

# **RCAP Rescue Line Entry Rules**

## **Category B**

### **(Demonstration)**

V1.0

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## 1. Mission

The robot must be able to carry out a rescue mission in a fully autonomous mode with no human assistance. The robot must be durable and intelligent enough to move around the search area and complete its assigned tasks efficiently, ensuring it does not get stuck or hindered.

### CHAPTER 1: GENERAL RULES

## 2. Team

### 2.1. Team Members

2.1.1 A team should consist of 2 to 4 members. Each participant can only register for one team. Each participant can only register for one team.

2.1.2 All team members must be at the right age for the respective age group.

- U12 group: Teams with all students aged 7 to 12 year old can participate in this category.
- U19 group: Teams with all student members aged 13 to 19 year old can participate in this category. If a team has mixed ages (with both U12 and U19 members), they will be allowed to compete in U19 category.

Age is specified as on 1st July in the year of the competition.

2.1.3 Teams should be responsible for checking updated information (schedules, meetings, announcements, etc.) during the event.

### 2.2. Responsibility

2.2.1 The team members are responsible for

- verifying the latest version of the rules prior to the competition. If any rule clarification is needed, please contact the Technical Committee.
- checking updated information (schedules, meetings, announcements, etc.) during the event.
- coding for the robot.
- uploading the correct code to the robot.
- communication with Technical Committee and Organising Committee for all Rescue Line Challenge related matters.

2.2.2 As the space around the competition fields is limited (and crowds can often result in accidents that damage the robots), only the team captain is allowed to operate the real robot, based on the stated rules and as directed by the referee. Other team members (and any spectators) within the vicinity of the real world are to stand at least 150 cm away from the real world while their real robot is active, unless otherwise directed by the referee.



#### 4.2. Lines:

- The lines are 15-25 mm wide and can be either white or black in color.
- Straight sections of the line may contain gaps, with at least 5 cm of straight line before each gap.
- The length of a gap will not exceed 20 cm.



Figure 2. Line Sample

#### 4.3. Mysterious Mission Areas:

- These areas present specific tasks for the robot to complete.
- Tasks may vary and can include challenges like obstacle navigation, object manipulation, or sensor-based tasks.

#### 4.4. End Area:

- The destination where the robot must reach to complete the course. The size of the area is 250mm in length and 250mm in width.

#### 4.5. Field Size:

- The maximum dimensions of the playing field are 3,000mm long and 2,000mm wide.

#### 4.6. Level Surface:

- The playing field will be installed in a place as level as possible to ensure fair competition.

#### 4.7. Variations:

- Contestants should be prepared for variations in the actual competition models, such as color, size, or height of track lines and task elements.

## 5. Tasks

RCAP Rescue Line Entry Category B (Demonstration) includes three different types of tasks: basic tasks, random tasks, and mysterious missions.

### 5.1. Basic tasks

#### 5.1.1 Smooth Launching

- The robot leaves the starting area.
- At the beginning of the game, if the vertical projection of the robot completely leaves the starting area (only recorded once in each round of competition), 50 points will be scored.

#### 5.1.2 Line Following through Checkpoints

- In this task, the robot is required to navigate the track lines to pass through designated checkpoints.
- The robot must continuously move forward in the direction of the line throughout the task process.

- Temporary deviations from the current line are allowed if the robot needs to complete other tasks. However, after completing these tasks, the robot must return to the position where it previously deviated from the line and continue driving.
- Both wheels of the robot must always remain within the road, or press directly on the edge of the road.
- If any driving wheel of the robot touches the dividing line of a check point, it will be scored 5 points, with a total possible score of 50. The same check point will not be scored repeatedly.

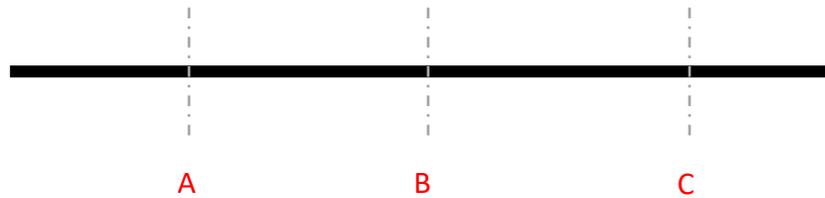


Figure 3. Checkpoints

### 5.1.3 Slope Challenge

- The slope challenge will be positioned at one location on the line. For the U12 age group, the challenge will be fixed at the end area. For the U19 age group, the challenge will be randomly positioned at a certain point on the line.
- The slope challenge consists of a platform with dimensions of 300mm in length, 300mm in width, and 20mm in height, along with two slopes. For the U19 age group, the referee will randomly select letter marks for the dividing line before programming and debugging commence. Upon confirmation, the slope challenge will be placed directly over the line at the corresponding dividing line.

