WUURC 2025
Competition Rules

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AUV Competition Track Rules

1. Competition Overview

1.1 Autonomous Underwater Vehicle (AUV)

An Autonomous Underwater Vehicle (AUV) is a primary category of underwater robots, integrating controllers, sensors, software, and energy systems. It possesses autonomous perception and decision-making capabilities, enabling independent navigation and large-scale exploration missions such as marine surveying, target search, and seabed exploration.

This competition evaluates the comprehensive autonomous control capabilities of underwater robots, including environmental perception, target recognition, decision-making, motion control, and task execution.

1.2 Venue Description

The competition venue is an indoor swimming pool approximately 20 meters long, 8 meters wide, and 1.3–1.6 meters deep. The layout is shown in Figure 1.

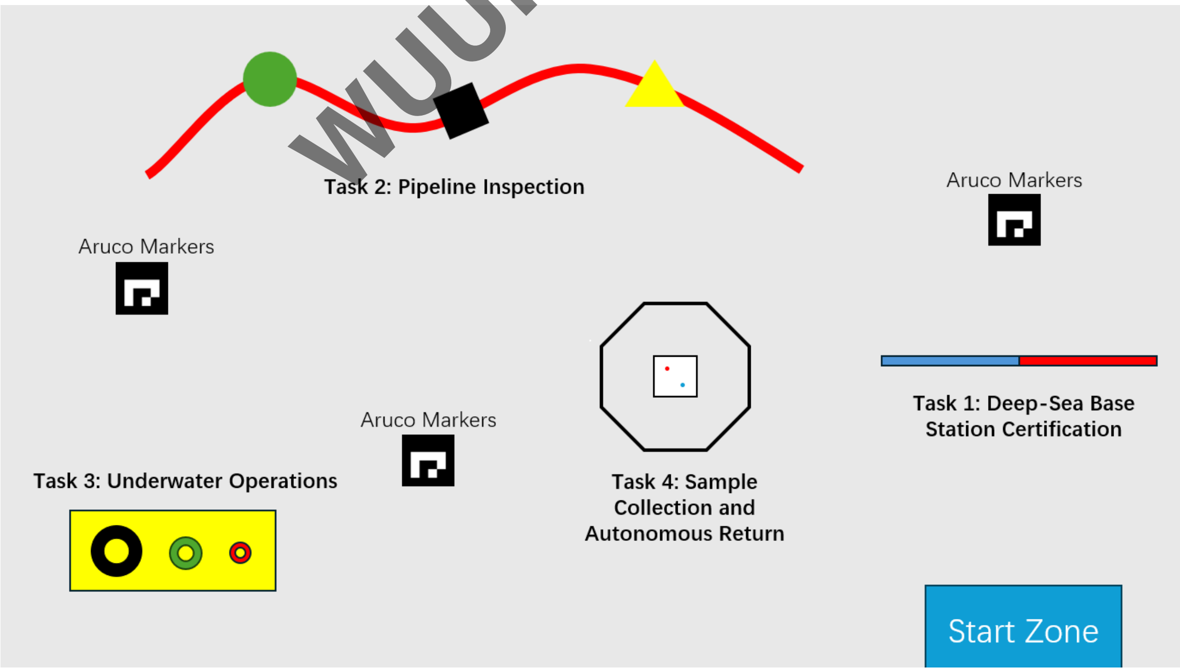


Fig.1 Competition Venue Layout

1.3 Competition Requirements

1. **Number of Robots**: 1
2. **Robot Dimensions**: Each robot must fit within a 1m×1m×2m cuboid.
3. **Power Supply**: Battery-powered only (no 220V supply). Battery voltage must not exceed 72V.
4. **Safety**: Each robot must have an externally accessible emergency stop button to halt all thrusters immediately.
5. **Environmental Compliance**: No objects except mission props may be discarded into the pool. No oil or pollutants may leak.
6. **Autonomy**: AUVs must operate fully autonomously. No remote control or physical contact with the pool is allowed.

1.4 Competition Process

1. **Total Time**: 30 minutes (10 minutes for setup/debugging, 20 minutes for competition). Teams must start within 10 minutes of declaring readiness.
2. **Attempts**: Up to 3 attempts within 20 minutes. Teams may terminate an attempt and retrieve the robot, but the timer continues. The highest score across attempts is recorded.
3. **Surfacing**: Robots may only surface within the designated surfacing frame. Any part surfacing outside ends the attempt.
4. **Communication**: One designated team member may communicate with referees.
5. **Attempt Termination Conditions**:
   1) Surfacing outside the frame.
   2) Voluntary termination by the team.
   3) Remaining surfaced in the frame for 3 seconds (task completion).

2. Competition Background

"Deep Sea No.1" is China’s first independently developed and constructed 100,000-ton-class deepwater semi-submersible production and storage platform, representing a pinnacle achievement in the nation’s marine engineering. On June 25, 2021, at approximately 10:30 AM, as an underwater robot successfully opened a subsea oil and gas valve at a depth of 1,500 meters, hydrocarbons flowed through underwater manifolds into the production system, igniting the surface torch. This marked the official commencement of operations for China’s first independently explored and developed 1,500-meter ultra-deepwater gas field, "Deep Sea No.1."

The competition simulates tasks performed by China’s “Deep Sea No. 1” ultra-deepwater gas field platform, including deep-sea base station certification, pipeline inspection, underwater operations, sample collection, and autonomous return. AUVs use visual (Aruco markers) and acoustic guidance.

3. Competition Tasks

Task Sequence Explanation:

The robot must complete the first major task before it can proceed to carry out the subsequent tasks. The sequence of the subsequent tasks can be decided by each participating team on their own.

3.1 **Deep-Sea Base Station Certification**

Before entering the "Hai Ji No.1" deepwater conductor frame, the robot must undergo safety testing. The robot must pass through the qualification gate to verify its performance and safety. Additionally, the robot may perform self-rotations to simulate stability under the impact of internal wave currents in the South China Sea. Robots that pass these tests will qualify to proceed to subsequent tasks.

