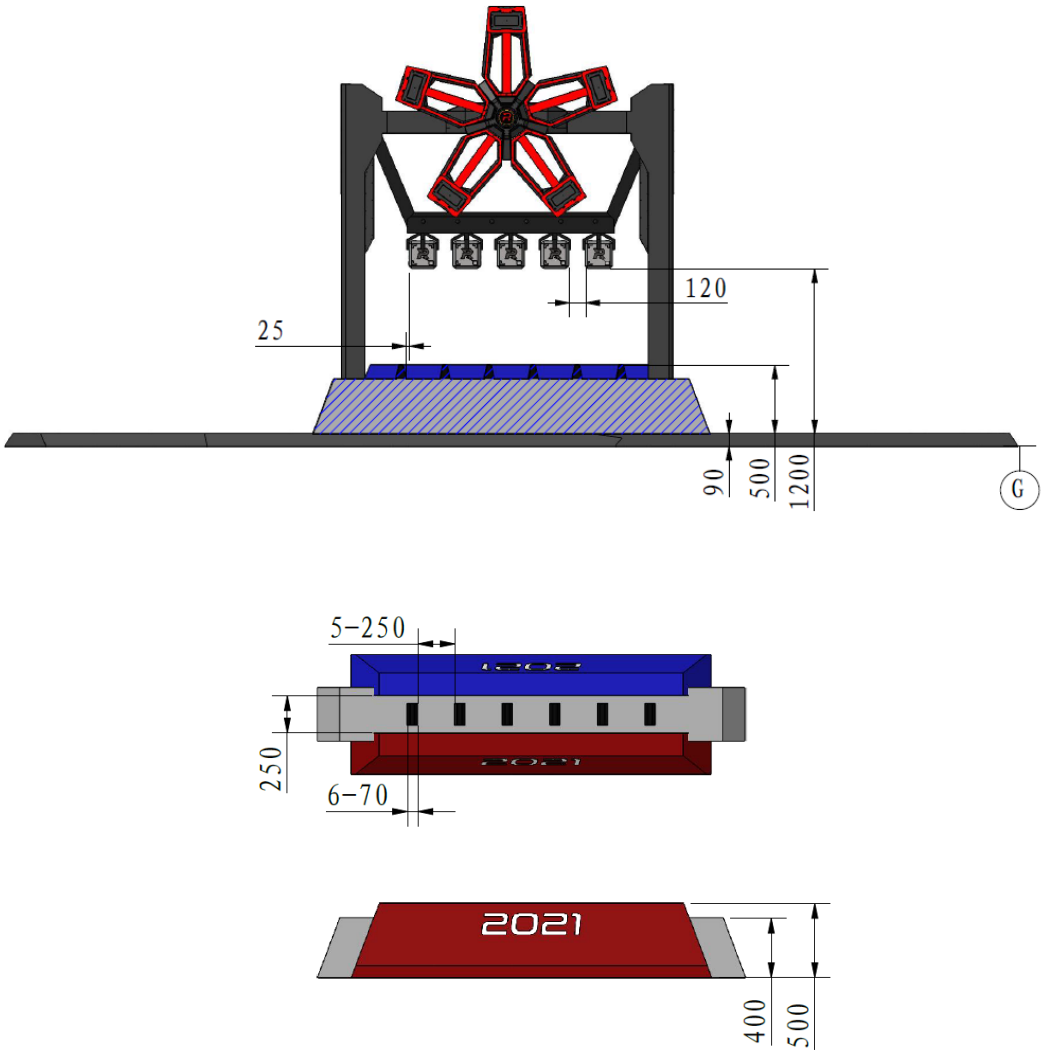

Figure 4-2 Dimensions of Resource Island

4.1.1.2 Minerals

The graphics on the mineral will later be changed and updated.

The mineral is an EVA cube with chamfered corners, in the dimensions of 200*200*200mm. It contains a RFID Interactive Module card. An illustration of the mineral is shown below.

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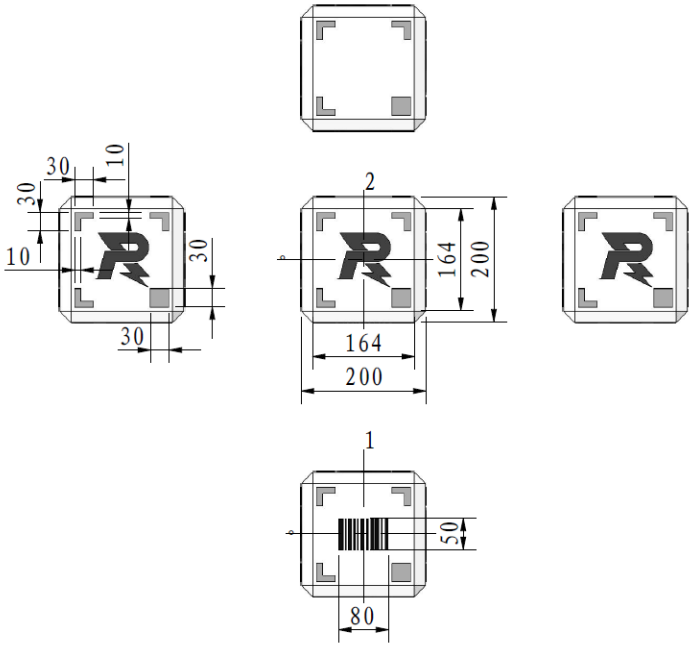

Figure 4-3 The mineral

4.1.1.3 Exchange Station

During the competition, an Engineer Robot may procure minerals from the Resource Island and then place them at the redemption point of the Exchange Station in the correct position (with the bar code facing downwards). When the RFID Interactive Module of the Exchange Station detects the RFID Interactive Module card in the mineral, the light indicator will flash indicating that the exchange is complete. After completing the exchange, the Engineer Robot needs to push the minerals into the receptacle.

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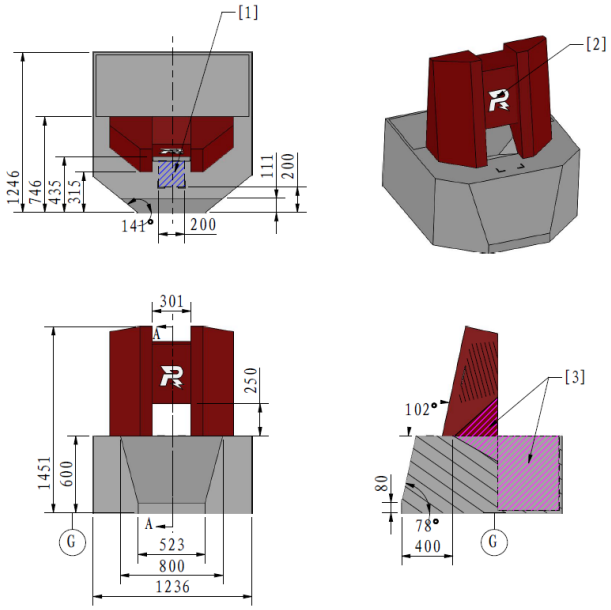

[1] Mineral identification zone [2] Light indicator [3] Mineral receptacle

Figure 4-4 Exchange Station

4.1.2 Mission

The Engineer Robot stands by in the Starting Zone before the match. After the match begins, the Engineer Robot needs to procure minerals at the Resource Island and place them at the Exchange Station. The match ends after all the minerals have been successfully placed or the time for the match has run out.

Th minerals will be dropped in two batches. As the first batch, Mineral No. 2 and 4 will be dropped 10 seconds into the match, while Mineral No. 1, 3 and 5 will be dropped as the second batch after 1 minute. Each mineral in a batch will be dropped randomly at a 5 seconds' interval.

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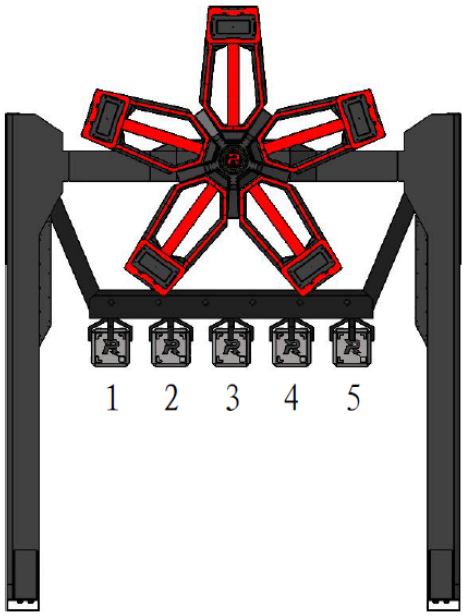

Figure 4-5 Numbering for minerals

4.1.3 Scoring

Five points will be given for each mineral successfully placed at the Exchange Station. If all 5 minerals have been deposited and there is still N seconds remaining, a further N points will be added to the score.

4.1.4 Ranking

The teams will be ranked based on the following rules:

1. Each team can attempt the challenge twice and take the highest total score out of the two attempts as its final score. Teams with the higher scores are ranked higher.
2. In the case of two or more teams having the same scores, the team whose robot is lighter will be ranked higher.

4.1.5 Judging Criteria

The Engineer Robot has placed at least 1 mineral at the Exchange Station.

4.2 Standard Racing and Smart Firing

Teams are given 1 minute to prepare for and 1 minutes and 30 seconds to complete the challenge.

