

WRS Simulation Disaster Challenge Rulebook (Ver.1.0.0)

WRS Simulation Disaster Challenge Competition Committee

1. Competition Overview

In the WRS2025 Harsh Environment F-REI Challenge Simulation Disaster Challenge (Simulation Challenge), competitors will carry out a disaster response by completing different tasks in a simulated post-disaster plant competition field. These rules may be modified.

1.1. Required Environment to Participate in the Competition

The Simulation Disaster Challenge will be conducted in a virtual space using computers. To participate in the competition, the following devices are required.

1.1.1. Hardware

The following PC specifications will be used in the competition. ROS2 communication with a PC of equivalent specification may also be used.

Specification: CPU: Core i9-13980HX

GPU: GeForce RTX 4080

Memory: 32GB, SSD: 1TB

< Sample Computer Model > : ASUS PC ROG Strix SCAR 16 Gaming Laptop

1.1.2. Software

Choreonoid: The latest version will be used in the competition

Argorix AGX Dynamics Choreonoid Plug In

※ Once the participating teams are selected, the software in USB format will be available to rent for free from the competition administration

1.2. Supplemental Information Sharing

Any future and supplemental information on the competition will be provided through GitHub (henceforth referenced as the Participant's GitHub). Please reference the link below.

<https://github.com/wrs-frei-simulation/WRS-2025>

2. Team Composition

2.1. Number of Members

The number of team members corresponds to that of other WRS2025 Harsh Environment Challenges.

2.2. Number of Members Permitted into the Paddock Area

4 persons may enter the paddock area.

2.3. Competing Members

Only 2 members may compete during the competition (competitors). Members may switch throughout the competition, however, switching during the competition is not permitted.

3. Competition Description

Please reference the Participant's GitHub for further details on the competition tasks, competition field, and competition missions.

Although the rules will vary from the upcoming competition, information from the October 2024 pre-tournament will be accessible through the Participant's GitHub.

3.1. Competition Tasks

- 3.1.1. The competition will have the following 4 task categories. The competition tasks will be represented by the codes written in the following manner.
【Task Category-Category Task Type_Specifics or order number】
- 3.1.2. The competition tasks are compiled from 《competition categories basic score》, 《type coefficient》, and 《detail coefficient》. Therefore, the competition task score is composed in the following manner: 《competition categories basic score》x 《type coefficient》x 《detail coefficient》.
- 3.1.3. The competition categories' basic scores are described below. The 《type coefficient》 and 《detail coefficient》 will be shared via the Participant's GitHub in the future.

Move 【M】 《competition task basic score: 10 points》

Method: Move from A to B.

Requirement: Move on the route between A and B.

- Ramp 【M-r】
- Catwalk 【M-c】
- Duct interior 【M-d】
- Stairs 【M-s】
- Other 【M-*】

- 3.1.4. Recognize 【R】 《competition task basic score: 10 points》

Method: Collect required information

Requirement: Information reading and reporting

- Recognize target 【R-t】 *reference appendix
- Meter 【R-m】
- Water level 【R-r】
- Other 【R-*】

- 3.1.5. Operate 【O】 《competition task basic score: 10 points》

Method: Operate as instructed

Requirement: Complete instructed operations

- Operate switch 【O-s】
- Operate valve 【O-v】
- Open/close door 【O-d】
- Retract pole 【O-r】
- Operate obstructions
 - move 【O-o_m】, stack 【O-o_s】
- Other 【O-*】

- 3.1.6. Work 【W】 《competition task basic score: 10 points》

Method: Complete work according to instructions

Requirement: Achieve the goal using specified instructions

- Fire extinguishing work 【W-f_1】 ~ 【W-f_4】 *reference appendix

- Other 【W-*】

3.2. Competition Field

3.2.1. There will be several competition tasks placed around the competition field. The competition missions require the competitors to complete the competition tasks in the designated competition field areas.

3.2.2. Competition Field Environment

The competition field will simulate a harsh environment setting. In this competition, environmental conditions will be added to increase the difficulty of completing tasks, including wind, smoke, water, dark lighting, etc.

3.3. Competition Mission

3.3.1. Missions will be divided throughout the designated areas in the competition field. The competitors will carry out a number of missions (4 to 8).

3.3.2. Each competition mission has a designated 【start】 point and 【goal】 point. In the event that the tasks cannot be completed by the competition time limit, please make sure to return to the 【start】 point or 【goal】 point to end the mission.

- If all the robots used in the simulation mission do not return to the 【start】 point or 【goal】 point by the time limit, it will be as if the robot was lost, and points will be deducted.
- In the preliminaries, robots that have been lost cannot be used for the next mission.

4. Competition Time

4.1. Managing Competition Time

The overall competition time will be allotted each mission. The competition time is managed in real time, not simulated time.

- Competition duration per mission

Preliminaries: 15 minutes, Semi-finals and Finals: between 15-20 minutes.

4.2. Retrying During the Competition

In case a robot is dropped or lost, there is no limits to the number of retries during the competition. However, a retry will reset the points achieved previously during the mission, and the score will become 0. Furthermore, the countdown will continue as it was after the retry.

5. Robots

5.1. Permitted Robots

5.1.1. Robot Platforms

The robots used in the simulation will be prepared by the WRS administration. Please reference the robot platform examples presented in Figure 5.1.

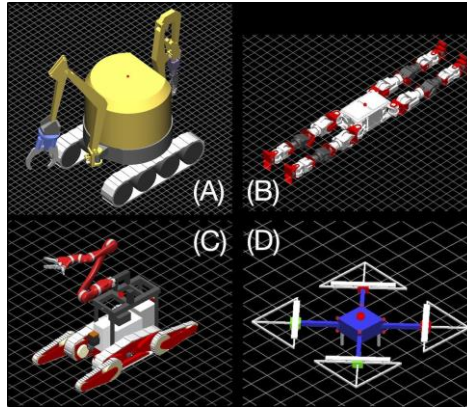


Figure 5.1: Robot Platforms (A) Dual Arm Robot: full length 2m, height 1.7m (not including arms). (B) WAREC: full length 2.7m. (C) Spider: full length 1.1m, height 0.6m (height until the base of the arm). (D) Multicopter: size 70cm x 70cm.