3.1.1 Prop descripton

The square qualification gate is constructed from interconnected red and blue PVC pipes, divided at the center by a white PVC pipe. It has a total length of approximately 3 meters and a height of 1.3 meters. A blue counterclockwise (CCW) rotation indicator is located on one side, while a red clockwise (CW) rotation indicator is positioned on the opposite side. Detailed dimensions and structural specifications are illustrated in Figure 2 below.

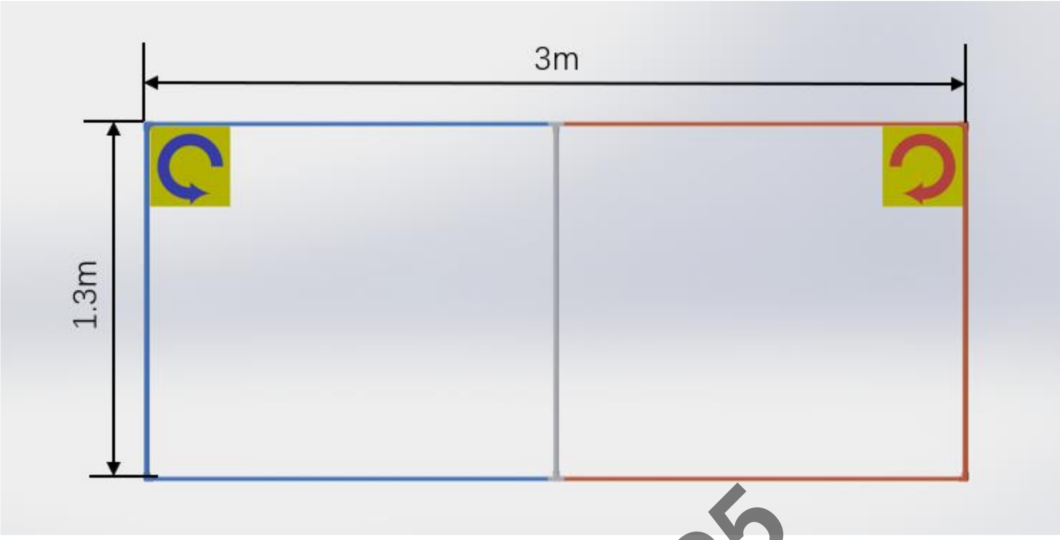


Fig.2 Qualification Gate (Front View)

Distinct Aruco markers are placed between tasks within the venue (as shown in the figures) to assist robots in positioning and orientation. For example, the orientation of the Aruco marker behind the qualification gate indicates the direction for the pipeline inspection task. Each Aruco marker board measures 400mm × 400mm and has a rotation angle range of -180° to +180°. Their placement is depicted in the figures below (not further elaborated in subsequent sections).

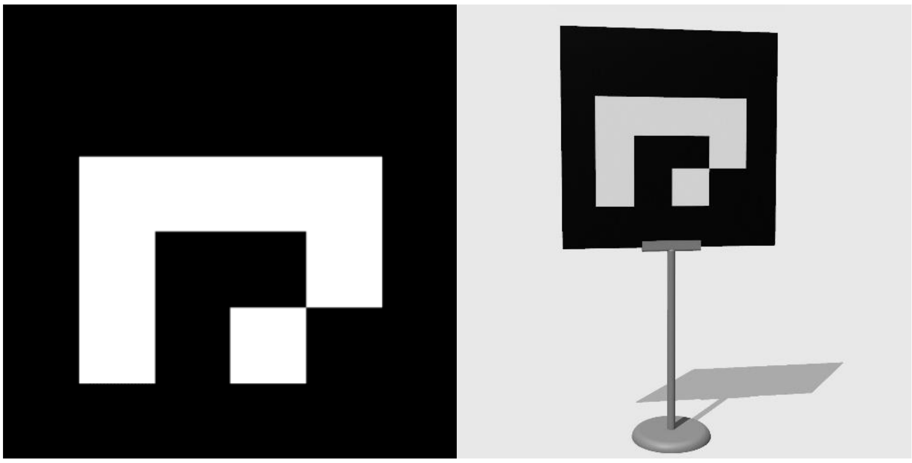


Fig.3 Aruco Markers and Placement

3.1.2 Rule Explanation

Before the competition begins, a color will be determined by random draw. This color dictates the gate passage color, corresponding rotation direction for the robot, and the sample color to be collected during the surfacing task.

The AUV must submerge within the launch area and begin the mission by passing through the qualification gate to initiate scoring. Failure to pass the gate disqualifies the team from scoring.

This task score includes base points and bonus points, where the robot completes the gate to obtain base points and qualify for the competition.

Bonus Points - Fancy Gate Maneuver: While passing through the gate, the robot can rotate 360 degrees in the specified direction towards the gate. This includes horizontal rotation (around the z-axis) and pitch/roll rotation (around the x-axis or y-axis). Points are awarded at 5 points per 90° for horizontal rotation (maximum 20 points) and 10 points per 90° for pitch/roll rotation (maximum 40 points). Reverse rotation will deduct previously earned points, with a full 360° rotation earning the maximum score.

Rotation Direction Determination: Using Figure 2 as the front view of the qualifying gate, judges will evaluate the robot's rotation direction from three perspectives: the front view, left-side view, and top view.

Note: Passing through the door underwater will secure the base points (base points) and qualify the robot for subsequent competition events.

3.2 Pipeline Inspection

Subsea oil and gas pipelines are subject to long-term seawater corrosion and ocean current impacts, leading to varying degrees of damage at different locations, necessitating regular inspections. Some require immediate repairs, while others demand replacement. To address this, robots must inspect along the subsea pipelines and complete corresponding tasks at designated task points.

3.2.1 Prop description

The subsea pipeline (as shown in Fig. 4) is divided into 4 segments, colored red, with an inner diameter of 50mm and lengths of 5–10 meters. The underwater robot must sequentially pass through three task points (illustrated in Fig. 5) and perform specific operations at each. The task points differ in shape and color.

Prop parameters are shown in the figures.