The Standard Racing and Smart Firing as well as the Engineer Mining challenges share the same Battlefield.

A Standard Robot will move from the Starting Zone, pass through the designated task points one by one as quickly

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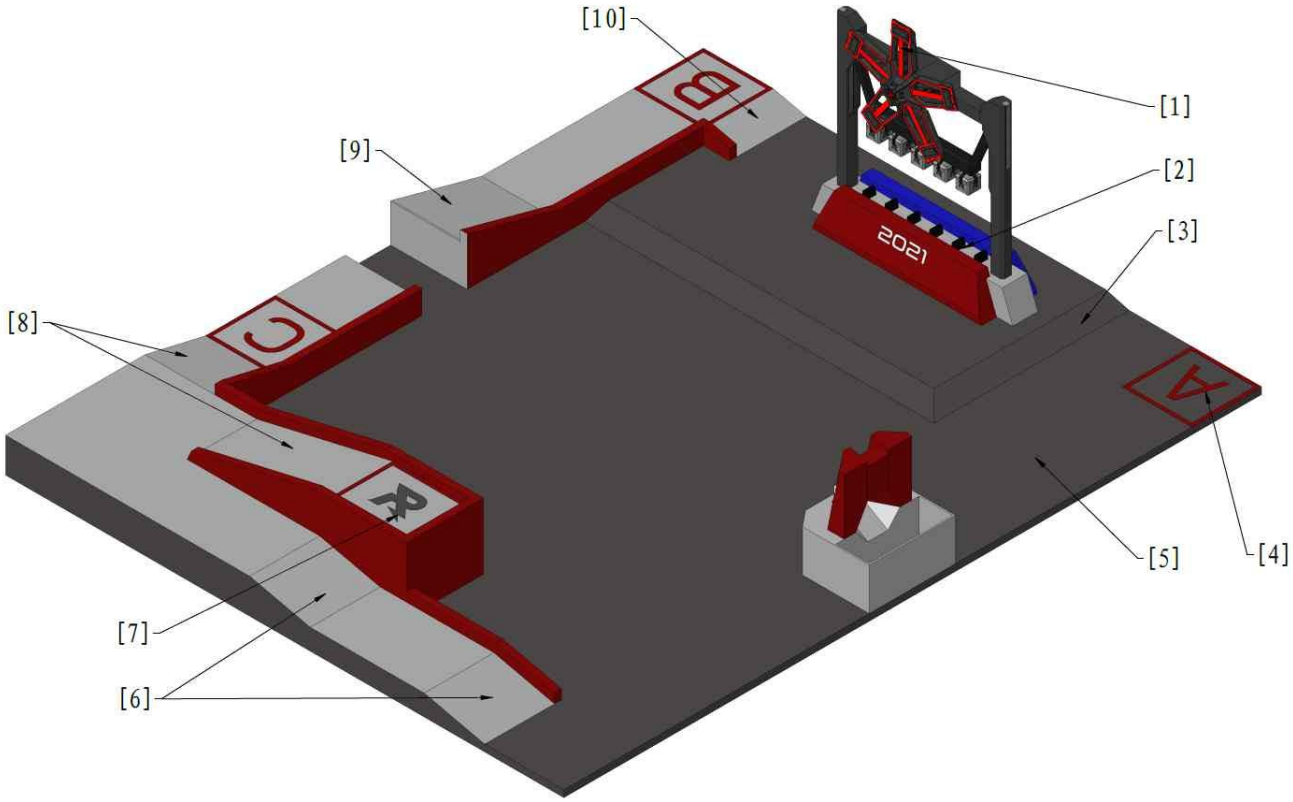
as possible, and arrive at the Power Rune activation point. The task is deemed completed as soon as the Power Rune is successfully activated. The final scores and ranking will be based on the time spent completing the task.

4.2.1 Competition Site



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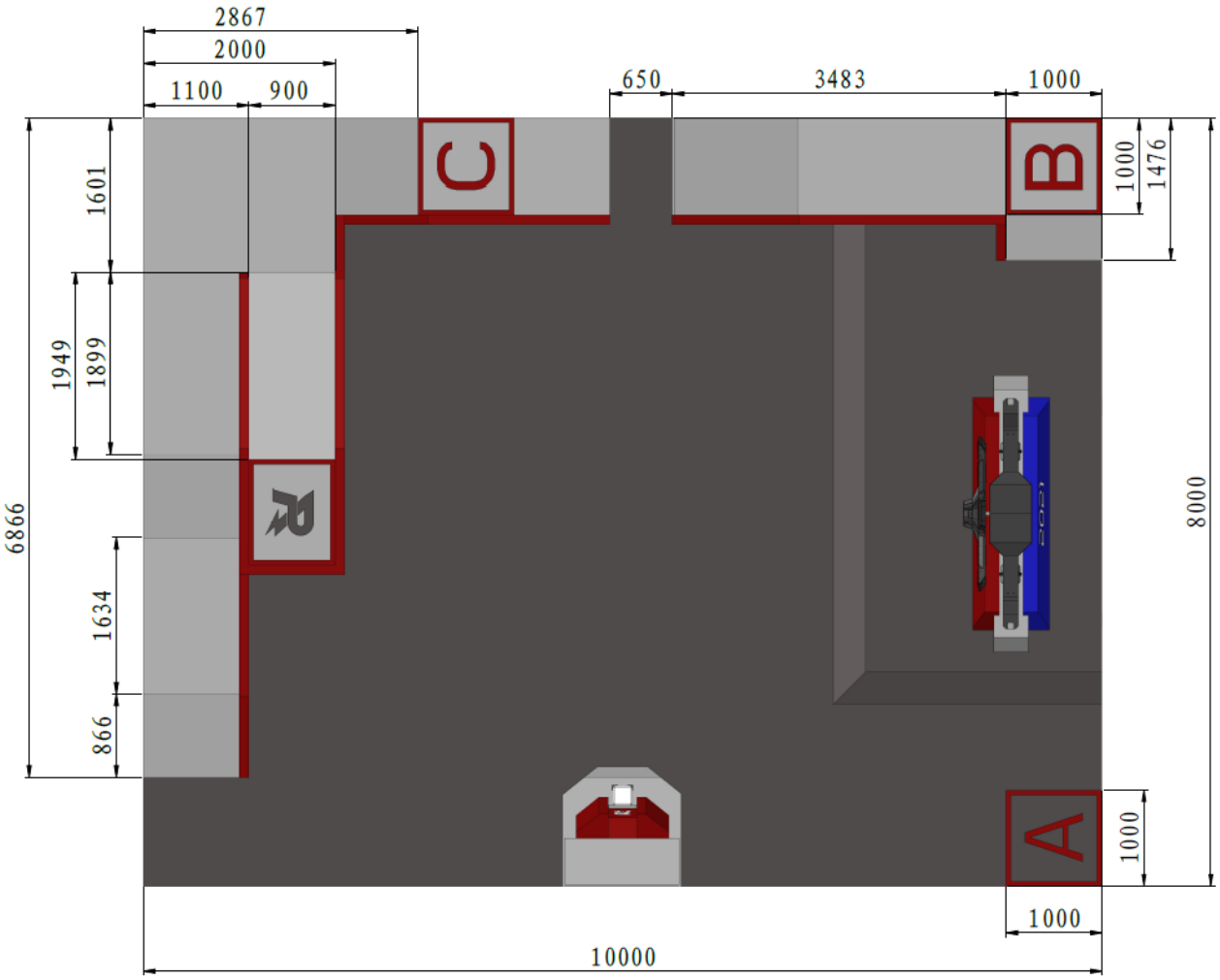

[1]	Power Rune	[2]	Resource Island	[3]	15° slope
[4]	Starting Zone (Zone A)	[5]	Ground	[6]	13° slope
[7]	Power Rune Activation Point (Zone D)	[8]	13° slope	[9]	15° slope
[10]	13° slope				

Figure 4-6 Battlefield Components Involved in Standard Racing and Smart Firing

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4.2.1.1 Power Rune Activation Point