5.1.2. Self-designed Robots (Original Robots)

It is possible to participate with self-made robots. If participating with a self-made robot, the robot is required to have a robot inspection, which will be carried out by the competition committee.

- Both original robots and platform robots that have undergone modification require a robot inspection.
- Teams that carry out tasks with original robots will gain a **【Robot Coefficient】** that will increase the total score.
 - The coefficient factor will be examined and decided by the competition committee. Please reference the Participant's GitHub for future information on robot modification and the inspection details.

5.2. The Quantity of Robots

5.2.1. Robot Number Limit

There are no limits on the number of robots to be used during a mission.

5.2.2. Robots and Simulation Time Limit

Even if the time difference between the simulation time and real time grows because of the increase in robot quantity, the competition time is managed by real time, meaning the competition time will end with the real time limit.

6. Scoring, Point Deduction, and Ranking

6.1. Scoring Points

6.1.1. Scoring Requirements

Tasks carried out in the specified procedure, will earn **【Competition Task Points】** when all requirement to complete the task are fulfilled.

6.1.2. Score Types and Coefficients

- **【Competition Mission Score: P_m 】**
 - Points to be gained from different tasks that compose the competition mission.

- **【Competition Task Points: P_t 】**
 - Points to be gained when completing competition tasks. The basic competition task score is 《competition categories basic score》 x 《type coefficient》 x 《detail coefficient》 .
- **【Robot Coefficient: Cr 】 (1.0~1.5)**
 - When completing competition tasks using original robots, the **【Competition Task Points】** will be multiplied by the **【Robot Coefficient】** .
- **【Environment Coefficient: C_e 】 (1.0~3.0)**

When environmental conditions increase the difficulty level of completing the task, like wind, smoke, water, dark lighting, etc., the **【Competition Task Points】** will be multiplied by the **【Environment Coefficient】** .
- **【Autonomy Coefficient: Ca 】 (1.3~3.0)**
 - When mission tasks that are completed using autonomous mobility, the **【Competition Task Points】** will be multiplied by the **【Autonomy Coefficient】** .
- **【Mapping Coefficient: C_m 】 (1.0~1.2)**
 - When information about the mission's competition field (map, temperature, etc.) is successfully reported, the **【Competition Task Points】** will be multiplied by the **【Mapping Coefficient】** .
- **【Additional Time Points: P_i 】**
 - Points to be gained when the competitors complete the tasks before the designated time limit.
 - It is required that all robots are positioned on the **【start】** point or **【goal】** point.
 - From the remaining competition time, every second will earn a 2/60 points, which will be added to the **【Competition Mission Score】** .
Example) for a remaining time of 1:34,
 $94(s) \times 2/60 \text{ point} = 3.1 \text{ points}$

6.2. Point Deduction

In the following cases, points will be deducted from the score earned until that point.

6.2.1. **【Restart Deduction: Dr 】**

- In the event where not all robots are positioned in the 【start】 point or 【goal】 point, or when a robot is lost during a mission, 0.5 points will be deducted from the 【Competition Mission Score】 .

6.2.2. 【Competition Task Deduction: Dt 】

- If an action during a task requires point deduction, points will be deducted from the 【Competition Task Score】 .

6.2.3. 【Committee Member Point Deduction: Dc 】

- If a referee/committee member has reason to believe that an action done during the task requires point deduction, points will be deducted from the 【Competition Mission Score】 .
 - if the committee deems the point deduction as valid, the object of deduction and deduction point amount will be published.

6.3. Competition Score

6.3.1. Competition Mission Score

The following formula demonstrates the achievable competition missions score (Pm).

$$Pm = \left\{ \sum_{i=1}^n (Pt_i \cdot Cr_i \cdot Ce_i - Dt_i) \right\} \cdot Ca \cdot Cm + Pi - Dr - Dc$$

In this formula,

Pm : Competition Mission Score

n : Number of competition tasks in the mission

Pt_i : Tournament Task Points = 《competition categories basic score》 x 《type

coefficient》 x 《detail coefficient》

Cr_i : Robot Coefficient

Ce : Environment Coefficient

Ca : Autonomy Coefficient

Cm : Mapping Coefficient

Pi : Additional Time Points

Dr : Restart Deduction

Dt : Competition Task Deduction

Dc : Committee Member Point Deduction

6.3.2. Scoring for the Preliminaries, Semi-finals, and Finals

The scores for the preliminaries, semi-finals, and finals are the grand total of all the points gained in every competition mission from every round.

6.4. Ranking

The rankings will be ordered by highest score in descending order.

7. Appendix

7.1. Targets

The targets are QR Codes that are built into pipes. The size of the “targets” (QR Codes) and length of the pipes are shown in Table 7-1.

Table 7-1: Target Types and Codes

Target Codes		QR Code Width (mm)		
		140	35	7
Pipe Length (mm)	0	140-0	35-0	7-0
	50	140-50	35-50	7-50
	100	140-100	35-100	7-100

- 7.2. The QR Codes Version 1 (21x21 modules) will be used as targets. The QR Code error correction level used is Level Q (25%).



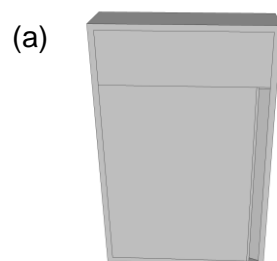
Figure 7-1:Target (140-50)

7.3. Fire Extinguishing

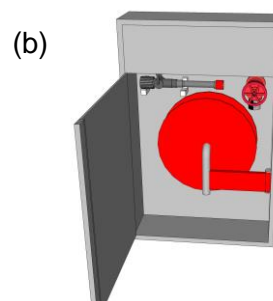
7.3.1. Description

Use the extinguishing equipment in the tunnel and extinguish the fire that has erupted in the tunnel.