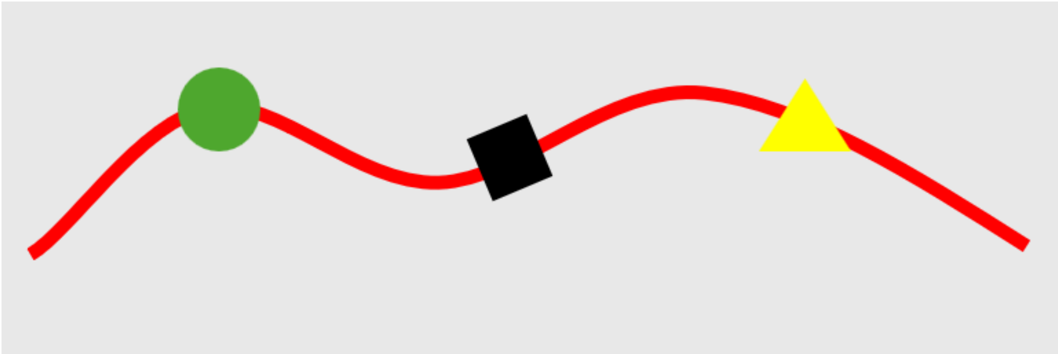


Fig.4 Subsea Pipeline Schematic

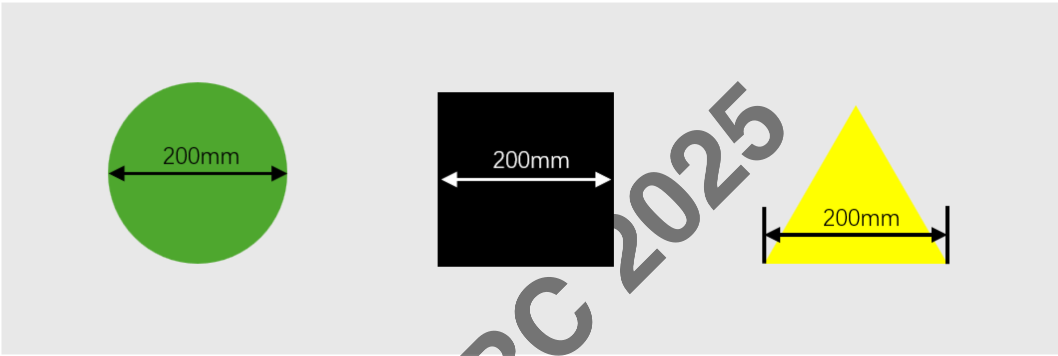


Fig.5 Task Points Schematic

3.2.2 Rule Explanation

The robot must complete pipeline inspection and task point operations in sequence. Points are awarded for each pipeline segment and task point.

Task Point Descriptions:

- Yellow Triangle: The robot must perform a full horizontal rotation (360°) to complete the inspection.
- Black Square: The robot must have an externally visible LED light and activate a red light at the black square.
- Green Circle: The robot must contact the sensor with any part of its body and activate a green light.

If the robot's projection deviates from the pipeline during inspection or task attempts, the current task is terminated.

After entering the pipeline inspection task, the robot must not activate red or green lights prior to detecting the black square or green circle. Premature activation invalidates points for those task points.

During the competition, the three task points are randomly arranged, but their order remains consistent across rounds.

3.3 Underwater Operations

The "Hai Ji No.1" deepwater conductor frame requires the installation of valve pins to activate oil and gas pipelines. Prior to deployment, the robot must carry a subsea valve pin and insert it into a designated hole on the frame to open the underwater valve.

3.3.1 Prop description

Three holes are available on the frame, with diameters of 50mm, 100mm, and 200mm. Each hole is encircled by a colored ring (as shown in the figures) with a width of 20mm. The holes are positioned on a plane perpendicular to the horizontal plane. The frame's approximate dimensions and structure are illustrated in Fig. 6.

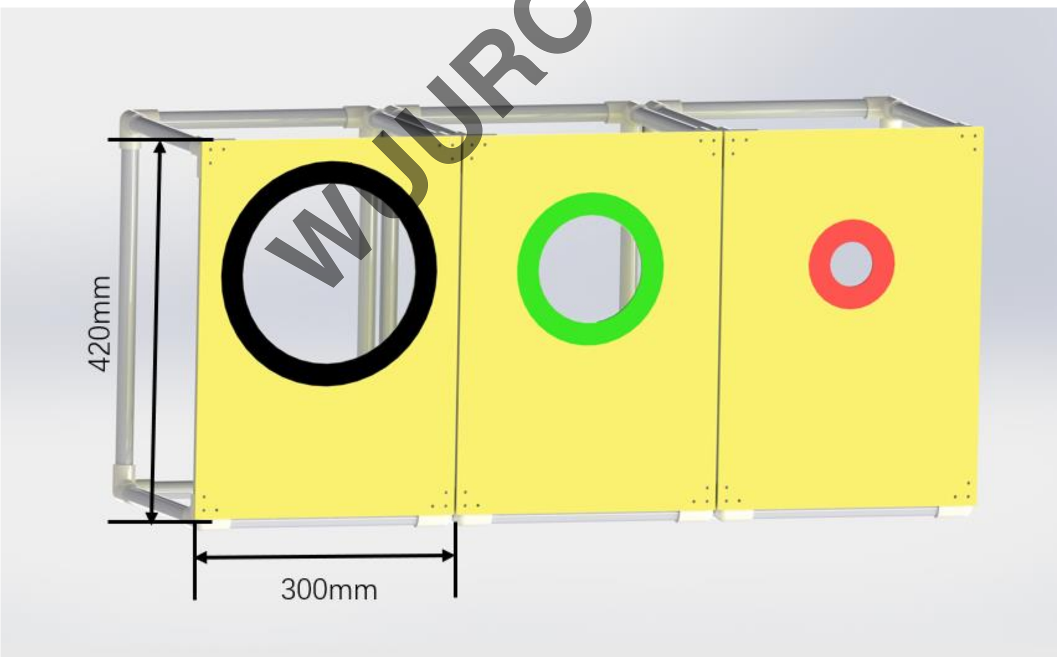


Fig.6 Frame Schematic

The subsea valve pin is a T-shaped PVC pipe. Its dimensions and design are shown in Fig. 7.