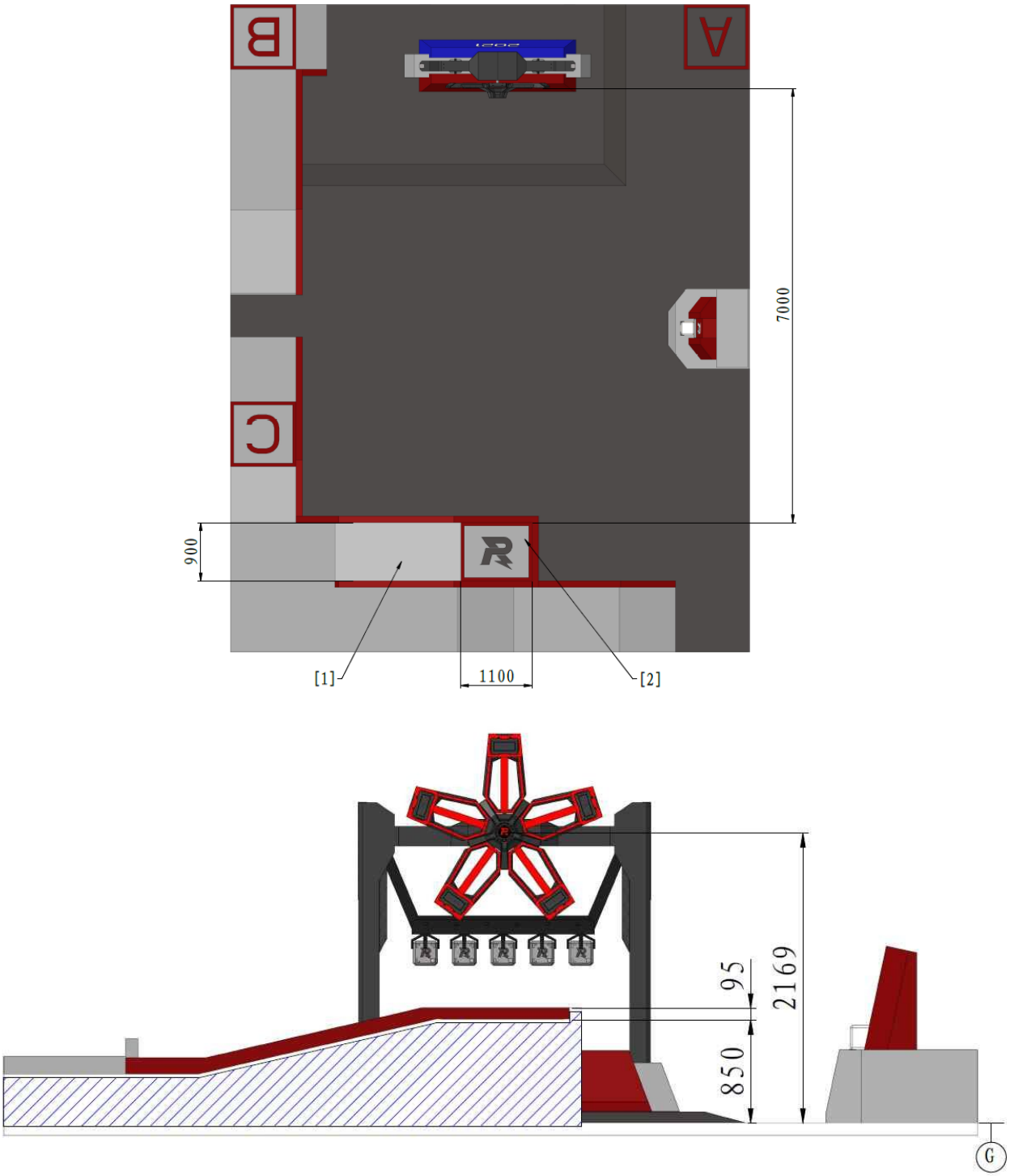

Figure 4-7 Dimensions of Power Rune Activation Point

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4.2.1.2 Road

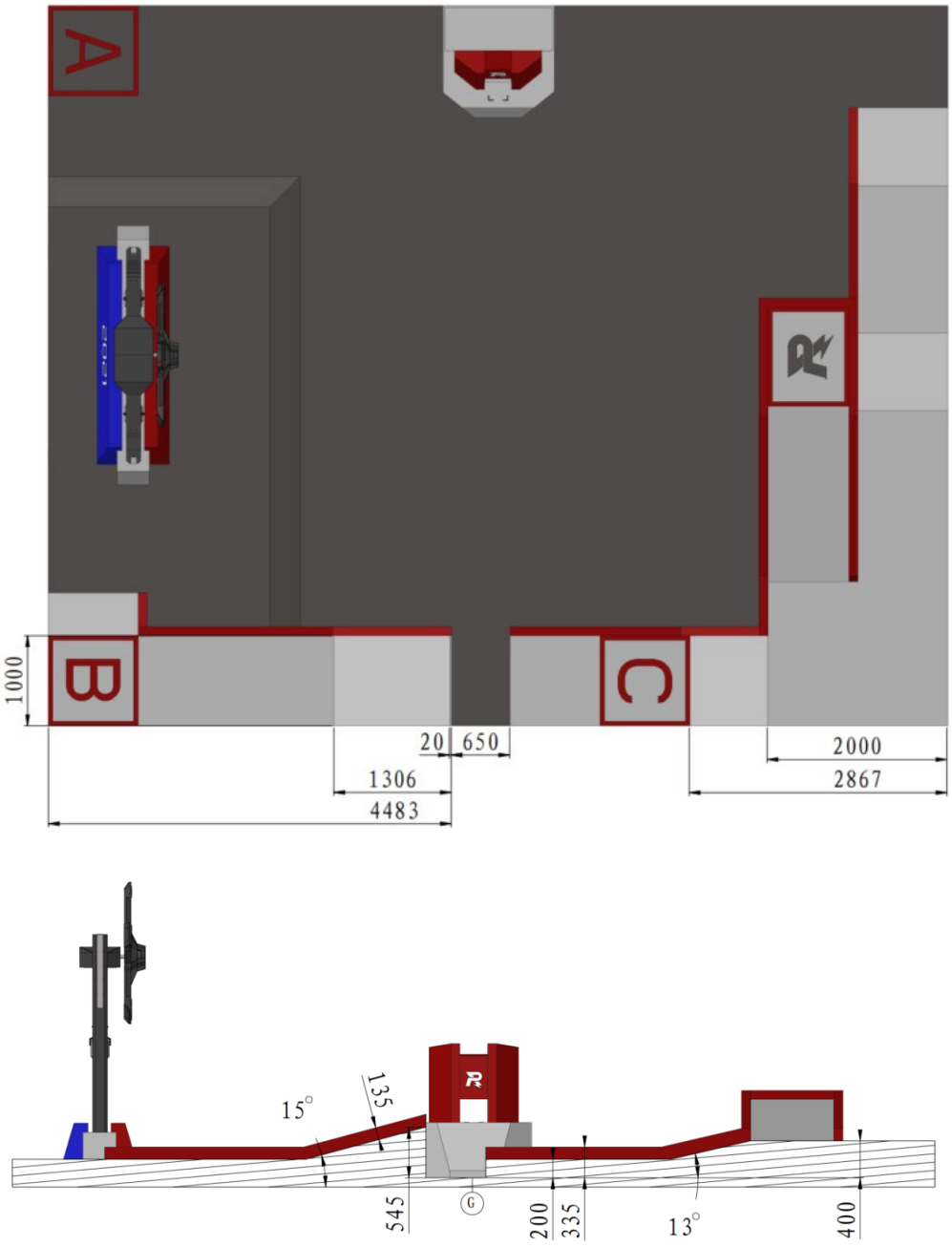

Figure4-8 Road

4.2.1.3 Power Rune

- The Power Rune will have a slight dip in the middle due to its weight. The dip is around 0~50 mm.
- In the Regional Competitions, there will be no lighting effects on the pillars of the Power Rune.

The Power Rune is located directly above the Resource Island. The Power Rune is powered by the motor and rotates

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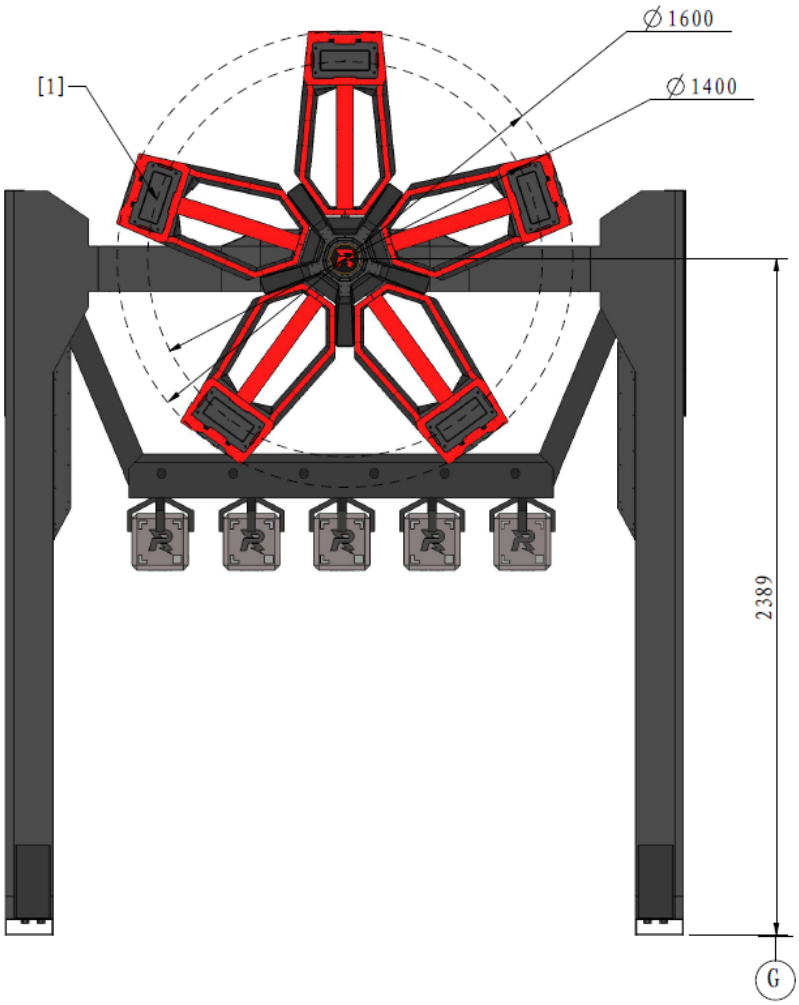
at a regular rhythm. The robot needs to occupy the Power Rune Activation Point to activate the Power Rune. The red team's Power Rune is used in RMUT.