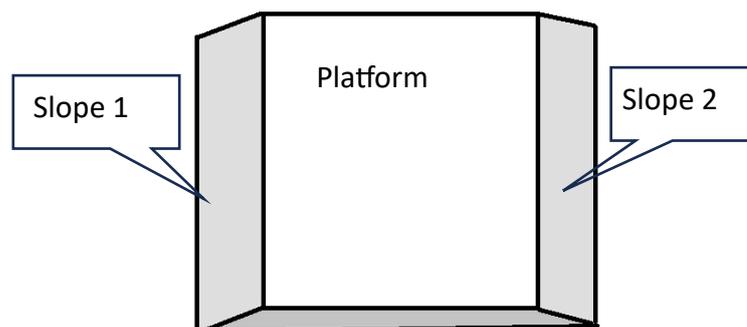


Figure 4. Slope Platform

- For the U12 age group, the slope challenge is fixed in the end area. Both groups of robots must move along the line direction and climb onto the slope challenge without leaving the line.
- Throughout the process of robots from the U12 age group climbing onto the slope challenge, the driving wheels on both sides of the robot must remain in contact with

the slopes of the model and the top surface of the platform, without touching the field map. Completing this task scores 50 points.

- Robots in the U19 age group need to move in the line direction, climb over the slope challenge without leaving the road, and reach the connected parts to proceed forward.
- For the robots in the U19 age group, their driving wheels on both sides must maintain contact with the slope and the platform's top surface during the entire climbing process over the slope challenge. Afterwards, the robots can continue traveling on the remaining line normally. Completing this task scores 50 points.

#### 5.1.4 Teleportation Challenge

- The task consists of a teleportation gate, a teleportation converter, and an LED terminal.
- The teleportation gate is fixed in task area 1, and the teleportation converter is installed at the gate.
- If the robot successfully navigating straight through this gate scores the robot 10 points.
- The robot needs to use a key to activate the teleportation converter, enabling the LED terminal to initiate the teleportation process.
- When the "X" mark lights up on the LED terminal, it can be scored 50 points.
- The full score for this task is 60 points.

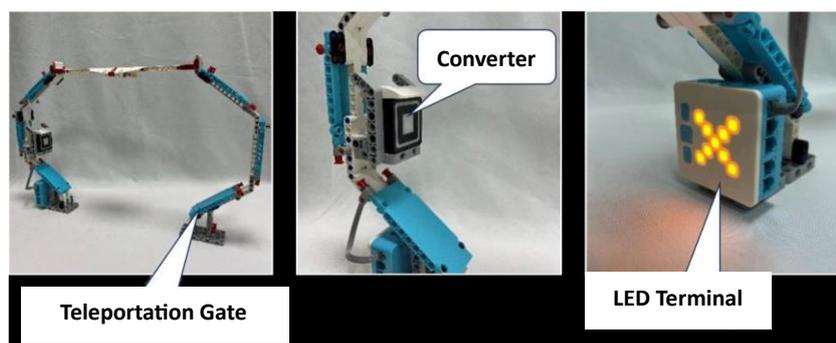


Figure 5. Teleportation Gate

#### 5.1.5 Safe Return

- The robot must pass through waypoints in alphabetical order while staying on the road, refer to section 5.1.2.
- For the U12 age group, the robots should stay stationary on the top of the slope challenge's platform (without contacting the field map), refer to section 5.1.3. For the U19 age group, the vertical projection of the robot's driving wheels should be fully within the end area. Completing this task will score 50 points.

#### 5.2. Random Tasks

In the RCAP Rescue Line Entry Category B (Demonstration), the random tasks include the Tower Elevation Challenge and the Wheel Rotation Challenge. However, it's specified that the U12 age group does not have any random tasks, while the U19 age group may have one or two random tasks.