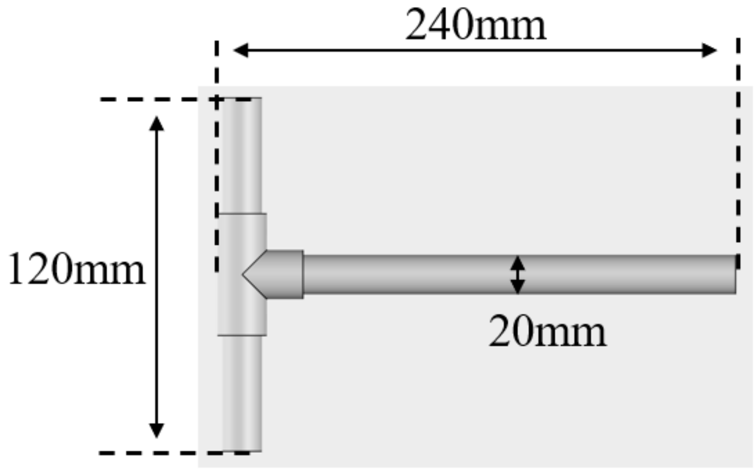


Fig.7 Subsea Valve Pin Schematic

3.3.2 Rule Description

The AUV must navigate to the frame using Aruco marker guidance. Using the pre-validated pin carried by the robot, it must successfully insert the pin into a hole, release it, and activate the valve to earn points.

Points vary depending on the hole size (larger holes yield higher scores). If insertion fails, the robot may autonomously retrieve the pin and reattempt.

Judgment Criteria: The final state of the pin determines success:

Success: The pin passes through the hole and drops behind the frame.

Failure: The pin is withdrawn by the robot or falls in front of the frame.

3.4 **Sample Collection and Autonomous Return**

To mitigate environmental impacts from oil platform operations, regular seawater sampling near the platform is required to monitor water composition. After completing underwater tasks, the robot must collect samples and return to the platform by surfacing within a designated frame.

3.4.1 Prop description

Surfacing Frame: A regular octagon constructed from 8 PVC pipes, each approximately 620mm long (*Fig. 8*).

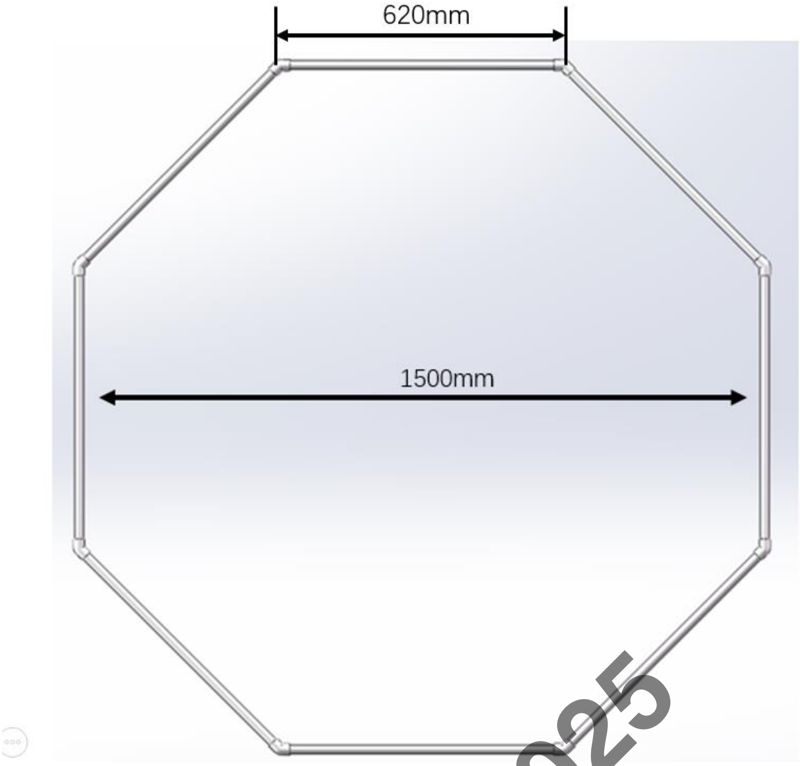


Fig.8 Surfacing Frame Schematic

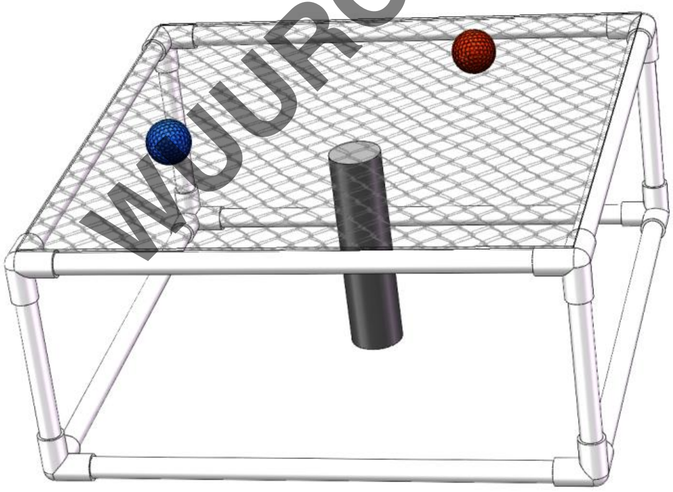


Fig.9 Sample Platform and Beacon Schematic

A 37.5kHz CW acoustic beacon located near the center of the octagon guides the robot to the task area (*Fig. 9*).

Sample Platform: Positioned at the octagon's center, holding two colored samples—red and blue golf balls (*Fig. 9*).

3.4.2 Rule Description

The robot must navigate to the task zone using acoustic or visual guidance, collect the correctly colored sample (matching the color drawn during the gate qualification), and surface within the frame.

1.4.3 Scoring Criteria:

Full Points:

The robot surfaces within the frame, with any part above water for ≥3 seconds. It carries the correct sample and does not contact the frame.

Partial Points:

The robot contacts the frame during surfacing or carries the incorrect sample.

Retry Conditions:

If the sample detaches during surfacing and the robot remains fully submerged, it may reattempt collection.

Failure Conditions:

If the sample detaches while the robot is surfaced for 3 seconds, it is deemed to have surfaced without the sample. If the robot surfaces with both correct and incorrect samples, it is treated as carrying no sample.