- Diagram 7-7-1 demonstrates the outer appearance of the box for the extinguishing equipment.



(a) In a state where the door is closed



(b) In a state where the door is opened

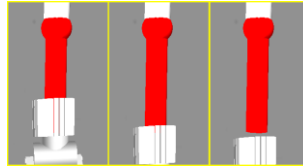
Figure 7-7-1: Outer appearance of First Extinguishing Equipment

- The tasks are to be completed in the following sequence:

- (1) 【W-f_1】 Open the fire hose box and extend the hose
 - The mass per unit length of hose is 0.275 kg/m.
 - The mass of the fitting attachment at the end of the hose is 0.5kg.

(2) 【W-f_2】 Take out the nozzle and attach it to the hose.

- Take out the nozzle that is mounted in the fire hose box.
- The mass of the nozzle is 1kg.
- Insert the hose bracket into the nozzle bracket, until the front end of the hose bracket reaches the bottom inside of the nozzle bracket. Keep pushing the hose bracket into the nozzle bracket for a short time (View the image below for reference).

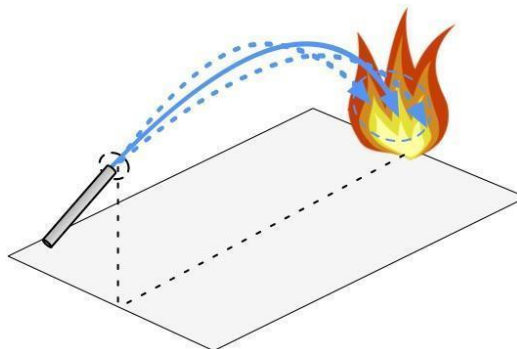


(3) 【W-f_3】 Turn the valve to the fire hydrant

- Rotate the valve 90 degrees counter-clockwise.
- To rotate the valve, the required torque is 5Nm (If a torque of over 5Nm is used, the valve will rotate).

(4) 【W-f_4】 Carry the hose with the attached nozzle to the fire location, direct the nozzle towards the fire, and extinguish the fire.

- Release the water from the predetermined location (move to the designated spot).
- Turning the lever on the nozzle will release the water.
- The required torque to turn the nozzle is 2Nm (adding torque will cause the valve to rotate).
- Once the specified amount of water hits the fire source, the fire will be extinguished.
- The fire source gradually increases from the start of the task.



<Reference Materials>

Pre-Tournament Rulebook (October 2024)

WRS2025 Harsh Environment Challenge Pre-Tournament Simulation Disaster Challenge Rulebook (Ver.1.0.0)

WRS Simulation Disaster Challenge Competition Committee

Competition Overview

1. Competition

1.1. Competition Description

In a simulated plant disaster under harsh conditions, collect information and carry out an emergency response.

1.2. Competition Field

The competition field is divided into four areas, Areas 1-4, and the contestants are to carry out the designated tasks for each area.

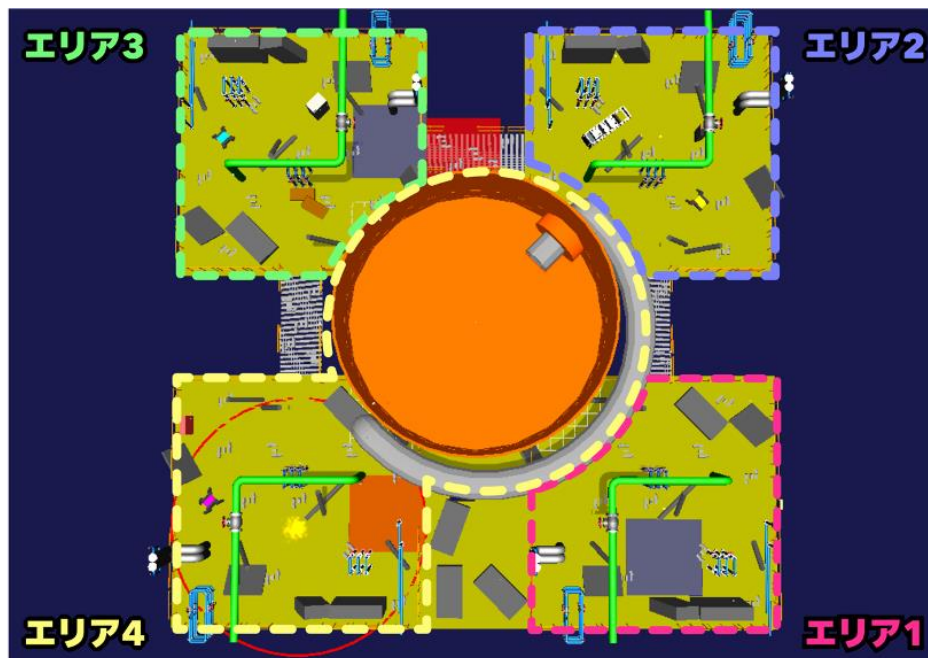


Figure 1-2-1: Overhead View of the Competition Field

1.3. Missions, Task Codes, and Mission Types

1.3.1. Mission/Task Code Rules

The mission tasks will adhere to the following rules. For further details on missions, please reference “Chapter 6: Missions”.

【Mission Code】 - 【Area Number】 _ 【Task Code】 - 【Task Number】 _ 【(Task Stage Number)】

Mission Code: The code for the Simulation Disaster Challenge is 【PS】

Area Number: 1～4

Task Code: for task type, and code by location, reference section 1.1.2.

Task Number: Number

Task Process Number: is assigned when there are multiple stages to achieve a task.