### 5.2.1 Tower Elevation Challenge

- The robot must operate a lever to activate a mechanism, lifting a tower structure.
- Scoring:
  - 10 points awarded for moving the tower from its initial position.
  - Additional 50 points earned if the tower's bottom rises above a set target position.
  - Total Possible Score: 60 points.

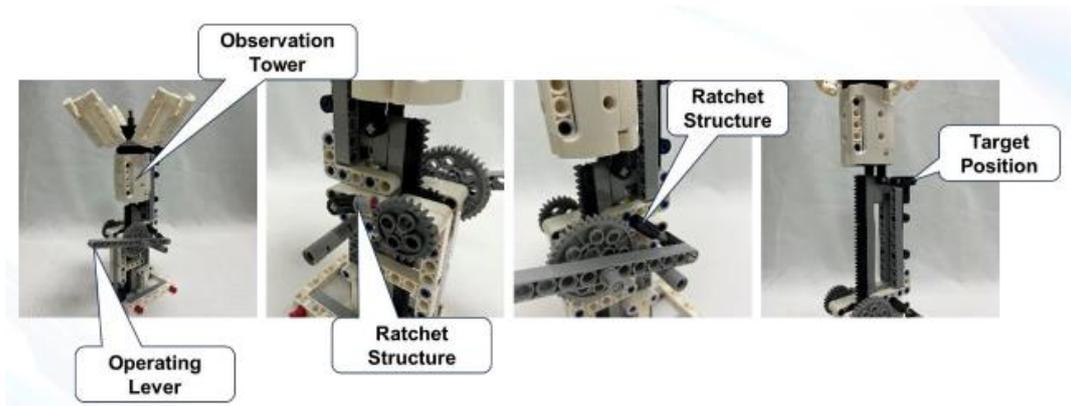


Figure 6. Tower Elevation Challenge

### 5.2.2 Wheel Rotation Challenge

- The robot must rotate a wheel using a handle, aiming to align a pointer with a target area. At the start, the pointer on the wheel points to the center of the target area. The robot's task is to turn the handle, causing the wheel to complete more than one full rotation.
- Components: Task model includes a rotating wheel, pointer, handle for turning, and target area.
- Scoring:
  - If the orthographic projection of the pointer plate intersects with the receiving surface, 10 points will be scored.
  - If the orthographic projection of the pointer intersects with the receiving surface, 50 points will be scored.

- Total Possible Score: 60 points.

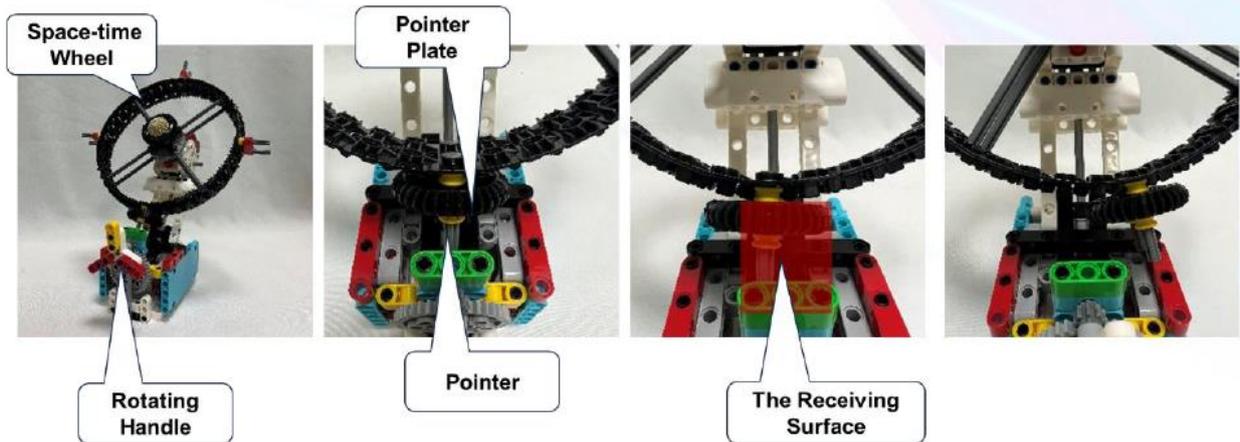


Figure 7. Wheel Rotation Challenge

### 5.3. Mysterious Missions

In RCAP Rescue Line Entry, Category B (Demonstration), a Mystery Mission Area will be included with the following specifications:

- Size: The maximum size of the Mystery Mission Area is 60 x 90cm.
- Optional: Participation in the Mystery Mission Area is optional for teams. Successfully navigating through it is not necessary to complete the overall competition.
- Tasks: The Mystery Mission Area will contain 1-2 tasks, with the task location chosen randomly before the game starts.
- Scoring:
  - Entering the Mystery Mission Area: 10 points.
  - Exiting the Mystery Mission Area: 10 points.
  - Completing a mission in the Mystery Mission Area will earn 120 points. Completing 2 missions will earn 240 points.
- Task Types: Tasks may include avoiding obstacles, identifying color cards, or following irregular lines, among others.

- Surface: The floor of the Mystery Mission Area is white and may have a smooth or textured surface, such as linoleum or carpet. There could be steps up to 5mm high between tiles, and steps or gaps may be present on the field due to the construction materials used.

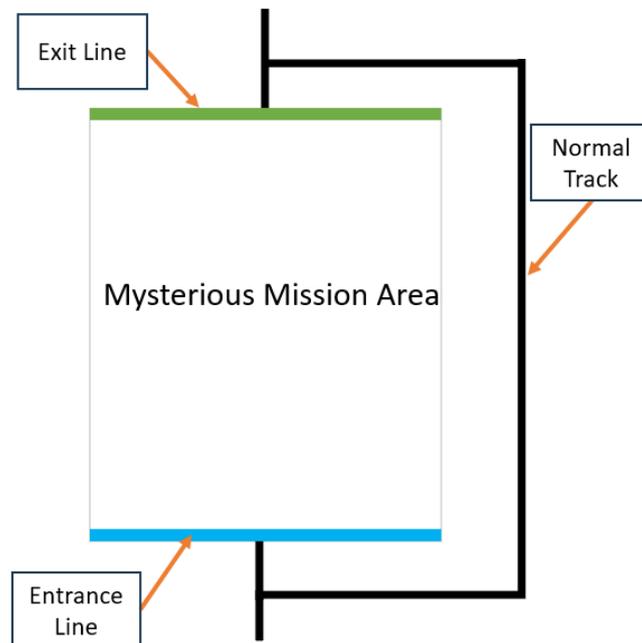


Figure 8. Mysterious mission area

### 5.3.1 Obstacle Avoidance Challenge (U19 Only)

- In this challenge, the robot must navigate around a large and heavy obstacle, such as a brick or bottle, and return to the track.
- The robot is allowed to move the obstacle as it navigates, but it must ensure that the obstacle does not fall over or exit the designated task area.
- Points are awarded only if the obstacle remains within the task area by the end of the game. If the obstacle is outside the task area, no points are awarded for this challenge.
- If the robot successfully completes this task, it will earn 120 points. Points will be allocated according to the percentage of the task completed by each team.

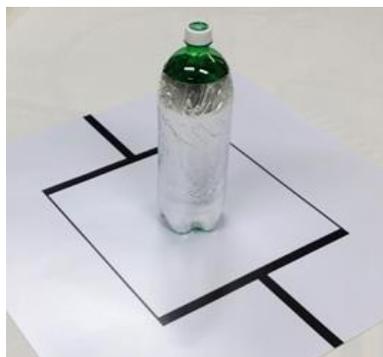


Figure 9. Obstacle Avoidance Challenge

### 5.3.2 Color Recognition Challenge

- The task involves encountering 2 or 3 ribbons of different colors, with the order of the ribbons being randomized. Each ribbon measures no less than 25 mm x 250 mm.
- As the robot passes through each ribbon, it must switch its LED light to match the color of the corresponding ribbon. The robot should pause appropriately to allow the referee to observe.
- Points may be awarded based on the accuracy of the robot's color recognition and response, with a total possible score of 120 points. Points will be allocated according to the percentage of the task completed by each team.