The above pictures are for reference only, the competition is subject to the actual.

The final interpretation right belongs to the organizing committee

4. Scoring Rules

Teams must successfully complete the first task (qualification) to proceed to subsequent tasks. Remaining tasks must be completed in sequence but may be skipped.

For teams with tied scores, the **shorter total time** determines the winner. If times are identical, the **lighter robot** prevails.

Task	Points	Max Points
Task 1: Deep-Sea Base Station Certification		60
Pass the correct gate Pass the wrong gate	+20 +10	20
Fancy Gate Maneuver: n*90°	+5/10n（n≤4）	40
Task 2: Pipeline Inspection		200
Inspect 4 sections of pipeline	+30 per section	80
Complete the task points' tasks	+40 per point	120
Task 3: Underwater Operations		300
The subsea valve pin is mounted on small/ medium/ large frame	+300/+150/+50	300
Task 4: Sample Collection and Autonomous Return		240
Correct color sample Wrong color sample	+120 +60	120
Float without touching the surfacing frame Float but touch the surfacing sample	+120 +60	120
Total points		800

ROV Competition Track Rules

1. Competition Overview

1.1 Remotely Operated Underwater Vehicle (ROV)

A Remotely Operated Underwater Vehicle (ROV), also known as an underwater drone, is a robotic system designed for extreme underwater operations. It can descend into water to perform tasks that replace human divers, who are limited by depth and safety risks. As a critical tool for ocean exploration and development, ROVs are powered via umbilical cables and operated by personnel on a mother ship. They use specialized equipment such as underwater cameras, sonar, and manipulators to observe and execute underwater operations.

This competition evaluates the comprehensive underwater operational capabilities of ROVs, including maintenance of marine aquaculture systems, recovery of net box data, collection of marine organisms, and activation of seabed exploration devices

1.2 Venue Introduction

The competition venue is an indoor swimming pool with a water depth of approximately 1.3–1.6 meters. The pool floor is slightly inclined (not level). The venue measures approximately 10 meters in length and 5 meters in width. The layout is illustrated in Figure 1.

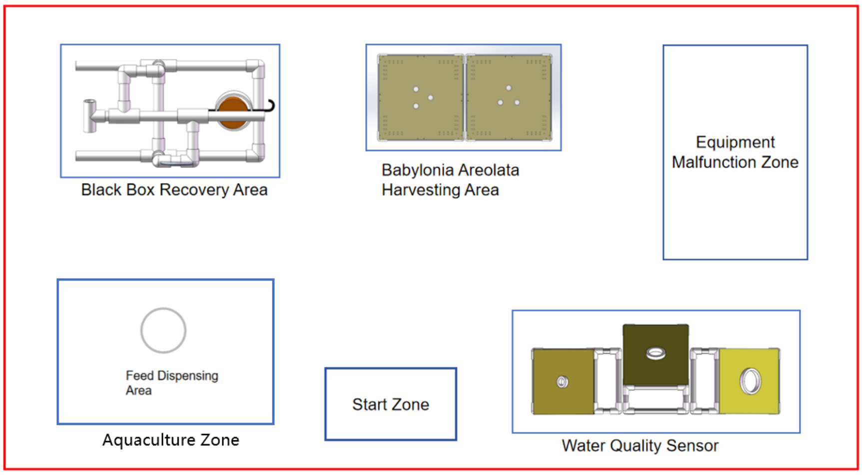


Fig.1 Competition Venue Layout

1.3 Competition Requirements

1. Number of Robots: 1 unit (tracked mobility systems are prohibited to avoid damaging the competition venue).

2. Weight Limit: The robot’s airborne weight must not exceed 25 kg (umbilical cable weight is excluded). Exceeding this limit will disqualify the team.

3. Dimensions: When the manipulator is retracted, the robot must fit within a rectangular box measuring 1m × 1m × 2m.

4. Controller Operators: Maximum of 2 operators. Both must be members of the participating team and may only represent one team during the competition.

5. Umbilical Operators: Maximum of 2 operators.

6. Competition Time: 10 minutes, debugging time: 5 minutes. There is only one chance to complete the task within ten minutes.

Controller Operators: Must remain seated at designated positions. During operation, they cannot directly observe the robot in the pool but may communicate with judges to inquire about time or request a pause.

Prohibited Actions: No objects (except required competition props) may be discarded into the pool during the competition. Oil leaks or other contaminants are strictly prohibited.

2. Competition Overview

Hainan Province is China's largest breeding base for Babylonia areolata. Its coastal waters, characterized by suitable temperatures, stable salinity, and abundant plankton, provide an ideal environment for large-scale Babylonia areolata farming. In recent years, however, climate change have led to challenges such as water quality deterioration, facility damage, and ecological imbalances. To address these issues, the application of intelligent aquaculture technologies is being prioritized.

This year’s competition simulates critical operations in a typical Babylonia areolata farm in Danzhou City, Hainan Province. Participants’ ROVs are tasked with precise feed distribution, post-typhoon facility repairs, ecological maintenance of farming zones and deployment of smart monitoring equipment. These tasks aim to advance green and efficient aquaculture management practices.

2. Competition Tasks

Task Sequence Explanation:

The sequence of completion for each major task can be decided by each participating team on their own. Major tasks cannot be executed concurrently; they must complete one major task before starting the next one. If a major task starts to execute other major tasks before all sub-tasks within it are completed, it will be regarded as giving up the execution of the sub-tasks within the previous major task that were not completed. If the team returns to execute the previously uncompleted sub-tasks later, the obtained score will be invalid. The sequence of sub-tasks within a major task can be decided by each participating team on their own.

3.1 **Feed Dispensing**

Babylonia areolata is sensitive to feed distribution and water quality, and overfeeding can easily lead to uneaten feed accumulation and increased ammonia-nitrogen levels. The ROV must periodically replace feed containers and monitor water temperature in real time to optimize feeding strategies.

Contestants must operate the robot to retrieve the empty feed container and hand it over to the umbilical operator, then collect the new feed container from the umbilical operator and deploy it into the aquaculture zone. While placing the feed, the robot must measure the water temperature within the aquaculture zone's boundaries. The measurement requires the robot to be within the zone, and the temperature must be displayed in degrees Celsius on the operator's screen. The operator must actively signal the judge to read and record the temperature.