A Power Rune has five mounting brackets that are distributed evenly. The end of each mounting bracket is installed with a Large Armor Module. The specific location and dimensions of the Large Armor Module are as follows:



[1] Large Armor Module

Figure 4-9 Power Rune

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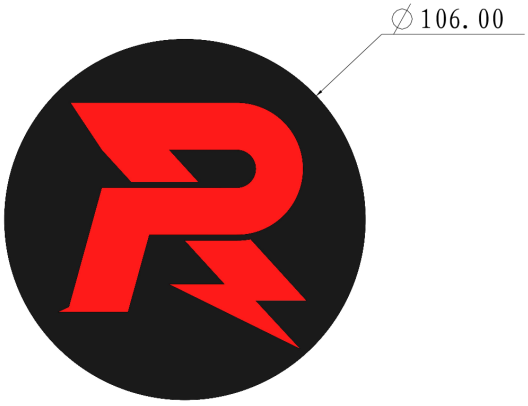

Figure 4-10 Central logo of the Power Rune

Rotation Strategy

After the round has begun, the Power Rune starts to rotate in a random direction and remains the same throughout the round.

The rotational speed of the Power Rune is based on the cyclical change of a trigonometric function. The target function for speed is: spd=0.785∗sin (1.884∗t)+1.305□ where the unit of "spd" is rad/s; the unit for "t" is s; and "t" is reset as 0 every time the Large Power Rune enters the available state.

The margin of error for time between the actual spinning speed of the Large Power Rune and the objective speed function is within 500 ms.

Status

1. Unavailable

Before the start of a match, the Power Rune is in the unavailable state.

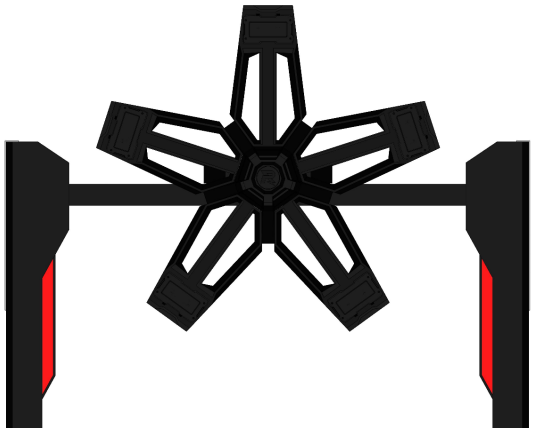

Figure 4-11 Power Rune When Unavailable

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2. Available

After a match begins, the central light indicator of the Power Rune turns on, and the Power Rune is in the available state.

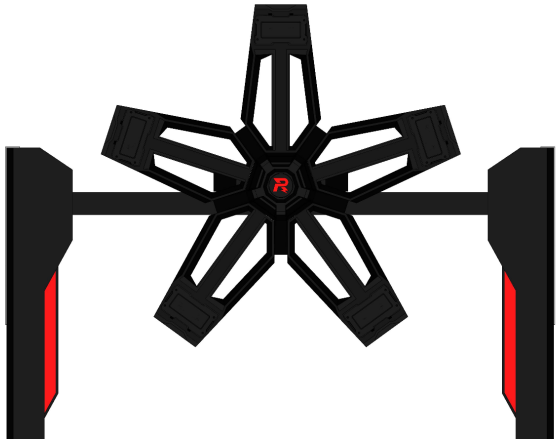

Figure 4-12 Power Rune When Available

3. Activating

When the Power Rune is available, a Standard Robot that occupies the Power Rune Activation Point and stays there for 3 seconds will launch the Power Rune into the activating state ("Figure 4-13 Power Rune in Activating State"). The arrow light effects on the mounting bracket of any of the 5 Armor Modules will be turned on at random. If a projectile manages to hit the Armor Module within 2.5 seconds, its mounting bracket will be completely lit up. At the same time, the Power Rune will randomly illuminate one of the remaining four armor modules, so on and so forth, as shown below:

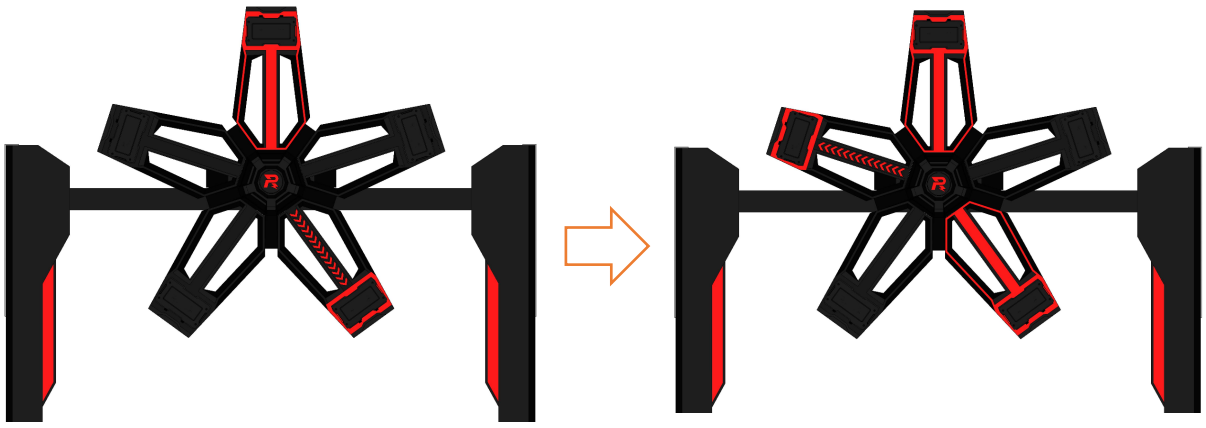

Figure 4-13 Power Rune when activating

4. Activated

If all five mounting brackets are illuminated, the Power Rune is then activated as shown below:

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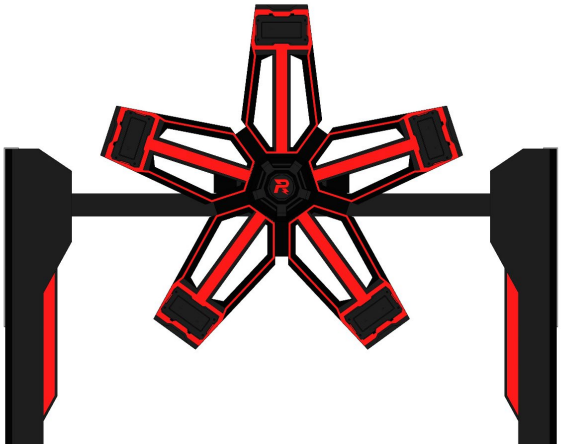

Figure 4-14 Power Rune When Activated

5. Activation Failed

If any of the following conditions occur during activation, the activation will fail and the Power Rune become available for activation again.

- Failure to hit a randomly lit Armor Module within 2.5 seconds
- A non-randomly lit Armor Module is hit

4.2.2 Mission

The Standard Robot is pre-loaded with 50 rounds of 17mm projectiles. During the competition round, the robot must complete the following missions in order:

1. Depart from Zone A, pass through Zone A, B and C on the site, and eventually reaching Zone D. The barrel cooling value per second of the Standard Robot is now five times its original value.
2. The robot activates the Power Rune in Zone D. The match ends once the Power Rune is activated completely.

The team can decide the route of the Standard Robot's movements.

4.2.3 Ranking

Each team can attempt the challenge twice. The teams will be ranked based on the following rules:

Activated Power Rune:

1. The team that spent the least amount of time finishing the challenge will be ranked higher.
2. If the time to finish the challenge is the same, the teams will be ranked based on the remaining HP of their robots.

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3. If the time and the remaining HP are the same, the teams will be ranked based on the weight of their robots, with the lighter ranking higher.

Failed to activate Power Rune:

1. The highest ring number struck by the team on the Power Rune will be taken as its final score. Teams with the higher ring numbers will be ranked higher.
2. In the case of two or more teams having the same struck ring numbers, the team whose hit was achieved in the shortest time will be ranked higher (time accurate to the second).
3. If the time of achieving the highest strike rings of Power Rune is the same, robot with the higher remaining HP ranks higher.
4. If the time and the remaining HP are the same, the teams will be ranked based on the weight of their robots, with the lighter ranking higher.

4.2.4 Judging Criteria

Teams that have hit at least 2 rings on the Power Rune will qualify for the judging process.

4.3 Dart Targeting

Dart Targeting shares the same Battlefield with the RMUC 2021. The Dart's Object is the Outpost and Base of the opposing side.

For more details on the Battlefield and the Dart Launching Mechanism, refer to the latest version of the RoboMaster 2021 University Championship Rules Manual.

4.3.1 Mission

Teams are given 2 minutes to prepare for and 1 minute to complete the challenge.

Before the start of a match, the team must place its Dart Launcher at the corresponding Dart Launching Station on the Battlefield and adjust the Darts. The Radar must also be placed on the Radar Base. After the preparation is done, the operator shall launch all the Darts loaded in the Dart Launcher within 1 minute. The mission is deemed completed once all the Darts have been launched. The team with the highest remaining HP on their Outpost and Base will be the winner.

