
# HANDBOOK

Version 2: January 2024

# Introduction

## Welcome to the North Africa SeaPerch Challenge!

This Team Handbook contains information that teams need to compete at the North Africa SeaPerch Challenge. It includes task descriptions, rules and requirements, and other guidance and specifications. Teams are encouraged to read this document for a thorough understanding of what is necessary to compete effectively.

These instructions apply specifically to participation in the 2024 North Africa SeaPerch Challenge. Please check with your local regional competition coordinator for rules and required submissions related to that event which may differ from the International SeaPerch Challenge.

## Why compete in the North Africa SeaPerch Challenge?

The annual SeaPerch Challenge is aninvitation-only event open to teams that excel at registered regional competitions and earn a slot to compete in the season's culminating event.

On land, teams show off their engineering skills through technical papers and presentations. In the pool, they navigate their SeaPerch remotely operated vehicle (ROV) through a series of obstacles inspired by the real world that test maneuverability, control, and utility. Each season has a new theme and a new set of competition tasks, challenging teams to expand on their original vehicle design.

Beyond the friendly rivalry, all competitions bring students together from different schools, states, and countries to form a supportive community.

## Why robotics competitions?

The goals of the RoboNation student competitions are to provide opportunities for students to experience real-world engineering challenges and to develop the skills needed to solve those challenges. The objective is to produce the people who will push the envelope in the future. Competitors gain anappreciation for the tradeoffs inherent in any system design and the lessons learned in transitioning from a working bench prototype to operating reliably in the real world.

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*2024 North Africa SeaPerch Challenge*

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# SECTION 1: Competition Overview

*2024 International SeaPerch Challenge*

## 1.1. Dates & Venue

The 2024 North Africa SeaPerch Challenge will be conducted March 2024 at Cairo,Egypt.

## 1.2. 2024 Theme

The 2024 theme is Deep-Sea Exploration with an emphasis on hydrothermal vents. First discovered in 1977 near the Galápagos Islands off the coast of Ecuador, hydrothermal vents are a critical area of ocean exploration. ROVs are necessary to aid researchers in exploring the harsh environments that surround hydrothermal vents where extreme temperatures and pressures, toxic chemicals, and reduced visibility are the norm.

The seafloor surrounding hydrothermal vents is a dense oasis of life, teeming with microorganisms such as bacteria and archaea that use the chemical-rich fluids as a source of energy (chemosynthesis) much like plants use sunlight and carbon dioxide (photosynthesis) in the surface ocean and on land. These microbes are the basis of a food web that includes remarkable life forms such as tubeworms, shrimp, clams, fish, crabs, and octopods. The 2024 International SeaPerch Challenge was inspired by the wealth of information that can be gathered by exploring these deep-sea geysers.

## 1.3. Competition & On-Site Elements

The 2024 North Africa SeaPerch Challenge includes pre-event online submissions as well as on-site events.

### 1.3.1. Pre-Event Submissions

**Technical Design Report (Required)**

A Technical Design Report (TDR) succinctly describes your unique SeaPerch ROV and the engineering design process, providing insight into the iterative design process and allowing for data analysis that supports the final ROV design.

**Meet the Team (Required)**

We want to get to know you! Share your team or school's logo, an overview of what your team is all about, and social media information so we can share it with the SeaPerch community. This is your chance to introduce us to your team and team's personality.

**Team Video (Required)**

Introduce you team! Share your team information and your experience journey in SeaPerch through small video shoes the identity and team communication skills.

### 1.3.2. On-site Elements

**Pool Courses (Required)**

- **Obstacle Course:** The Obstacle Course tests high-speed maneuverability and requires the SeaPerch ROV to navigate the course as quickly as possible.
- **Mission Course:** The Mission Course incorporates a mission that teams must complete with their SeaPerch ROV related to Deep-Sea Exploration.

**On-site Team Presentations by Invitation (Required)**

Presentations are a great opportunity for teams to share their SeaPerch experience and practice their academic presentation skills. During registration, teams will be required to present a short abstract that gives a high-level overview of what their presentation would cover.