The aquaculture zone is approximately a 1-meter-square area. The feed dispensing area is a cylindrical structure with a diameter of 150 mm and height of 150 mm, placed at a designated position on the pool bottom.

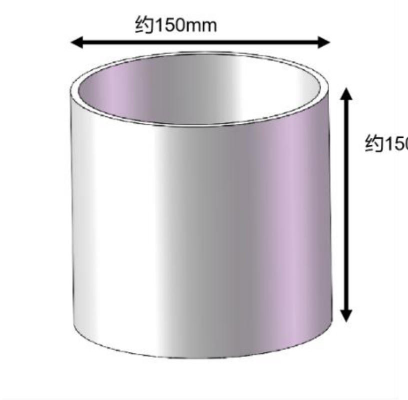


Fig 2. Feed Dispensing Area Schematic

The feed containers are 500 mL plastic bottles containing feed (with ballast). The empty feed container has a gravitational force slightly exceeding 5 N in air (exhibiting slight negative buoyancy in water), while the new feed container has a gravitational force of 10 N in air. The feed container design is shown in Fig. 2.

Fig 3. illustration of a 500 mL bottle without ballast

2.2 Recovery of net Cage

Hainan Province experiences 3–4 typhoons annually, which often destroy fish farm buoy markers with massive waves. The ROV must quickly recover critical data (black box) and re-secure safety ropes to prevent the net cages from drifting.

A damaged net cage's black box (with a tail rope and positive buoyancy) must be retrieved by the robot. Teams must operate the ROV to:

1. Disconnect the black box from the cage by removing the connector and a 5mm-diameter pin (refer to Figs. 5 and 6).

2. Return the black box to the umbilical operator.

3. Receive a safety rope (with a carabiner, see Fig. 4) from the umbilical operator and secure it to the net cage.

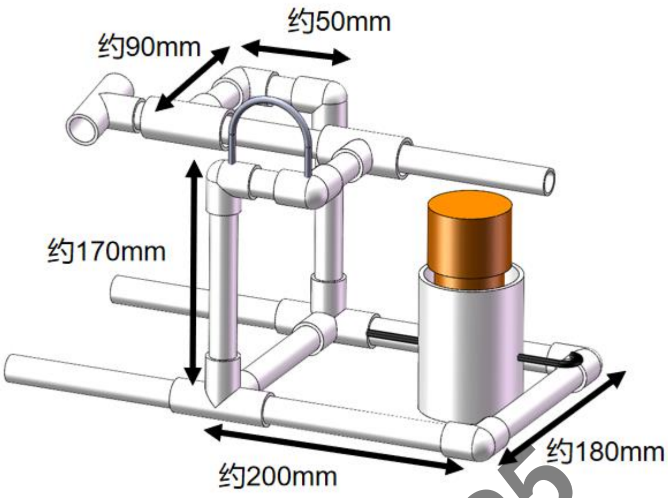


Fig 4. Net cage

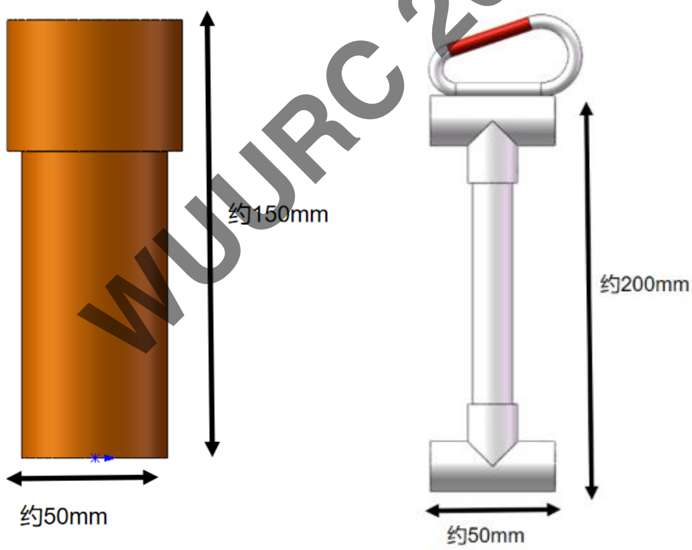


Fig 5. Black Box (left) and Safety Rope with Carabiner (right)

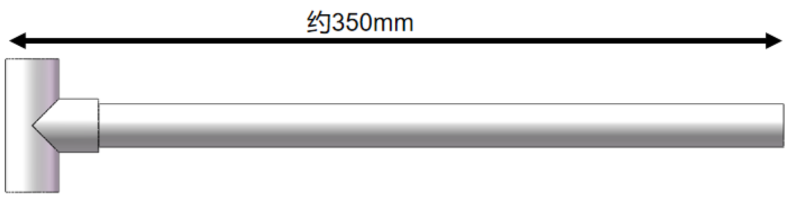


Fig 6. Connector

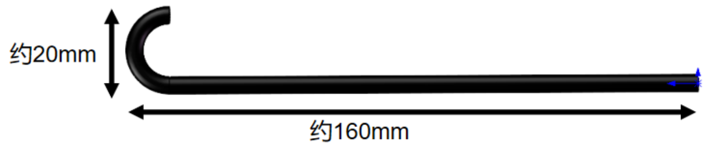


Fig 7. Pin (5mm diameter)

2.3 Babylonia areolata Harvesting

Babylonia areolata (light-averse marine snails) prefer to cluster in dark, sheltered corners, making their capture challenging.

In two connected reef structures at different heights, there are clusters of snails (simulated by three golf balls arranged in a triangular pattern at each location).

During the competition, the umbilical operator will hand the snail collection bin (weighted at the base) to the ROV. Operators must control the underwater robot to carry the collection bin, harvest the snails from the reefs, deposit them into the bin, and finally return the filled bin to the umbilical operator.