If the Outpost has not been destroyed, a Dart's attack on the Outpost will be ineffective. For more details on damage inflicted by Darts, refer to "3.2.4Attack Damage".

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4.3.2 Ranking

The teams will be ranked based on the following rules:

1. Each team can initiate two challenges and take the highest total Hp deduction of the two challenges as the final score. All teams will be ranked from high to low based on their total HP deduction.
2. In the case of two or more teams having the same HP deduction, the team whose last subject hit was achieved in the shortest time will be given the higher ranking (time is accurate to milliseconds and subject to server record time).

4.3.3 Judging Criteria

The Dart must be able to hit the Outpost at least once.

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5. Competition Process

Each challenge is called a round, and a match consists of multiple rounds.

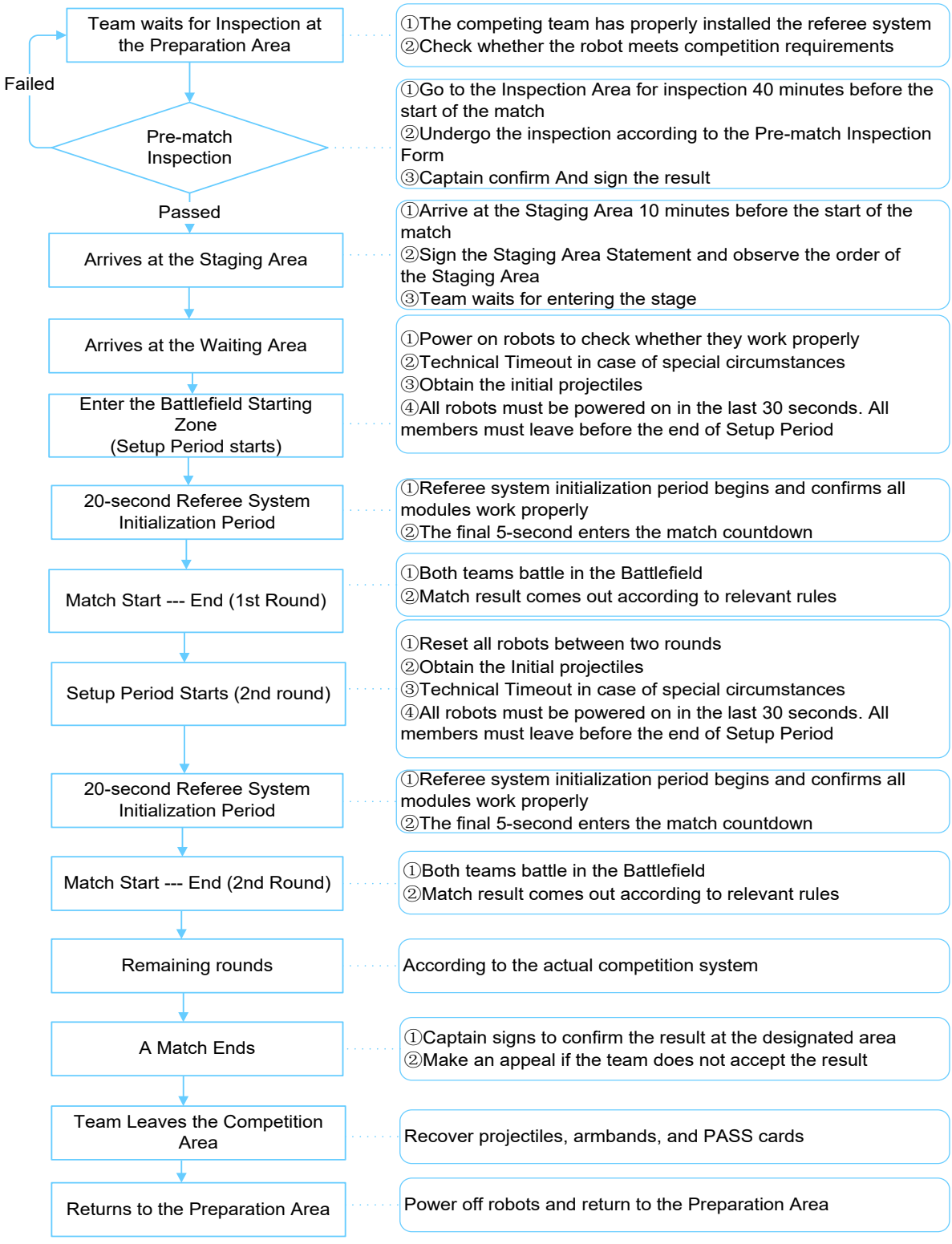

Figure 5-1 Process of a single match

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5.1 Pre-Match Inspection

To ensure that robots meet the required standard specifications, each team must undergo Pre-match Inspection in the Inspection Area 40 minutes before the start of each match. For the requirements of the Pre-match Inspection, please refer to the RoboMaster 2021 University Series Robot Building Specification Manual. The inspection process is as follows:

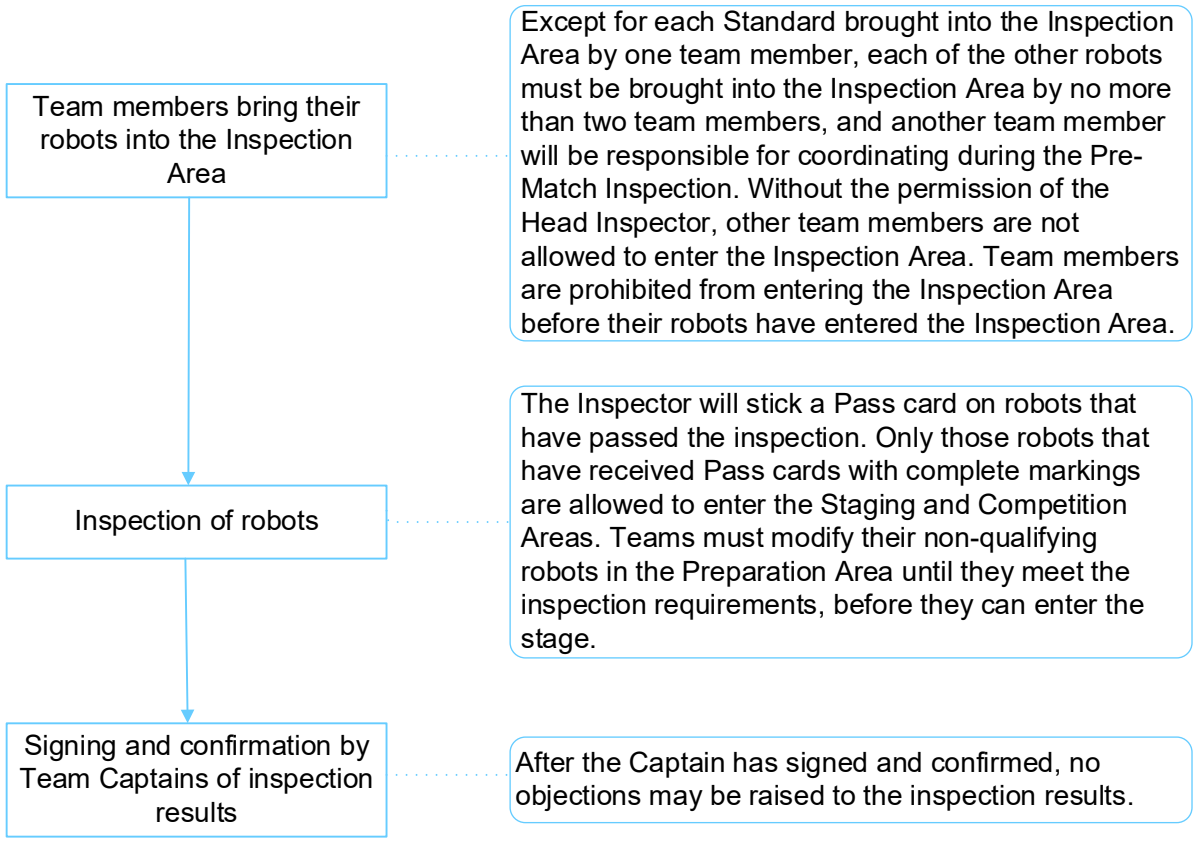

Figure 5-2 Process of Pre-Match Inspection

The rules regarding backup robots are as follows:

- Each team is allowed to have backup robots for each match. For the specific numbers allowed are, refer to "Table 1-1 Robot Lineup"
- After passing the Pre-match Inspection, backup robots cannot be replaced without permission. During Mock Inspection, the RMOC will issue Referee Systems to backup robots that have passed Mock Inspection. A team can borrow the Referee System for no more than one backup robot. Teams need to immediately return the Referee Systems of backup robots after finishing its competitions in the division.

5.2 Staging Area

Teams must arrive at the Staging Area 10 minutes before the match. Staff at the Staging Area will check the status

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of the participating robots and the information of the Pit Crew. The team needs to sign the Staging Area Statement after confirmation.

If any team needs to repair its robots after entering the Staging Area, it must obtain the permission of the staff at the Staging Area. Only when staff at the Staging Area has removed the Pass Card on the robot and the Staging Area Statement originally signed become invalidated can a robot leave the Staging Area for repair. When repair is finished, the robot needs to be brought back to the Inspection Area for another Pre-Match Inspection before re-entering the Staging Area, and the Team Captain must sign a new Staging Area Statement. If a Staging Area Statement cannot be signed in time as a result of this delay, the robot will not be able to enter the match, and the team will bear its own consequences.