1.3.2. Task Type and Code

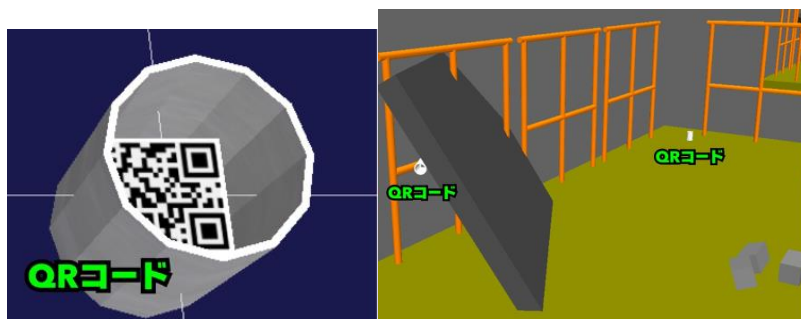
The tasks will be carried out in the Simulation Disaster Challenge are managed by the following codes.

Code 【Swi】 Switch-type Operations



Code 【ReG】 Damage Location Identification

Identify targets in specified locations



Code 【ReC】 Damage Location Identification in Specified Locations and Environments.

Code 【Lev】 Lever and Valve Operation



Code 【Com】 Passing Through Confined Spaces, like Duct Interiors



Code 【Fex】 Extinguishing Fire

Reference the [Task: Fex: Details on Fire Extinguishing Task](#) for further information.



【Task Appearance Code】

Example) PS-4_Fex-1_(2)

Area 4, Fire Extinguishing 1st Task, Step 2.

PS-1_Swi-1

Area 1, Switch operation 1st Task.

1.4. Competition Time

1.4.1. The time allocated to each Simulation Disaster mission carried out in each area is 15 minutes.

1.4.1.1. Even if the simulation time is extended, you are not allowed to exceed the real competition time (the competition will halt once the real time is up).

1.5. Competition Attempts

1.5.1. During the competition time, teams may carry out all missions at once.

1.6. Competitors and Number of Members

1.6.1. 'Competitors' are registered team members that participate during competition and operate the robots.

1.6.1.1. The number of competitors is limited to a maximum of 2 persons.

1.6.1.2. Only 1 competitor may operate the robot.

1.6.1.2.1. However, in case 2 robots collaboratively carry out a task, 2 persons may operate the 2 robots.

- Examples for acceptable collaboration work scenarios:

- 1) 2 robots collaborate to remove 1 piece of debris.

- 2) Using a camera equipped drone to get a bird-eye's view of the ground robot and its operation.

- Examples for unacceptable collaboration work scenarios:
 - 1) 2 robots simultaneously carrying out 2 tasks. The robots must collaborate on 1 task, like carrying 1 piece of debris.
 - 2) A drone collects information to create a 3D model map while a robot carries out tasks.
- 1.6.2. The competitors cannot switch with other members of the team during the competition.
- 1.6.3. Other team members cannot enter the control area (team booth seating area) while the competitors are competing and carrying out missions (tasks).
 - 1.6.3.1. The competitors cannot communicate with the other team members during the competition.
- 1.6.4. The competitors and other members may prepare for start and restart, however, during the preparations, only 1 team member may enter the control area aside from the competitors.

2. Ranking, Scoring, Penalties, and Disqualifications

2.1. Score

- 2.1.1. The designated scores for tasks in each area are shown in Table 1.1.
- 2.1.2. Scores are given based on the points gained in each mission (task), and bonus scores gained by fulfilling the bonus point requirements.
- 2.1.3. Scores will be rounded up to 1 decimal place, and will be officially recorded up to 1 decimal space.

2.2. Scoring Scenarios and Bonus Scoring Scenarios

- 2.2.1. Scorable scenarios are set work tasks that will “earn points” in every mission.
 - 2.2.1.1. Score by completing tasks.
- 2.2.2. Bonus Score (field): earn bonus points depending on the field.
- 2.2.3. Bonus Score (tasks): Earn bonus points depending on the set task conditions, like difficulty, field environment, situation, etc.
 - 2.2.3.1. Bonus scores will be awarded only after receiving the task score.
 - 2.2.3.2. Bonus scores (task) will be awarded depending on the tasks score. The score is the (basic task score) multiplied by a coefficient of 1.0~2.0.
- 2.2.4. Bonus Score (environment): a bonus awarded when the information on the field environment is submitted (map, temperature, etc.).
 - 2.2.4.1. Submit 3D environmental information like mapping and temperature, in the intercloud standard format.
- 2.2.5. Bonus Score (control)
 - 2.2.5.1. Tasks achieved using autonomous mobility will receive double points.
 - 2.2.5.2. Report to the referees in case autonomous tasks will be used to carry out tasks.
- 2.2.6. Bonus Score (time): bonus points will be awarded in each mission depending on the task time (calculated time).
 - 2.2.6.1. Teams that complete each mission (tasks) and reach the goal quickly will receive bonus points.
 - 2.2.6.1.1. For every second from the time remaining, 2/60 points will be added to the score.
Example) If 1:34 minutes remain to the end of the designated competition time, 94 (s) x 2/60 points = 3.1 points (a bonus of 3.1 points will be added to the score).
 - Bonus scoring is subject to change.
 - 2.2.6.2. Bonus points for the scenarios above will not be granted if the tools used to complete the mission are not carried to the goal.
- 2.2.7. Penalties
 - 2.2.7.1. In every mission (task), if a deductible scenario described below takes place, points will be deducted for that action.