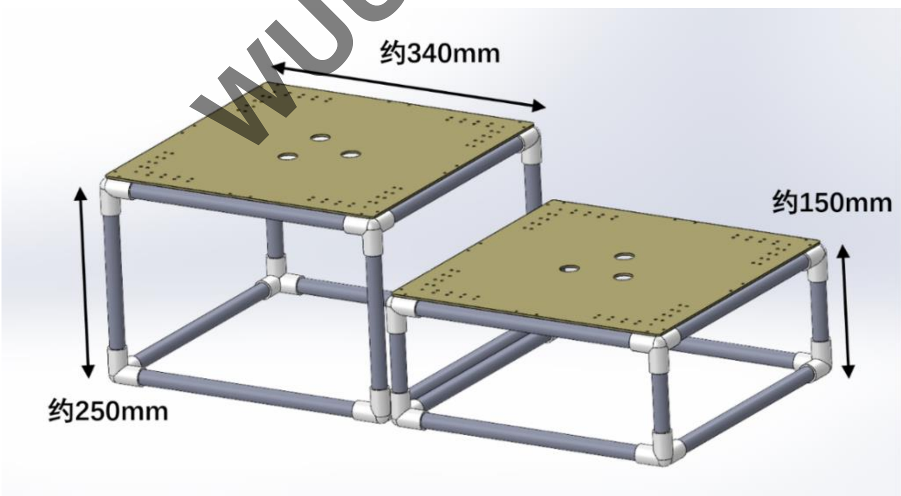


Fig 8. Reef Crevice Schematic

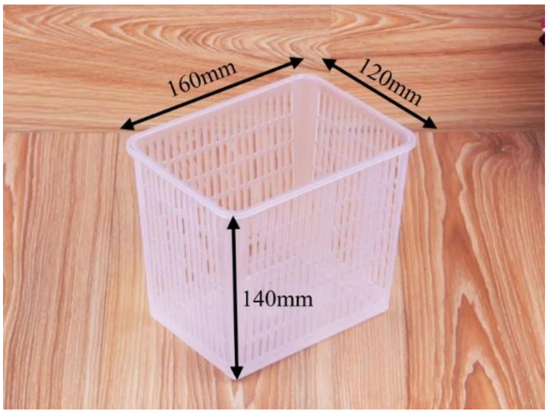


Fig 9. Snail Collection Bin

2.4 **Precision Operation**

To prevent disease outbreaks, multiparameter water quality sensors must be deployed in the aquaculture zone to transmit real-time data to the shore-based control center.

Contestants must operate the robot to first collect three probe fragments from the "equipment malfunction zone", transfer them to the umbilical operator on the shore, and exchange them with the judges for a complete probe, then operate the robot again to receive the probe and insert it into the water quality sensor; in this task, the water quality sensor interfaces are set in three sizes and inserting different-sized interfaces will result in different scores.

Specific Tasks:

(1) Retrieve probe fragments (assemble to form a T-shaped plug approximately 24cm long and 12cm wide) from the "equipment malfunction zone" and transfer them to the umbilical operator onshore.

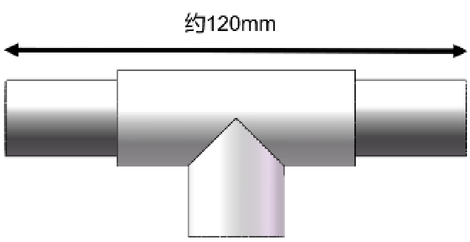


Fig 10. Probe Fragment (1)

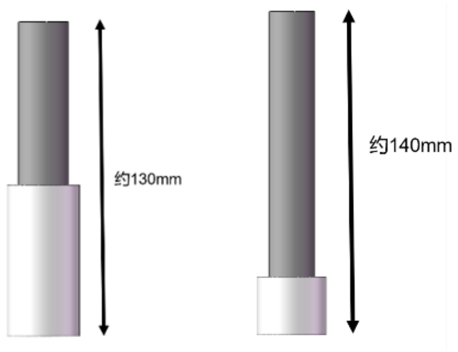


Fig 11. Probe Fragments (2 and 3)

(2) After the umbilical operator collects all fragments, they must exchange them with judges for the complete probe and hand it to the ROV for the next task.

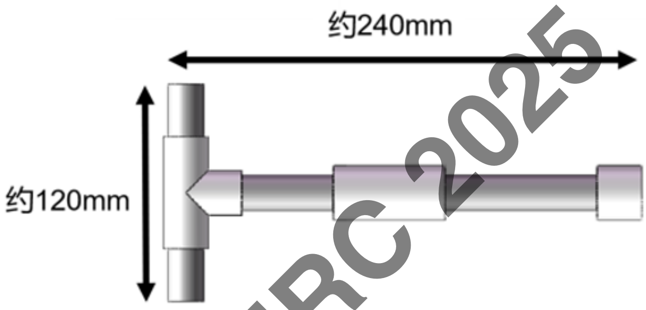
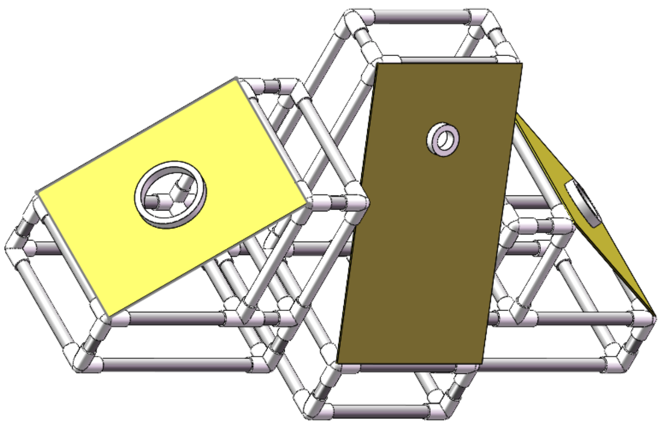


Fig 12. Assembled Connector-Probe Schematic

(3) Insert the probe into one of the water quality sensor interfaces (small: 30mm, medium: 60mm, large: 90mm).