After leaving the Staging Area, the participating teams will enter the waiting area of the Competition Area to place their robots. When the previous match has ended and with the permission of the referee, the next pair of participating teams will wait at the entrance of the Battlefield with their robots for further instructions. After the referee has confirmed that both teams are ready, he or she will open the door and lead the team members into the Competition Area. The countdown for the Setup Period begins the moment the door is opened.

5.3 Setup Period

During the Setup Period, the Pit Crew Members need to check whether the Referee System is working normally, load initial projectiles on robots whose Initial Projectile Quantity is not zero, load Darts on the Dart Launcher, and fix the Radar on the Radar Base. The Pit Crew Members may repair robots or perform replacements using equivalent parts. The referee may initiate an Official Technical Timeout at any time and perform immediate inspections on robots.

Equivalent parts: Standard modules or components having the same material, form and functions, for example motors of the same model and self-built friction wheel modules.

In the last 30 seconds of the Setup Period, the operator should preferably be in the Operator Room to complete debugging for the keyboard and mouse (which can be brought by the team itself), and double-check that

the robot's control and official equipment are operating normally. If any equipment in the Operator Room does not operate normally, the operator must raise the issue before entering the final 15 seconds of the Setup Period. Otherwise, no technical timeout will be allowed by the referee. Besides the operator, no other Pit Crew Members are allowed inside the Operator Room.

Thirty seconds before the end of the Setup Period, all robots on the Battlefield must be powered up, and personnel on the Battlefield should leave the Competition Area in an orderly manner. Pit Crew Members should place the debugging remote controller for the Dart System and Radar in the designated area at the Battlefield entrance.

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5.3.1 Official Technical Timeout

During the Setup Period, if the Referee System, equipment inside the Operator Room or other components experience any faults (for details see "Table 5-1 - Descriptions of Technical Faults "), the Chief Referee may announce an Official Technical Timeout and pause the countdown.

During an Official Technical Timeout, team members can only work with the staff in eliminating the relevant faults of the Referee System or other official equipment, and are not allowed to repair other faults. When the relevant fault of the Referee System or official equipment has been eliminated and the Chief Referee has resumed the countdown, Pit Crew Members are required to follow the set procedures for the Setup Period and leave the Battlefield within the specified time.

Table 5-1 Descriptions of Technical Faults

Rule	Description
1	A fault occurs with the official equipment in the operator room, and any key competition component in the Battlefield experiences structural damage or functional irregularity.
2	During the Setup Period of the first round, the Referee System Module on a robot fails, for example where the robot is unable to transmit images back to the Operator Room normally or connect to the Referee System server.
3	Other situations determined by the Chief Referee as requiring an Official Technical Timeout.

If the malfunction referred to in Rule 2 occurs during the Setup Period between rounds or during a round, it will be categorized as "regular battle damage", as it cannot be determined whether the malfunction was caused by the Referee System Module, a flaw in a robot's circuit or structural design, or robot combat from a previous match. Regular battle damage does not trigger an Official Technical Timeout, and the referee will provide a backup Referee System Module. Teams may request for a "Team Technical Timeout" to repair their robots.

5.3.2 Team Technical Timeout

If the mechanical structure of a robot, a software system, the keyboard or mouse in the Operator Room or other equipment experiences any faults, the Team Captain may make a request to the referee in the Battlefield or Operator Room for "Team Technical Timeout" before entering the final 15 seconds of the Setup Period, and indicate the requested timeout length and reasons for the request. Once a Team Technical Timeout request has been made and conveyed to the Chief Referee, the Technical Timeout cannot be revoked or revised.

Even if the team did not enter the Battlefield or ended the Technical Timeout early, the opportunity used will still be the opportunity corresponding to the timeout length indicated by the team during its request. At this time, the

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Chief Referee will continue the countdown of the Technical Timeout, or the Chief Referee may end the Technical Timeout early after confirming that both teams are ready.

After the match, the Match Results Confirmation Form will state whether Technical Timeout opportunities have been used during the match. The type of Technical Timeout allowed is determined by the Chief Referee based on the request of the team. The team cannot dispute the type of Technical Timeout allowed, and the Technical Timeout process cannot be the basis for any appeal after the match.

For every challenge, each team is entitled to one Technical Timeout opportunity for two minutes, in both the Regional and National Competitions. A team cannot request for more Team Technical Timeout opportunities once they have been used up.

5.4 Referee System Initialization Period

After the Setup Period, the match enters a 20-second Referee System Initialization Period. During the Initialization Period, the competition server will automatically detect the connection status of the client, the Referee System module status of the robot, the status of Battlefield Components and restore the HP of all robots, ensuring their HP are full when the match officially begins.

If a robot experiences a technical fault with the Referee System during a first challenge, which causes the initialization countdown to stop, a maximum of two Pit Crew Members for the team are allowed to enter the Battlefield to inspect and solve the issue.

When the Referee System Initialization Period is left with 5 seconds, a clear countdown sound effect and live animation will be played. At this time, the keyboard connected to the computer in the Operator Room will be locked. When the countdown finishes and the keyboard unlocks, the match starts immediately.

5.5 Competition Round

The teams complete the mission of the challenge.

5.6 End of Competition

A challenge is deemed completed after its time has run out or the team fulfills the criteria to end the challenge early.

5.7 Match Results Confirmation

During a match, the referee will record on the Match Results Confirmation Form the penalties issued for each round, the key competition data at the end of the match, the use of Technical Timeout opportunities by the teams, and other

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relevant details. After a team has completed all its challenge attempts, the Team Captain needs to proceed to the Referee Area and confirm the results.

Within 5 minutes after a match ends, the Captains of both teams must confirm the match results by signing at the Referee Area. If a Team Captain is not at the Referee Area within 5 minutes to sign and confirm the results and has not requested an appeal, it is deemed that the team agrees with the match results. Once a Team Captain has signed and confirmed the results, no further appeals can be made. Please refer to "8 - Appeal" for details on the appeal process.

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6. Violations and Penalties

Any penalty issued before the start of a competition will be executed after the competition officially starts. Penalty of violation stated in this chapter will be determined by the Chief Referee according to the actual situation.

To ensure the fairness of the competition and uphold discipline in the competition, participating teams and robots are required to adhere strictly to the Competition Rules. Referee will issue the appropriate penalty against any violation of rules.

Serious violations and all appeals in the competition will be publicized.

6.1 Penalty System

6.1.1 Forms of Penalties

During a match, the referee may issue penalties against participants and robots that have failed to comply with competition rules. The forms of penalties are as follows.

Table 6-1 Forms of penalties

Forms of Penalties	Description
Automatic penalties by the Referee System	HP deductions as a result of a robot exceeding its parameter limits or a Referee System Module going offline. The HP deductions mentioned in "3.2 HP Deduction Mechanism", except those caused by attacks, are all automatic penalties by the Referee System.
Manual penalties through the Referee System	Penalties issued by the referee through the server against participants and robots for violation of rules.
Manual Penalties	Used in situations where penalties cannot be issued through the Referee System, for example issuing a verbal warning or disqualifying a team.

6.1.2 Violation Scores

Before the start of each round, each robot has a violation score of zero. A robot that is issued a Yellow Card during the round will receive 2 violation points.

- When a robot has 4 violation points, a yellow exclamation point will appear on the robot's avatar on the client interface.

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- When a robot has 6 violation points, a red exclamation point will appear on the robot's avatar on the client interface
- When a robot has 8 violation points, the robot will be ejected automatically from the current round of the match.

6.1.3 Types of Penalties

Five types of penalties may be issued during a match, as shown below:

Table 6-2 Types of penalties

Types of penalties	Description
Verbal Warning	A Verbal Warning is given to the offending party with no HP deducted.
Yellow Card	● The operation interface of all operators from the offending team will be blocked for 5 seconds. ● The Referee System automatically deducts 15% of the robot's Maximum HP, while for each Yellow Card issued against the robot in the next 30 seconds, the deducted percentage will be twice that of the previous deduction. ● The offending robot will receive 2 violation points.
Red Card (Ejection)	● The offending robot is ejected: If this happens during a match, all of the robot's HP will be deducted automatically by the Referee System. If it is before a match, the robot will be barred from the match and must leave the Battlefield. ● Ejection of Pit Crew Members: Members ejected by the referee must immediately leave the Competition Area and no substitute Pit Crew Members are allowed in the remaining rounds of the match. The robot operated by the ejected Operator will be ejected for this round, and will not be allowed to enter or be substituted by other robots in all other rounds of the current match.
Forfeiture	The team's results for the challenge are revoked.
Disqualification	● The team member is disqualified from the current competition season. ● The team is disqualified from the current competition season, but its results so far in this season will be maintained as a reference for other teams.

If a robot's remaining HP is less than that needs to be deducted from penalty, this robot's HP reduces to 1.

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6.1.4 Others

Apart from forfeiture, no other penalties can form the basis for an appeal by a team. The Arbitration Commission may reject an appeal if it has been made on such a basis.