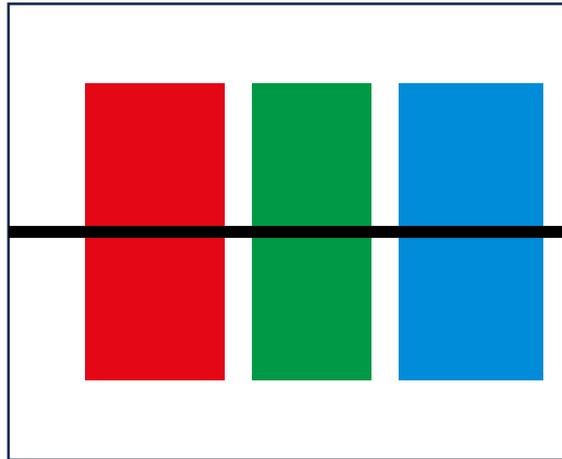


Figure 10. Color Recognition Challenge

### 5.3.3 Speed Bumps

- White speed bumps are affixed to the floor with a maximum height of 1 cm.
- The number and spacing of speed bumps may vary, presenting unpredictable challenges for the robot's navigation.
- If the robot successfully completes this task, it will earn 120 points. Points will be allocated according to the percentage of the task completed by each team.

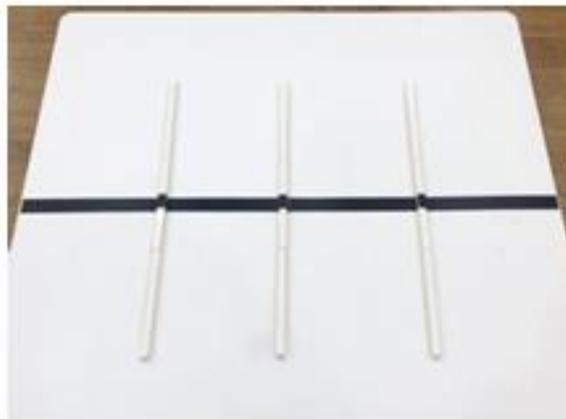


Figure 11. Speed Bumps

## CHAPTER 3: Robot

### 6. Robot

#### 6.1. Requirements for Building Equipment

6.1.1. Contestants in the competition must design and build robots capable of completing specific tasks. However, robot construction does not need to be done on-site. Only electronic parts with plastic shells and plastic building blocks are permitted for use. 3D-printed parts are prohibited. Additionally, robots must not cause damage to the competition field or task models during the event.

6.1.2. With the exception of motors, battery boxes, sensors, remote controls, and cameras, contestants may not use parts made of screws or welds. The use of auxiliary materials such as glue or double-sided tape is also prohibited. By signing up for the competition, contestants acknowledge that the organizing committee has the final authority to interpret these rules.

#### 6.2. Requirements for Designing Robots

Items	Requirements
Quantity	1 robot per team.
Specification	In the starting area, the robot must not exceed length and a height of 25cm × 25cm, and must not exceed width of 25cm, but can be extended after leaving.
Controller	Each robot is only allowed to use one controller, and the controller input and output ports (including motor control ports) must not exceed 12.
Sensor	The robot is allowed to use any type of sensor.
Motor	The total number of motors (including servos) must not exceed 6, and a single motor can only drive a single grounded wheel. The motor output speed shall not be higher than 330 rpm. The motor must not be modified. (Note: The organizing committee has the right to check the motor specifications of participating teams through disassembly, speed testing, etc. If the motor specifications are unqualified, the team will be disqualified.)
Driving wheel	The diameter of the wheels (including tires) used by the robot to land on the ground must not be larger than 70mm.
Structure	The robot must be built with 10mm plastic building blocks whose design dimensions are based on standards. 3D printed parts and auxiliary connection materials such as screws, bolts, rivets, glue, and tape are not allowed.
Battery	The rated input voltage of robots in the lower primary school group shall not exceed 6V, and the rated input voltage of robots in the upper primary school, junior high school, and high school groups shall not exceed 9V. The robot cannot be configured with a boost circuit.
Rollcall and check	Before entering the field in the first round, contestants can bring the complete robot with them. Still, the robot must pass a comprehensive inspection to comply with relevant regulations. Contestants should adjust the robot's non-compliance before participating in the competition.