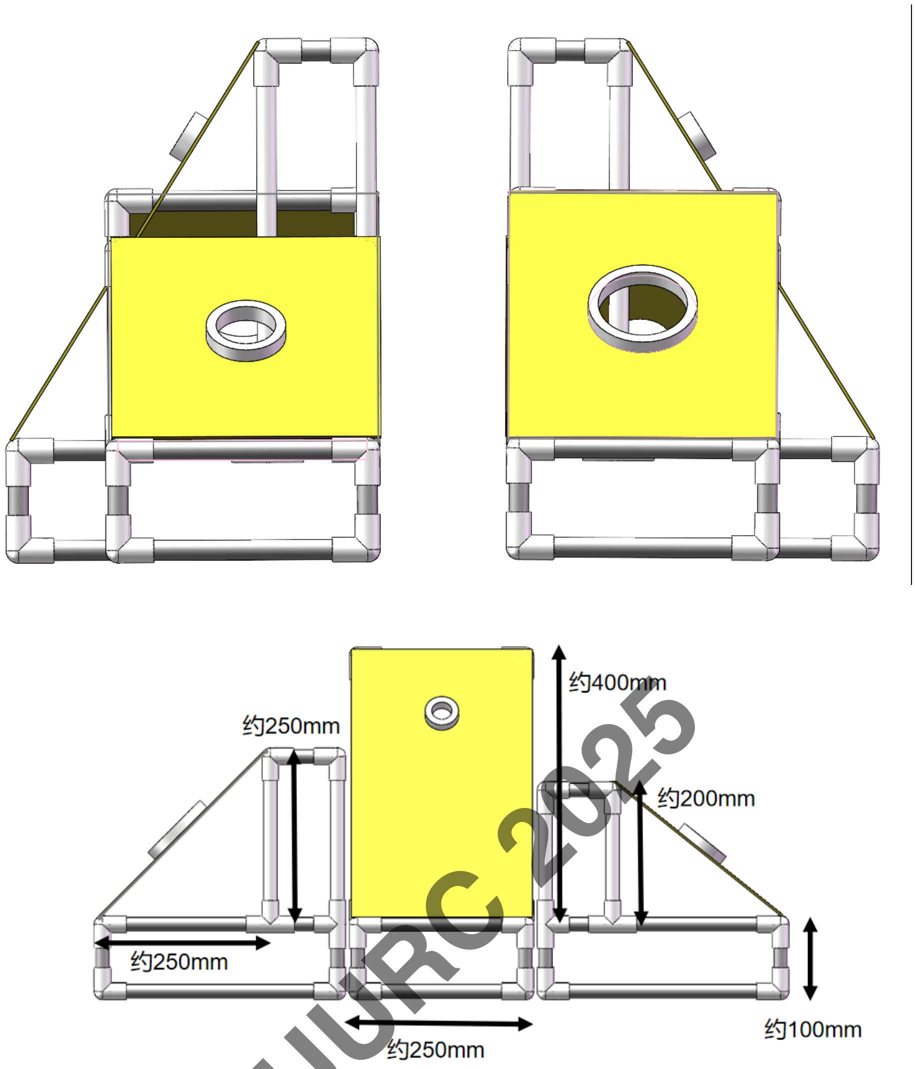


Fig 13. Water Quality Sensor Interface Schematic

2.5 **Competition Conclusion**

After completing all tasks, the ROV must immediately surface and signal the end of the competition. The 10-minute timer stops once the ROV surfaces.

The above pictures are for reference only, the competition is subject to the actual.

The final interpretation right belongs to the organizing committee

3. Scoring Rules

The total score is the sum of all points earned by completing tasks within the competition time. Operators may request to end the competition at any time after the robot surfaces, at which point the timer stops.

For teams with tied scores, the **shorter total time** determines the winner. If times are identical, the **lighter robot** prevails.

Task	Points	Max points
Task 1: Feed Dispensing		140
Remove empty feed containers	60	60
Drop the new feed container into the zone	40	40
Correct measurement of water temperature (within ±0.5 ° C)	40	40
Task 2: Recovery of net Cage		280
Remove connector	40	40
Remove pin	60	60
Recover the black box	60	60
Connecting safety rope	120	120
Task 3: Babylonia areolata Harvesting		120
Remove the snails from the reef gap and place it in the collection box	20 per snail	120
Task 4: Precision Operation		260
Successfully acquired probe fragments (3 in total)	40 per fragment	120
Insert probe into interface large/medium/small	40/80/140	140
Total points		800

Creative Concept Track Rules

1. Participation Requirements

The Creative Concept Track focuses on the creative design presentation and demonstration of underwater robots. Designs should be based on the operational tasks and technical requirements of the AUV/ROV tracks, incorporating overall assembly, components, and key technological innovations.

Design proposals should feature functional principle innovation or layout innovation. The main innovative points, calculation processes, design drawings, implementation approaches, and application analysis of the participating works should be introduced through the design documentation. The documentation must not exceed 25 pages, and the technical introduction section should not contain any identity information such as the name and logo of the participating units, to facilitate blind review online later.

Submissions are encouraged to include a functional demonstration video, which can be a real object demonstration or a 3D model demonstration. Two versions of the video can be prepared: a demo version not exceeding 2 minutes and 200MB in size, and a complete version not exceeding 5 minutes and 1GB in size.

The entries must not contain any content related to state secrets, with the participating units responsible for their review.

2. Competition Rules

2.1 Competition Process

Participating teams will determine the order of presentation defense through an online lottery. After the announcement of the defense order, the teams can enter the waiting room in advance and present their defenses in turn. Experts will score based on the team's defense and the design documentation to determine the final competition results.

The total time for each team's defense should not exceed 10 minutes, including no more than 5 minutes for product presentation, with the remaining time allocated for questions and answers.

The presenter must be a member of the team and cannot be replaced by anyone outside the team.

2.2 Scoring Details

The scoring criteria are as follows：

evaluation criteria	weight	criteria explanation
Innovation and Uniqueness	40%	The design is novel and innovative with unique principles, demonstrated by solving similar tasks in new ways or addressing previously unsolved challenges.
Feasibility and Practicality	30%	The design is rational, with clear implementation plans, potential task capabilities and features, application prospects, and engineering feasibility.
Content and Structure of Documentation	20%	The logic is strong, with clear layers, and the arguments are clear and distinct, supported by thorough theoretical analysis and experimental data.
Defense Performance	10%	The presentation is fluent and clear, with concise and precise language, tight logic, and good on-site performance.

The final interpretation rights belong to the competition organizing committee