- 2.2.7.1.1. If a scenario that is not described in the rulebook occurs, and the referee finds reason that it should be penalized, the referee can deduct points for that action.
 - After the referee decides to deduct points, the head of the judging committee will rule on the penalty.
- 2.2.7.1.2. The point deduction amount will be published if an act is defined as deductible.
- 2.3. Ranking
 - 2.3.1. The ranking will be decided Based on score amount, first place having the most points.
- 2.4. Disqualification and Misconducts
 - 2.4.1. Conditions for Disqualification
 - 2.4.1.1. Any action described below will disqualify the team.
 - 2.4.1.1.1. Any unfair conduct that has been confirmed by the referees to have recurred three times.
 - 2.4.1.1.2. An unfair conduct can vary from the competing method, robot, tools, etc.
 - 2.4.1.1.3. Not adhering to competition committee and referees on matters concerning the competition and its progress.
 - 2.4.1.2. In the case of a disqualification, the circumstance will be explained to all the competitors (representative: 1 person from each team), a statement will be taken, will be discussed among the judging panel and competition committee, the head of the competition committee will decide how to handle the circumstance.
 - 2.4.2. Competition Post-Disqualification
 - 2.4.2.1. In case a team is disqualified, the team will halt all its activities, and will not be able to continue the competition.
 - 2.4.2.2. In case a team is disqualified, all point will be lost and the official record will show "disqualified".
 - 2.4.3. Misconduct
 - 2.4.3.1. If any clear misconduct has been identified by the referees, the competition will be halted.
 - 2.4.3.1.1. If the competition is halted, all points earned during the competition will be lost.
 - In the case of a misconduct, the matter of the misconduct will be explained to all the team members (representative: 1 person per team), a statement will be taken, and after the matter is discussed among the judging panel, the head of the competition committee will decide how to handle the misconduct.
 - 2.4.3.1.2. If the cause halting the competition has been deemed by the referee resolved, the competition will commence once more, and the team will be permitted to compete.

Table 1-1: Task Scoring Table

Task		必要な工程と内容		Score					
Title	Code	Number of steps to complete the mission	Description	Base Score	Bonus Scenarios				
					Bonus (field)	Bonus (task)	Bonus (time)	Bonus (environment)	Bonus (control)
Switch-type Operation	Swi	1	Switch ON	10	Based on field environment and condition, the base point will be multiplied by a value between 1-2.	Based on difficulty level, the base point will be multiplied by a value between 1-2.	Based on the remaining time until the end of the competition time, for every remaining second, 2/60 points will be added.	Receive an additional 10 points for submitting information on the environment (3D map, etc.).	The base point will be multiplied by 2 in case autonomous mobility is used to complete tasks.
Damage Location Identification	ReG	1	Identifying and detecting targets	3					
Damage Location Identification in Specified Locations and Environments	ReC	1		8					
Lever and Valve Operation	Lev	1	Operating in specified locations	15					
Clearing and Moving (Manipulating) Obstacles	Man	1	Pulling out, moving	15					
Passing Through Confined Spaces, like Duct Interiors	Com	1	Maneuvering from the entrance to the exit	20					
Fire Extinguishing	Fex	5	Total	35					
			Pulling out the hose	5					
			Connecting the hose and the nozzle	10					
			Opening the valve	5					
			Pulling the nozzle bar	5					
			Extinguishing fire	10					

1.1. Competition Time

1.1.1. The time allocated to each Simulation Disaster mission carried out in each area is 15 minutes.

- 1.1.1.1. Even if the simulation time is extended, you are not allowed to exceed the real competition time (the competition will halt once the real time is up).

1.2. Competition Attempts

- 1.2.1. Each team may complete all the competition tasks in one setting.

1.3. Competitors and Number of Members

- 1.3.1. 'Competitors' are registered team members that participate in the competition and operate the robots.

- 1.3.1.1. The number of competitors is limited to a maximum 2 persons.

- 1.3.1.2. Only 1 competitor may operate the robot.

- 1.3.1.2.1. However, in case 2 robots collaboratively carry out a task, 2 persons may operate the 2 robots.

- Examples for permissible collaboration work scenarios:

- 1) 2 robots collaborate to remove 1 piece of debris.

- 2) Using a camera equipped drone to get a bird-eye's view of the ground robot and its operation.

- Examples for impermissible collaboration work scenarios:

- 1) 2 robots simultaneously carrying out 2 tasks. The robots must collaborate on 1 task, like carrying 1 piece of debris.

- 2) A drone collects information to create a 3D model map while a robot carries out tasks.

- 1.1.1. The competitors cannot switch with other members of the team during the competition.

- 1.1.2. Other team members cannot enter the control area (team booth seating area) while the competitors are competing and carrying out missions (tasks).

- 1.1.2.1. The competitors cannot communication with the other team members during the competition.

- 1.1.3. The competitors and other members may prepare for start and restart, however, during the preparations, only 1 team member may enter the control area aside from the competitors.

1.2. Referees and Competition Committee

1.2.1. Referees

- 1.2.1.1. The judging panel consists of referees and competition committee members.

- 1.2.1.2. The referees manage the competition, judges scores, and measures the competition time.

- 1.2.1.2.1. Each competing team will be assigned one referee that will instruct and make decisions regarding the competition, based on the instructions given by the competition committee.

- 1.2.1.3. The judging panel will decide on issues regarding the competition systems (networks, computers, etc.).

- 1.2.1.3.1. If a problem arises during the competition that is thought to have been caused by the competition systems, the competitors are to report the problem to the referee.

1.2.2. Competition Committee

- 1.2.2.1. Manage the competition and referee.

- 1.2.2.2. The head of the competition committee holds the highest responsibility over competition matters.

2. Robots

2.1. Number of Robots

- 2.1.1. There is no limit to the number of robots to be used to complete the missions (all missions).

- 2.1.1.1. The same robots must be used throughout all the missions.

- ※ Robots used in area 1 must also be used in Area 2 and Area 4.

2.2. Robot Types

2.2.1. In the competition, competitors may use platform robots or self-designed robots.

2.2.1.1. There are two types of platform robots, described below.

※For further details, reference the model (offered separately).

2.2.1.2. Self-designed robots

· Robots that are designed by the participants.

The participants may improve/upgrade the base robot offered by the competition administration, and/or develop a self-designed robot.

【Base Robot】

The robot used to inspect tasks in the simulator, (UGV, UAV, etc.).

The details for the model of the basic robot will be offered separately.