## CHAPTER 4: Game Procedure

### 7. Game Procedure

#### 7.1. Entry Order

- The competition operates on a points system, eliminating the need for preliminary or semi-final rounds.
- Teams will draw lots on-site to determine grouping and order of participation. They will take turns playing according to the draw.
- The organizing committee ensures each team in the same group has equal opportunities to play, typically no less than two rounds.
- Teams are notified to wait and prepare when the previous team starts the game. Failure to show up within the stipulated time will result in disqualification.

#### 7.2. Programming and Debugging

- Participating teams have at least 60 minutes to build and debug their robot before the first round. An additional 30 minutes are provided for debugging before the second round.
- Referees adjust the specific debugging time according to the situation and announce it before each round.
- Teams must program and debug in an orderly manner. Failure to comply may result in disqualification.
- Once programming and debugging are complete, teams must place their robots in a designated location and keep them there. Touching robots without permission leads to disqualification.
- Teams not ready when the game starts lose the opportunity to compete in that round, but it does not affect future rounds.

#### 7.3. Preparation Before the Game

- When it's the contestants' turn to play, they should bring their robots and enter the competition area under the guidance of referees or staff. Failure to show up within the stipulated time will result in disqualification.
- Contestants should stand near the starting area when taking the field. They then place their robots into the starting area, ensuring that no part of the robot or its projection on the ground exceeds this area.

#### 7.4. Start the Game

- After confirming the team is ready, the referee will issue a countdown command of "3, 2, 1, start". As the countdown begins, contestants can slowly approach the robot with their hands. Upon hearing the command "start", contestants can press the button on the controller to activate the robot.
- Starting the robot before the "start" command will result in an "incorrect start", and contestants will be warned or punished. Once activated, contestants are not allowed to touch the robot except in the case of a reset.

- The robot must not separate components or drop mechanical parts on the field after starting. Any parts that accidentally fall off will be cleared by the referee. Separating components for strategic reasons is considered a foul. If the robot crosses the boundary of the field due to excessive speed, a program error, or throws items out of the field, it and the items are not allowed to return to the field.

#### 7.5. Reset

- To encourage teams to improve program stability and optimize competition strategies, a "fluency" score was added. Teams automatically gain 50 points for fluency at the start of the game. Every time a reset occurs during the task process, the fluency score is deducted by 5 points, up to a maximum of 50 points.
- The robot must be reset back to the starting area in the following situations:
  - (1) Contestants request a reset from the referee,
  - (2) The robot leaves the competition venue,
  - (3) Contestants touch the task model or robot without permission,
  - (4) The robot does not move along the flight channel,
  - (5) The robot leaves the track line.

#### 7.6. Off the Track Line

- During the movement of the robot, it must adhere to the track line of the flight channel. This means the robot's driving wheels must either touch or be on both sides of the black line, passing through all track lines along the way. If the robot completely deviates from the black line, it must be restarted.
- To complete the task, the robot is allowed to temporarily leave the track line but must return to the point where it previously deviated and then continue driving. There is no limit to the number of restarts, and the time used for restarts is included in the game time; thus, the timer does not stop during restarts.

#### 7.7. End of Game

- If a team performs any of the following actions, the game will end with the referee's whistle, and the time will be recorded:
  1. The robot cannot continue to perform subsequent tasks.
  2. The team completes the "safe return" task.
  3. The team proactively sends a signal to the referee to end the game.
  4. The timer reaches 300 seconds.

#### 7.8. Final Score

- After each game, the team's single-round score will be calculated. The total score of the tasks is calculated according to the task completion standards outlined in Section 5. After all rounds of games are completed, the sum of the scores of each single game will be the final competition score of the teams.
- The remaining time score is the number of seconds remaining at the end of the round. Only full scores for all basic tasks and random tasks set in this group can add remaining time points.

- Single round score = total task score + fluency score + remaining time score.

#### 7.9. Ranking

- After all the games in a certain group are over, all teams will be ranked according to their total score. If two teams have the same score, they will be ranked again according to the following criteria:
  1. The team with the higher score in a single round will be ranked higher.
  2. If scores in a single round are also tied, the team with the shorter total time in two rounds is ranked higher.
  3. If total times in two rounds are also tied, the team with fewer resets is ranked higher.
  4. If resets are also equal, robots with a smaller total number of motors and sensors are ranked higher.