6.1 Penalty Rules

This chapter sets out the Competition Penalty Rules and defines the relevant measures to be taken by the referee after issuing penalties. Rules with a serial number R# are rules that must be adhered to by participating teams, team members and robots.

6.1.1 Staff

6.1.1.1 Participating Teams/Personnel

R1 The requirements stated in RoboMaster 2021 Technical Challenge Participant Manual must be met.

Penalties: The highest penalty that can be imposed on the offending party is disqualification.

R2 Teams must not set up their own wireless networks or communicate with team members using walkie-talkies in the relevant competition zones (including but not limited the Preparation Area, Inspection Area, Staging Area and Competition Area).

Penalties: The highest penalty that can be imposed on the offending party is disqualification.

R3 Except for emergencies, teams must be at the Inspection Area at least 40 minutes before the start of a match to carry out the Pre-Match Inspection.

Penalties: Forfeiture of the current match.

R4 Team members must wear protective goggles when entering official designated areas such as the Preparation Area, Staging Area and Competition Area.

Penalties: The offender will be prevented from accessing the area.

R5 Except for emergencies, Team Captains must sign the Staging Area Statement 5 minutes before the start of each match.

Penalties: Forfeiture of the current match.

R6 Team members must not turn on the power and commission or repair their robots in the Staging Area.

Penalties: Verbal Warning If the Verbal Warning is ineffective, the team shall be issued a Forfeiture of the match.

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R7 Apart from Pit Crew Members who have entered the Staging Area and Competition Area beforehand due to match-related reasons, no participants are allowed inside either area without special reasons.

Penalties: Verbal Warning If the Verbal Warning is ineffective, the offending team member shall be disqualified.

R8 Except projectiles preset in the Inspection Area, teams must not bring their own projectiles into the Inspection Area, Staging Area or Competition Area, and also must not take official projectiles away from the Competition Area.

Penalties: The staff confiscates the projectiles.

R9 Teams must not damage any official equipment (including but not limited to equipment in the Competition Area, Staging Area, Preparation Area and Inspection Area).

Penalties: Verbal Warning, and the offending party is required to pay compensation as per the price.

R10 Team members are not allowed to leave the Staging Area or Competition Area without permission.

Penalties: Offender is forbidden from entering the Staging and Competition Area.

R11 Pit Crew Members are not allowed to bring wireless headsets into the Operator Room.

Penalties: Verbal Warning If the Verbal Warning is ineffective, the team shall be issued a Forfeiture of the match.

R12 During the Setup Period, team members must ensure their robots are operating safely and will not cause harm to any person or equipment in the Competition Area.

Penalties: The offending party must bear the relevant responsibility.

R13 After a match is over, members from both teams must power off all their robots, remove them from the Competition Area and empty all projectiles inside the robots at the Projectile Unloading Area.

Penalties: The offending robot will be detained in the Projectile Unloading Area, until its projectiles are cleared.

R14 In the lighting on a dart's triggering device malfunctions, such as when a light bead is damaged and unable to light up normally, team members will need to replace the dart's triggering device, otherwise the Base and Outpost will not be able to detect the damage inflicted by the dart.

Penalties: The Base and Outpost will not be able to detect the damage inflicted by the dart.

R15 During an Official Technical Timeout, Pit Crew Members are not allowed to fix faults other than those in modules related to the Referee System.

Penalties: Verbal Warning If the Verbal Warning is ineffective, the offender shall be issued a Red Card.

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6.1.1.2 Pit Crew Members

- Pit Crew Members: Regular Member and Supervisor who have registered for this Season and have been entered into the registration system, can walk into the Preparation Area and Competition Area.
- Captain Armband: Any regular member that wears the 'Captain' armband performs the Captain role during the match. Captain needs to control the team's competition schedule, confirms result, raises Team Technical Timeout and appeal.

R16 Pit Crew Members must meet the identity and quantity requirements of the corresponding challenge. For details, refer to RoboMaster 2021 Technical Challenge Participant Manual. One Pit Crew Member should wear the "Captain" armband and undertake the Captain's role.

Penalties: Verbal Warning If the Verbal Warning is ineffective, the team shall be issued a Forfeiture of the match.

R17 Pit Crews must wear armbands which must not be covered. The "Captain" sign of the Captain's armband must face the front.

Penalties: Verbal Warning

R18 Team members are not allowed to power their equipment using the power supply for official equipment in the Competition Area. However, they may bring their own power supply.

Penalties: Verbal Warning If the Verbal Warning is ineffective, offender shall be ejected from the Competition Area.

R19 Pit Crew Members entering the Competition Area must not communicate with anyone from the outside.

Penalties: Verbal Warning If the Verbal Warning is ineffective, the team shall be issued a Forfeiture of the match.

R20 During the final 30 seconds of the Setup Period or the final 20 seconds of a Team Technical Timeout, Pit Crew Members must leave the Battlefield as quickly as possible.

Penalties: Verbal Warning If the Verbal Warning is ineffective, the offender shall be issued a Red Card. If the offender does not obey the penalty order, the team shall be issued a Forfeiture of the match.

R21 After the end of the Setup Period, Pit Crew Members must return to the designated area outside the Battlefield. During the competition, Pit Crew Members are not allowed to leave the area without the permission of the referee.

Penalties: Verbal Warning If the Verbal Warning is ineffective, the offender shall be issued a Red Card. If the offender does not obey the penalty order, the offending party shall be issued a Forfeiture of the match.

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6.1.1.3 Operator

R22 The use of one's own computers is prohibited in the Operator's Room.

Penalties: Forfeiture of the round.

R23 Operators must remain in the relevant Operator's Room during the Referee System Initialization Period and the Match, to operate the relevant computers, and must remain in position after a match has started, unless otherwise permitted by the referee.

Penalties: Verbal Warning If the Verbal Warning is ineffective, the offender shall be issued a Red Card. If the offender does not obey the penalty order, the offending party shall be issued a Forfeiture of the match.

R24 During the competition, an Operator must operate the relevant robots and wear a headset, equipped with at most one remote controller.

Penalties: Verbal Warning If the Verbal Warning is ineffective, the offender and the robots operated by the offender shall be issued a Red Card. If the offender does not obey the penalty order, the offending team shall be issued a Forfeiture of the round.

6.1.2 Robots

6.1.2.1 General

R25 Robots entering a match must pass Pre-match Inspection.

Penalties: Forfeiture of the round.

R26 In any challenge, the quantity of participating robots must meet the requirements stated in "Table 1-1 Robot Lineup".

Penalties: Forfeiture of the current match.

R27 When waiting in the Staging Area, team members are not allowed to bring robots out of the Staging Area without permission.

Penalties: Verbal Warning If the Verbal Warning is ineffective, the highest penalty that can be imposed on an offending robot is a Red Card.

R28 Robot must not carry or present safety issues including but not limited to short circuits, crashing and falling to the ground. If safety issues are present or have arisen, the relevant personnel must execute the relevant operations in accordance with the referee's instructions.

Penalties: Before the start of the competition, Pit Crew Members must resolve the safety issue as required by

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the referee. Otherwise the offending robot will not be allowed to enter the match, and the relevant Operator will not be allowed to enter the Operator's Room or must surrender its remote controller, and must return to the Pit Area. Verbal Warning given during the competition. If the Verbal Warning is ineffective, a Red Card shall be issued against the offender and the robot operated by him/her or the offending robot. Any situation involving serious safety hazards shall be dealt with by the Chief Referee in accordance with "6.2 Serious Violations".

R29 During the 5-second countdown in the Referee System Initialization Period, robot is not allowed to transform beyond their Maximum Initial Size.

Penalties: After the start of the competition, the offending team is issued a Yellow Card.

R30 During the Setup Period and the Referee System Initialization Period, robots in the Battlefield are not allowed to leave their corresponding initialization zones.

Penalties: If it is during the Setup Period, a Verbal Warning shall be given. If the Verbal Warning is ineffective, the highest penalty that can be imposed on the offending party is a Red Card. If it is during the Referee System Initialization Period, the Chief Referee shall issue a Yellow Card or Red Card against the offending team, judged based on the offending team's subjective intention and the impact of its violation on the competition.

R31 During the competition, the robot is not allowed to disintegrate into sub-robots or sub-systems connected by multiple flexible cables, and must not cast or launch their own parts.

Penalties: The offending robot will be issued a Red Card.

6.1.3 Interaction

6.1.3.1 Interaction between Robots

R32 During any match in this season, participating robots may only use projectiles supplied by the RMOC.

Penalties: Verbal Warning If the Verbal Warning is ineffective, the highest penalty that can be imposed on the offending party is disqualification, based on the seriousness of the situation.

R33 Robots are not allowed to procure directly projectiles that have fallen to the ground.

Penalties: The offending robot will be issued a Red Card.

R34 An Engineer Robot is not allowed to grab more than one ore at a time or grab an ore that has not been fully released.

Penalties: The offending robot will be issued a Red Card.

R35 During the competition, the moving mechanisms of robots must not actively cause any damage to the core

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components of the Competition Area.

Penalties: If the fault has been confirmed, the round ends and the offending party is issued a Forfeiture for the round.

6.2 Serious Violations

The following actions are considered serious violations of rules. The highest penalty a referee may impose on an offending party for serious violations is disqualification.