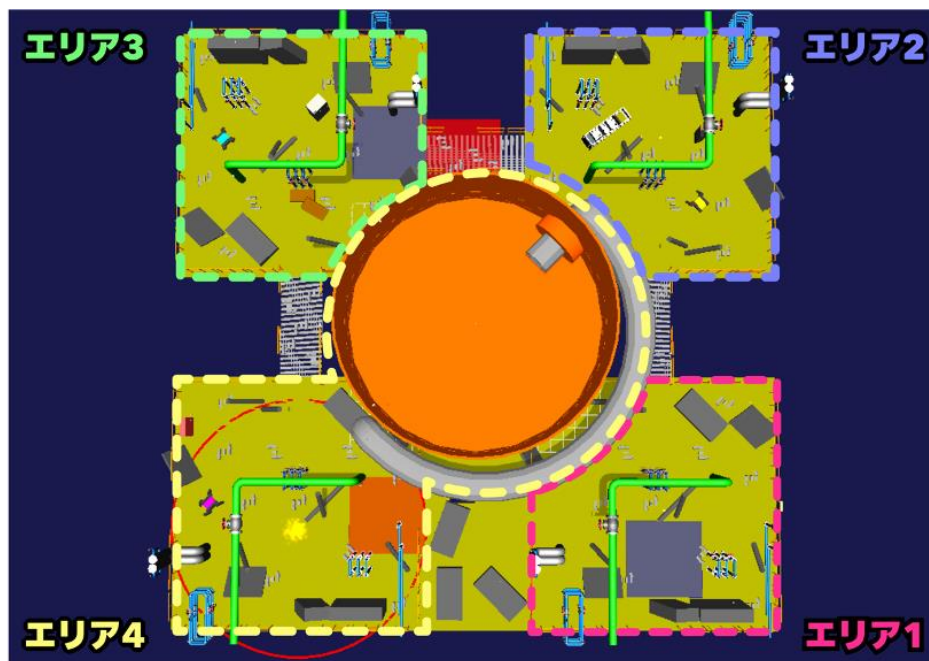
2.3. Robot Size and Competition

2.3.1. There is no limitations to the size of the robot.

3. Field

3.1. The Simulated Competition Field

3.1.1. In a simulated plant disaster under harsh conditions, collect information and carry out an emergency response.



3.2. Start and Goal

3.2.1. Mission and Start

3.2.1.1. As a rule, the competition will start by mission.

3.2.2. Competition Time

3.2.2.1. Rules on time are specified in

3.2.2.1.1. It is not permitted to go over the real competition time.

3.2.2.2. Preparation time is included in the competition time (preparation time during a restart is also included).

3.3. Start

3.3.1. The robot starting point is specified in each area.

- 3.3.1.1. Until the starting time, the robots are not allowed to move.
It is prohibited to collect field information with sensors, etc., before the starting time, while the robot is behind the starting line.
 - 3.3.2. The competition will start in the following procedure.
 - 3.3.2.1. The competitors are to place all the necessary machinery to maneuver the robot on the tables in the control area.
 - 3.3.2.2. When the referee makes the starting signal, the team may begin to prepare and start the mission.
 - 3.3.2.2.1. Preparation includes connecting the network between the computer used to operate the robot and the computer used for the competition.
 - 3.3.3. The referees will start the time clock with the starting signal.
- 3.4. Goal
 - 3.4.1. The referee will confirm that the robot's representing point reached the goal point, and only then will declare the goal.
 - 3.4.1.1. If 2 robots were used, the referee will confirm that both robot's representing point reached the goal point, and only then will declare the goal.
 - 3.4.2. A robot's representing point is the area on the robot that has a sphere attached to it. Therefore, it is required to attach the sphere to a location on the robot that would be clearly visible to the referees.
 - 3.4.2.1. Details on the sphere will be published with the field model.
 - 3.4.3. By reaching the goal, the competition's mission (task) has ended, and the time count will stop.
 - 3.4.3.1. If 2 robots were used, only when both robots have reached the goal, the competition's mission (task) will end, and the time count will stop.
 - 3.4.4. It is possible to reach the goal and end the competition without fulfilling every task required in each mission (task).
 - 3.4.4.1. However, in the case that not all tasks were carried out, no points will be counted from the tasks that were not completed.
 - 3.4.4.2. Bonus (time) points will not be counted as well.
- 3.5. Restart
 - 3.5.1. The competitors may apply for a restart
 - 3.5.1.1. A restart refers to starting again after the competition has started.
 - 3.5.1.2. The restart procedure complies with the starting procedure.
 - 3.5.1.2.1. A restart will return the field to its original state.
 - 3.5.2. Once a request for a restart has been made and accepted by the referee, preparations for a restart can be made.
 - 3.5.2.1. Once a referee accepts a restart request, it is not possible to take back the request.
 - 3.5.2.2. If a competitor requests to abstain after receiving a restart, there is no need to restart.
 - 3.5.3. Competitors may freely apply for a restart.
 - 3.5.3.1. Restarts will commence from the starting point.
 - 3.5.3.2. In case of a restart, the number of points gained before the restart will be compared with the number of points gained after the restart, and the higher score will be chosen.
 - 3.5.4. Once a restart has been accepted, the time count will pause, and the field will revert to its original state. The referees will decide on the right timing to restart, and then the time count will resume.
 - 3.5.5. The competition real time after the restart is the time until the referees accepted the restart subtracted from the allocated competition time.

 Example) The real time for the competition is 10 minutes. If the time until a restart appeal is accepted was 4 minutes and 30 seconds, the competition real time after the restart is 5 minutes and 30 seconds.

- 3.5.6. There is no limit to the number of restarts.
- 3.5.7. If a referee deems a restart necessary, the competitors must restart. This is called a compulsory restart.

3.6. Abstinence (Competition Renunciation)

- 3.6.1. The competitors may renounce all missions (task), or certain missions (tasks).
 - 3.6.1.1. Applying for an abstinence must be done to the referee.
- 3.6.2. The points earned during the competition until the moment of abstinence are valid.

4. Targets

4.1. Targets: Definition

- 4.1.1. Targets are QR Codes built into pipes. The table below describes the different size AR codes and pipes used as targets.