#### 8. Violations

- 8.1. Any violations of the inspection rules will prevent the offending robot from competing until modifications are made, and the robot passes inspection.
- 8.2. Teams must make modifications within the schedule of the tournament, and teams cannot delay tournament play while making modifications.
- 8.3. Suppose a robot fails to meet all specifications (even with modifications). In that case, it will be disqualified from that game (but not from the tournament).
- 8.4. No mentor assistance is allowed during the competition.
- 8.5. Any rule violations may be penalized by disqualification from the tournament or the game or result in a loss of points at the discretion of the referees, officials, or RCAP Committee.
- 8.6. In each round of tasks, every team is allowed to start their robot incorrectly once. However, if a team starts their robot incorrectly for the second time during the group stage, that team will receive zero points for that round and will be eliminated directly from the finals.
- 8.7. After the game starts, if a contestant touches objects or robots on the field without the referee's permission, he or she will be warned for the first time. If he or she does it again for the second time, the score for the round will be 0 points.
- 8.8. If there are tutors or parents dictating instructions to contestants that affect the competition, personally participating in construction and debugging tasks, or touching or repairing robot works, etc., once verified, the team will be scored as 0 points for this round.
- 8.9. After starting, the robot shall not deliberately separate parts or drop parts on the field for strategic needs. If the robot does this, it is a foul and a warning will be given as determined by the referee. If the violation occurs again, the score for this round will be 0 points. Parts that are separated or dropped due to foul play will be cleared immediately by the referee.
- 8.10. In case a contestant fails to follow the instructions of the referee, the referee will assess the severity of the situation and take appropriate action. The contestant may receive a warning, a score of 0 in the preliminary round, elimination from the final, or even disqualification from the event.

# Appendix 1

## RCAP Rescue Line Entry, Category B (Demonstration) Scoresheet

Date: \_\_\_\_\_

Team: \_\_\_\_\_

Group: \_\_\_\_\_

Tasks		Points	Round__
<b>Basic tasks</b>	Successfully left the starting area	50 points	
	Waypoints	Each time a marked line is touched, 5 points are scored, with a total score of 50 points.	
	Slope Challenge	50 points	
	Safe Return	50 points	
	Teleportation Challenge	Passing through the teleportation channel head-on will score 10 points.	
If the control terminal displays the "X" mark, 50 points will be scored.			
<b>Random tasks</b>	Tower Elevation Challenge	If the tower leaves its initial position, 10 points will be scored.	
		If the bottom of the tower is higher than the target position, 50 points will be scored.	
	Wheel Rotation Challenge	If the orthographic projection of the pointer plate intersects with the receiving surface, 10 points will be scored.	
		If the forward projection of the pointer intersects with the receiving surface, 50 points will be scored.	
<b>Optional Tasks</b> (The mystery mission area will contain 1-2 tasks)	Successfully enter the Mysterious Mission Area	10 points	
	Color Recognition Challenge	When the robot switches its LED to match each ribbon's color and pauses for observation, it earns 120 points.	
	Obstacle Avoidance Challenge	If the robot avoids obstacles and returns to the track without causing them to fall or leave the task area, it earns 120 points.	
	Speed Bumps	If the robot can safely navigate the variable white speed bumps, with a maximum height of 1 cm, and continue line following, it earns 120 points.	
	Successfully left the Mysterious Mission Area	10 points	
<b>Total Score for All Tasks</b>			
<b>Bonus Score</b>	The initial bonus score is 50 points, and 5 points will be deducted for each reset.		
<b>Completion Time of Tasks</b> (recorded to one decimal place, 0.1s)			

<b>Remaining Time Score</b> (= 300 - Completion Time of Tasks) (1 second is equal to 1 point, the result is rounded, and basic and random tasks require full points to get this score.)	
<b>Total Score in A Single Round</b> (= total task score + fluency score + remaining time score)	
<b>Total Score of All Rounds</b>	

Referee: \_\_\_\_\_

Contestant: \_\_\_\_\_

**Passing states of flight channel markers**

Round	1	2	3	4	5	6	7	8	9	10
1st										
2nd										