Table 6-3 Categories of Serious Violations

Rule	Robot Type
1.	Violating rules mentioned in this chapter and refusing to accept penalties, for example a Pit Crew Member interfering with the regular work process of a referee.
2.	Tampering with or damaging the Referee System, or interfering with any detecting function of the Referee System through technical means.
3.	Installing explosives or other prohibited materials on robots
4.	A situation has occurred in the Competition Area that violates Pre-Match Inspection requirements
5.	A team member deliberately damaging the opponent's robots, Battlefield Components and related equipment.
6.	Causing delays deliberately or refusing to immediately leave the Competition Area after a match has ended, thereby disrupting the schedule of the competition
7.	A team member using robots to collide into or attack other people deliberately, putting themselves and other people at risk of injury
8.	Serious verbal or physical conflicts between team members and the staff of the RMOC, other participating teams, audience, etc.
9.	A team member's refusal to cooperate, deliberate delay or provision of false materials and information during the RMCO's handling of an appeal request.
10.	In respect of any violation of local laws and regulations occurring inside the Competition Area, Audience Area, dormitories or other relevant competition zones during the competition, the RMOC, apart from issuing the most severe penalty of "disqualification", will fully cooperate with the relevant authorities to pursue appropriate legal actions against the offenders.

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Rule	Robot Type
11.	Any other violation that seriously affects the progress of the matches, goes against the spirit of fair competition, or is deemed as serious in nature by the Chief Referee.

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7. Irregularities

⚠ There may be some degree of delay in the referee's issuance of a manual penalty and handling of an irregularity. If the competition's outcome has been seriously affected, the Chief Referee will determine the final penalty based on the actual circumstances.

If any of the following anomalies occur during the competition, it shall be handled according to the corresponding process, to which the team cannot object. The handling process is as follows:

- When a robot safety hazard or irregularity in a robot has occurred on the Battlefield, such as battery explosion, Aerial breaking an Aerial Safety Rope, stadium power outage, explosion of a compressed gas cylinder, or interpersonal conflict), the Chief Referee will notify operators after discovering and confirming the emergency, and eject all robots through the Referee System. The result of the round will be invalidated. The round will restart after the safety hazard or exception has been eliminated.
- If non-key Battlefield Components are damaged during a match (damage to the ground rubber surface, ground lighting, or Base lighting), which do not affect the fairness of the match, the match will proceed as usual.
- If key Battlefield Components experience logical or structural faults, for example where the network connections are disrupted causing a robot to go offline, no buff is gained after a Power Rune is hit, or a Battlefield Component does not operate normally, the referee will solve the problem manually through the Referee System. If the problem cannot be solved manually, the referee will notify the operators and eject all robots. The round of the match is ended immediately and its results are invalidated. The round will restart after the issue has been solved.
- During a match, if the fairness of a match has been affected by the malfunction or structural damage of a key Battlefield Component, and the Chief Referee did not confirm the situation and end the competition in time, causing a round that should have been ended to continue and thereby producing a winner, a rematch will be required and the results of the round will be invalidated, after an appeal has been made or the Chief Referee has made a determination to that effect after the end of the round.
- In the case of a serious violation that would clearly have triggered a penalty of forfeiture, and the Chief Referee did not confirm and execute it in time, the results of the round will be invalidated after an appeal has been made or the Chief Referee has made a determination to that effect after the end of the round, and the offending party will be issued a forfeiture.

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8. Appeals

For every challenge, each team has one appeal opportunity during the Regional Competition and one during the National Competition. Appeal opportunities cannot be used cumulatively across competitions. If an appeal is successful, the team involved retains its right to appeal again in future matches. If it is unsuccessful, the team will have exhausted its one opportunity to appeal. When a team has exhausted its opportunity to appeal, the RMOC will no longer accept any appeal from the team. When processing an appeal, an Arbitration Commission will be formed by the Chief Referee and heads of the RMOC. The Arbitration Commission has the final right of interpretation on all appeal decisions.

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8.1 Appeal Process

Teams lodging an appeal must follow the procedure below:

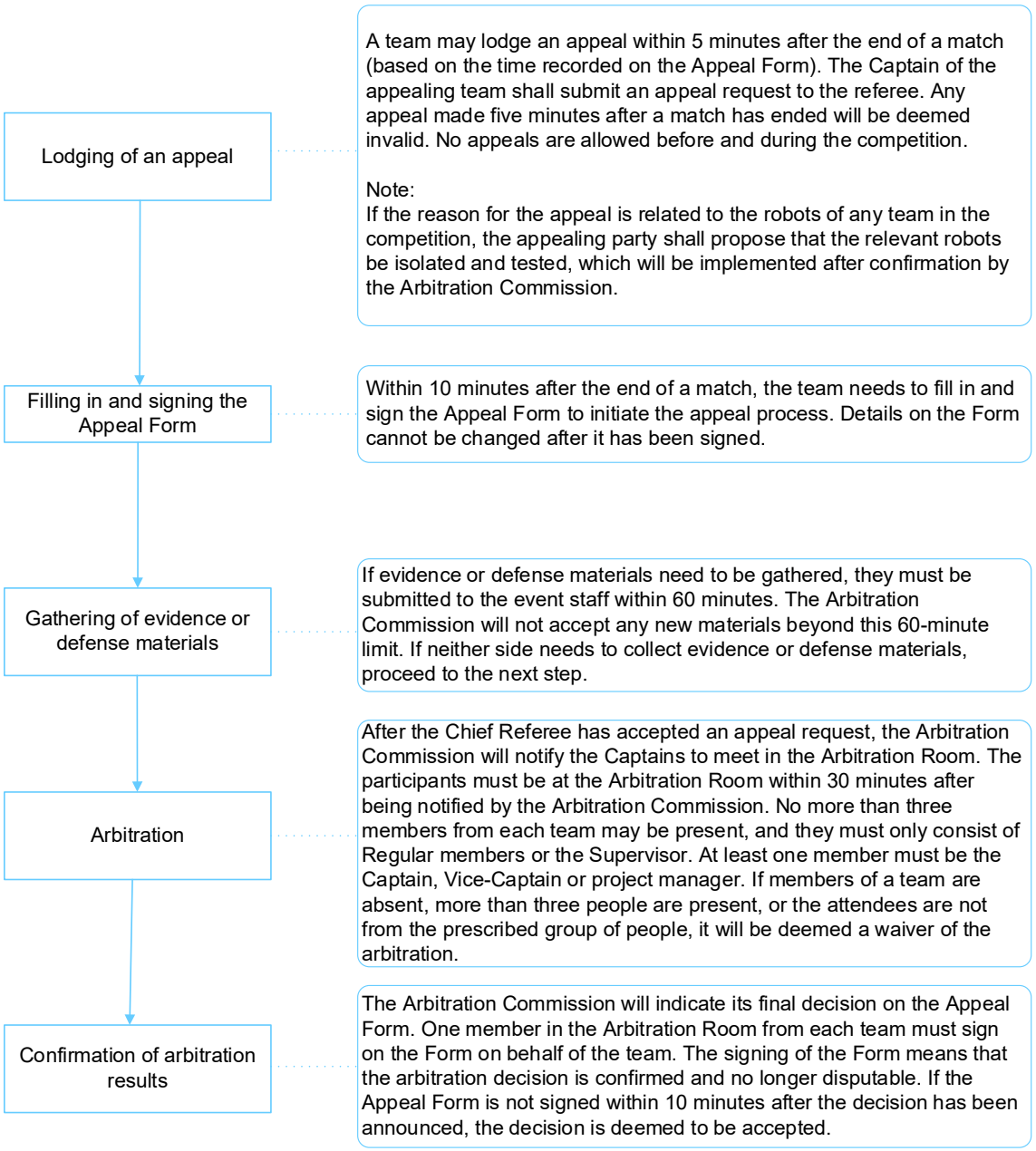

Figure 7-1 Process of an appeal

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8.2 Appeal Materials

Appeal materials submitted by teams must follow the below specifications:

- Material type: Only materials stored on a USB flash drive and the robots themselves will be accepted as appeal materials. Materials submitted in other forms will not be accepted by the Arbitration Commission.
- USB flash drives: The edited video (the video materials should be prepared by the team itself) and the text files for the appeal should be placed according to the directory.
- Material format: No video may exceed one minute in length or 100MB in size. The name of the video must indicate the specific match, the round of the match and the time it was taken (rounded to minutes). The videos should be compatible with the latest version of Windows Media Player; the photos must be in JPG format; and the text documents must be in PDF format and not exceed 1,000 words in length.
- Material naming: The file name of each video and photo must be within 30 Chinese characters.
- Text requirements: One text file can only correspond to one video or a photo, which must be indicated in the text. Text files only need to explain the violations reflected in the corresponding materials.
- Robot evidence: The Arbitration Commission has the authority to isolate any relevant robot from both teams after an appeal has been made. These robots will be returned to the teams at the latest when the arbitration decision is announced.

8.3 Appeal Decision

The Arbitration Commission may either rule to maintain the match results or to have a rematch. Teams are not allowed to appeal against the decision made by the Arbitration Commission.

Provided it does not affect the schedule of the entire competition, the rematch will in principle be held on the same day after all the other matches.

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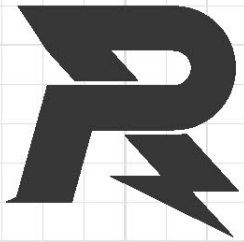

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