Table 4-1: Target Types and Codes

Target Codes		QR Codes Width (mm)		
		140	35	7
Pipe Length (mm)	0	140-0	35-0	7-0
	50	140-50	35-50	7-50
	100	140-100	35-100	7-100

- 4.1.2. The QR Codes version 1 (21x21 modules) are used as targets. The QR Code error correction level used is Level Q (25%).



Graph 4-1-1: Target(140-50)

4.2. Targets Used for Recognition

- 4.2.1. Table 5-1 demonstrates the targets to be used in the competition

4.3. Number of Targets

- 4.3.1. The number of targets in each mission (task) varies depending on the mission.

4.4. Identifying Targets

- 4.4.1. Identifying targets is defined as the act of reading the contents of a QR Code in the target.
 - 4.4.1.1. The competitors operating the robots are to report when identifying a QR Code, and insert into the competition sheet.
 - 4.4.1.2. The content to insert in the competition sheet are the target number and QR Code content.
 - 4.4.1.3. The competition sheet is to be quickly submitted to the referees once the competition (mission) ends.

5. Missions

5.1. Mission Details

5.1.1. The described tasks in each mission will provide the necessary robot technological capability necessary to carry out the mission.

5.1.2. A map of the plant in its original state will be distributed in advanced, assuming that plant blueprints exist.

5.1.2.1. The field environment and conditions may change in the same mission, depending on the location of the robot, time, etc.

5.1.3. Using Tools

5.1.3.1. Tasks must be carried out using tools that have been constantly mounted on the robot.

5.1.3.1.1. Robots may use tools prepared/placed in the field.

5.1.3.2. Robots may use simple tools to complete missions (tasks) when necessary. Simple tools refer to tools that do not contain any advanced mechanisms, and a camera attached to the end of a stand or long pole (commonly known as a stick camera, etc.).

5.2. Task Number and Type in Every Mission

The following table demonstrates the number and type of tasks to be completed in every mission.

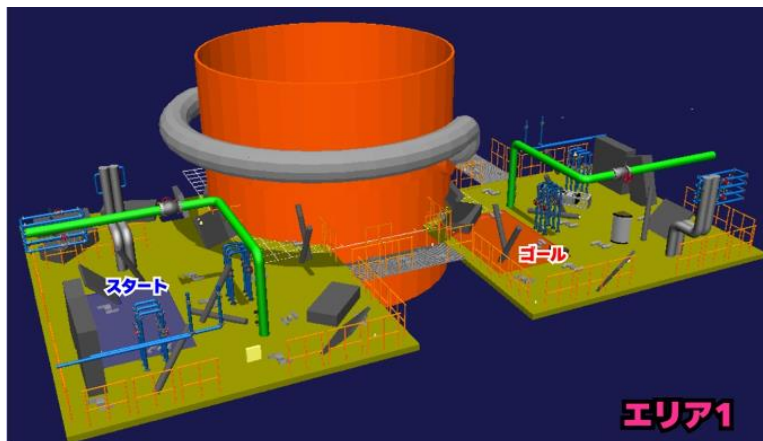
Mission	Area	Task	Code	# of Tasks	Basic Score	Total	Mission Total
PS-1	Area 1	Switch-type Operation	Swi	1	10	10	
		Damage Location Identification	ReG	10	3	30	
		Total					40
PS-2	Area 2	Switch-type Operation	Swi	1	10	10	
		Damage Location Identification	ReG	10	3	30	
		Lever and Valve Operation	Lev	1	15	15	
		Total					55
PS-3	Area 3	Damage Location Identification	ReG	10	3	30	
		Lever and Valve Operation	Lev	1	15	15	
		Clearing and Moving (Manipulating) Obstacles	Man	1	15	15	
		Fire Extinguishing	Fex	1	30	30	
		Total					90
PS-4	Area 4	Damage Location Identification	ReG	5	3	15	
		Lever and Valve Operation	Lev	1	15	15	
		Passing Through Confined Spaces, like Duct Interiors	Com	1	20	20	

		Damage Location Identification in Specified Locations and Environments	ReC	5	8	40	
							Total
							90

5.3. Mission 【PS-1】 Area 1: Lever Operation/Power Restoration

5.3.1. Description

The mission requires a robot to search across an area which is scattered with objects following a plant disaster. As the area is dark, the robot is required to operate the lever to switch on the electric light. To grasp the situation, the robot is required to identify the targets in various locations around the area, as well as reach the goal by the designated time limit. This competition requires robot mobility, manipulation, and searching ability. Moreover, the robot should be prepared to respond in cases of deterioration of visibility caused by remote piloting communication failure, or a sudden power cut.



5.4. Mission 【PS-2】 Area 2: Valve Operation

5.4.1. Description

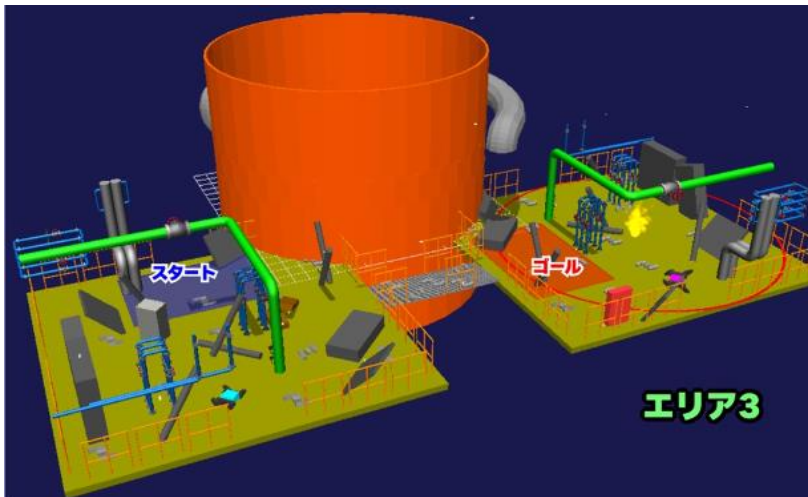
The mission requires a robot to search across an area which is scattered with objects following a plant disaster. The robot is required to operate the valve to stop gas pipe (smoke) and water pipe leakages in the area. To grasp the situation, the robot is required to identify the targets in various locations around the area, as well as reach the goal by the designated time limit. This competition requires robot mobility, manipulation, and searching ability. Moreover, the robot should be prepared to respond in cases of deterioration of visibility caused by remote piloting communication failure, or a sudden power cut.



5.5. Mission 【PS-3】 Area 3: Extinguishing a Fire

5.5.1. Description

The mission requires a robot to search across an area which is scattered with objects following a plant disaster. The robot is required to operate the valve to stop gas pipe (smoke) and water pipe leakages in the area. To grasp the situation, the robot is required to identify the targets in various locations around the area, as well as reach the goal by the designated time limit. This competition requires robot mobility, manipulation, and searching ability. Moreover, the robot should be prepared to respond in cases of deterioration of visibility caused by remote piloting communication failure, or a sudden power cut.

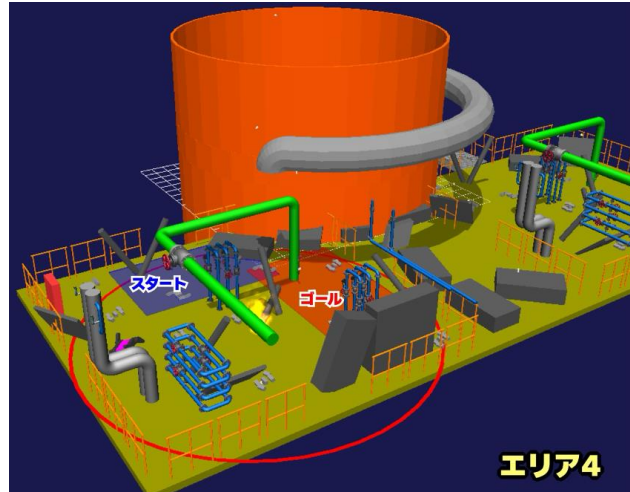


5.6. Mission 【PS4】 Area 4: Entering Ducts, and Investigating the Tank Interior

5.6.1. Description

Similar to Areas 2 and 3, stop any leakages from piping, and after grasping the situation, extinguish the fire that has erupted in the after the disaster using the fire extinguisher inside the fire hose box. To grasp the situation inside the tank, infiltrate the ducts and enter the tank. the robot should be prepared to respond in cases of deterioration of visibility caused by remote piloting communication failure, or a

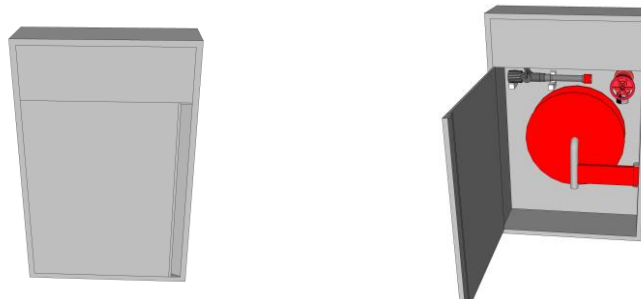
sudden power cut in Area 4 as well.



5.7. Task: Fex: Details on Extinguishing Fire

5.7.1. Figure 7-7-1 demonstrates the outer appearance of the fire hose box.

- The color of the door may change.

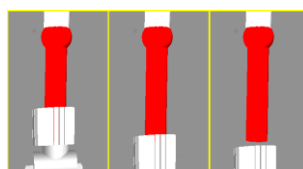


(a) In a state where the door is closed (b) In a state where the door is opened

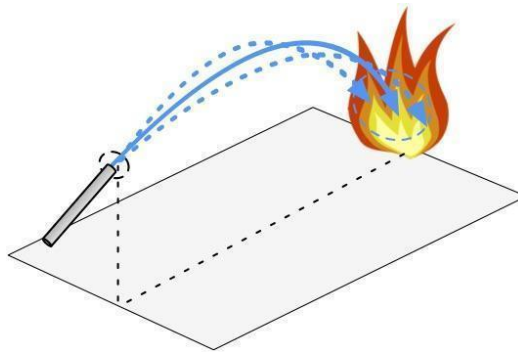
Figure 7-7-1: Outer appearance of First Extinguishing Equipment

5.7.2. Complete tasks in the following sequence.

- (1) 【Fex-*(1)】 Open the door of the fire hose box, and extend the hose.
 - The mass per unit length of hose is 0.275 kg/m.
 - The mass of the connection fitting at the end of the hose is 0.5kg.
- (2) 【Fex-*(2)】 Take out the nozzle and attach it to the hose.
 - Take out the nozzle that is mounted in the fire hose box.
 - The nozzle mass is 1kg.
 - Insert the hose bracket into the nozzle bracket, until the front end of the hose bracket reaches the bottom inside of the nozzle bracket. Keep pushing the hose bracket into the nozzle bracket for a short time (View the image below for reference).



- (3) 【Fex-*_(3)】 Turn the valve to the fire hydrant
- Rotate the valve 90 degrees counter clockwise.
 - To rotate the valve, the required torque is 5Nm (If a torque of over 5Nm is used, the valve will rotate).
- (4) 【Fex-*_(4)】 Carry the hose with the attached nozzle to the fire location, direct the nozzle towards the fire, and extinguish the fire.
- Turning the lever on the nozzle will release the water.
 - The required torque to turn the nozzle is 2Nm (adding torque will cause the valve to rotate).
 - Once the specified amount of water hits the fire source, the fire will be extinguished.
 - The fire source gradually increases from the start of the task.



5.7.3. Scoring and Deductions

5.7.3.1. Scoring Scenarios

【Fex-*_(1)】

- Extending the hose 6 points.

【Fex-*_(2)】

- Attaching the hose and nozzle 10 points.

【Fex-*_(3)】

- Valve operation 8 points.

【Fex-*_(4)】

- Extinguishing fire 10 points.