## 1.4. Season Schedule/Timeline

| Date | Event |
|---|---|
| **December 18, 2023** | Regional competition registration opened |
| **February 10, 2024** | Regional competition registration closed |
| **February 25, 2024** | Pre-Event Submissions:<br>• Technical Design Report (Required)<br>• Meet the Team (Required)<br>• Team Video ( Required) |
| **March, 2024** | 2024 North Africa SeaPerch Reginal Challenge In-Person Event |
| **May 31 – June 1, 2024** | 2024 International SeaPerch Challenge In-Person Event |

## 1.5. Eligibility & Qualification

The annual International SeaPerch Challenge is an invitation-only event open to student teams from anywhere in the world that have been awarded a slot by winning at an approved regional competition or by earning a Wild Card space. Elementary School, Middle School, and High School students are eligible to compete.

## 1.6. Team Registration

### 1.6.1. Competition Classes

The 2024 International SeaPerch Challenge will include three (3) competition classes.

**Middle School Stock Class:**

- Teams include students in 8th grade and below
- The total cost of modifications to the final ROV must be $25 or less

- Frame built using only PVC, CPVC, PEX pipe and fittings. Any size pipes and pipe fittings may be used. Pipes and pipe fittings may be modified using hand and power tools, but may not be machined using CNC or other automated process.
- Must only use simple on/off switches for thruster controls
- May use PWM, microcontrollers, or other devices for non-thruster controls
- May use a fixed or variable resistor to reduce voltage

**High School Stock Class:**

- Teams include students in 9th grade and above
- The total cost of modifications to the final ROV must be $25 or less
- Frame built using only PVC, CPVC, PEX pipe and fittings. Any size pipes and pipe fittings may be used. Pipes and pipe fittings may be modified using hand and power tools, but may not be machined using CNC or other automated process.
- Must only use simple on/off switches for thruster controls
- May use PWM, microcontrollers, or other devices for non-thruster controls
- May use a fixed or variable resistor to reduce voltage

**Open Class:**

- The cost of modifications may exceed $25
- Frame may include 3D printed or additive manufactured parts as well as other materials, and may be made using CNC machinery or other automated process.
- May include more than 3 thrusters (i.e., motor and propeller assembly)
- May use power conditioning or pulse-width modulation (PWM) controls for thruster controls

### 1.6.2. Registration Fees

To complete the North Africa SeaPerch Challenge registration, teams must pay the registration fees and register each competitor. Teams are limited to 4 students and 1 Supervisor.

- ROV Registration Fee: $250 USD per team.

## 1.7. Communications

### 1.7.1. 2024 SeaPerch Challenge Website

The official competition website is the 2024 SeaPerch Season. This website includes all official documents and a detailed list of the registered Challenge teams. Helpful resources, past competition results, and other engagement opportunities can be found on this website. Information and documents are updated regularly, and it is the team's responsibility to check the website for updates.

### 1.8.2 Points of Contact

**SeaPerch Questions:**

info@seaperchnorthafrica.org

# SECTION 2: Pool Courses

*2024 International SeaPerch Challenge*

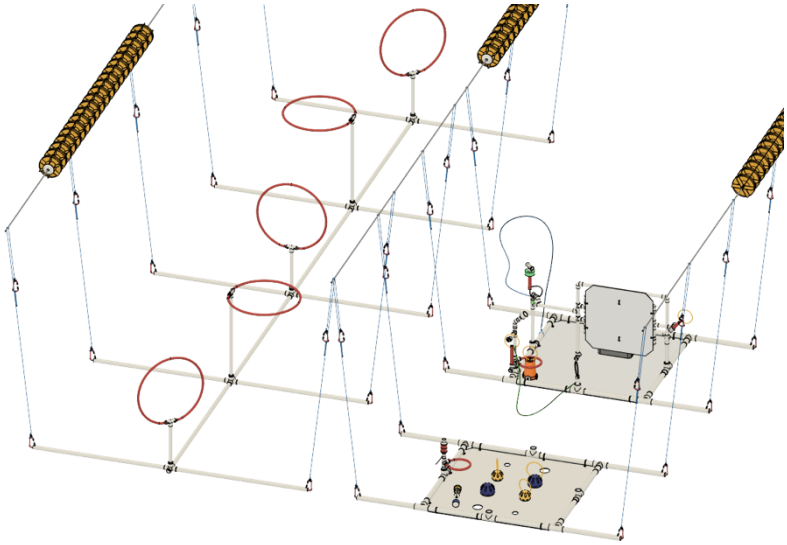
## 2.1. Pool Course Events Overview

The competition will include two in-pool courses:

- **The Obstacle Course** tests high-speed maneuverability and requires the SeaPerch ROV to navigate the course as quickly as possible.
- **The Mission Course** incorporates a mission that teams must complete related to Deep-Sea Exploration. This course simulates the tasks and environment that an ROV might encounter while exploring the harsh environments that surround hydrothermal vents.

## 2.2. Lane Setup

Courses will be suspended from the pool's lane dividers with the lower course frames approximately 5-6 feet below the water surface and 5-6 feet from the side of the pool.



The obstacle course and mission course will be arranged beside each other and considered a single competition lane. The pool will include eight (8) competition lanes to accommodate eight (8) teams simultaneously. Competition lanes will be separated by a vacant pool lane (i.e. no course). Each team will have sole use of their assigned competition lane for their allotted time slot.

## 2.3. Timing

Teams have 20 minutes to complete Pool Course runs. After the course judge verifies the team and provides instructions, a 20-minute course timer will start. Teams are responsible for managing their time and may take as much time as needed for setup and reset within the twenty minutes allocated. When the course timer expires and reaches zero, the team must depart the Pool Course.

Runs will be timed using a run timer. The run timer starts when the run starts and records the official run times. Teams may start subsequent runs immediately after completing a prior run but much receiving a start signal from the judge to ensure the run will be scored. Teams may abort runs at any time without completing the course if they are experiencing problems and want to ensure they have enough time for subsequent runs. A run ends when the run time expires, the team has aborted the run, or the team has completed the course (whichever comes first). Guidelines for obstacle course and mission course runs are below.

### 2.3.1. Obstacle Course Timing

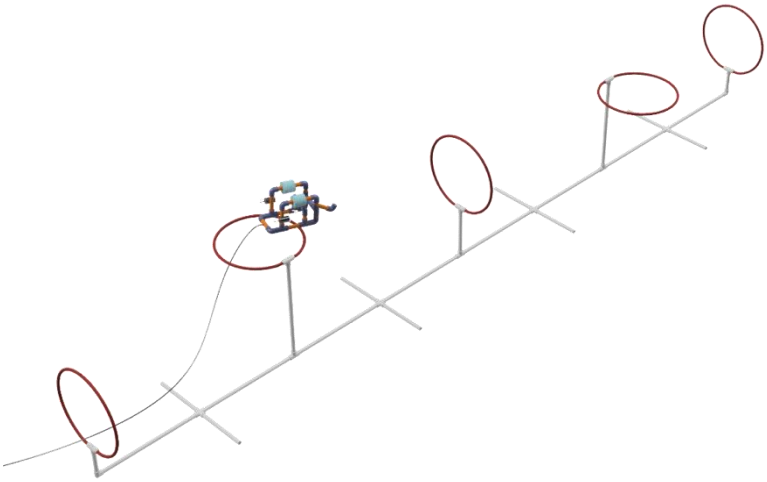
- Teams may attempt up to two (2) runs.
- Each run is limited to four (4) minutes maximum.

### 2.3.2. Mission Course Timing

- Teams may attempt one (1) run on the mission course.
- The mission course time limit is eight (8) minutes maximum.

## 2.4. Obstacle Course

The Obstacle Course consists of five 18" hoops oriented at different angles and suspended 5-6 feet below the water surface. *Please note that there is no guarantee of the position of the hoops when the course is deployed in the pool at the International SeaPerch Challenge and may not appear as pictured below.* Operators should not try to memorize actions such as in playing a video game but should instead practice a variety of general high-speed maneuvers.



### 2.4.1. Navigation Overview

- *Start of run:* The ROV must be surfaced, within six inches (6") of the wall, and under its own power. Team members are not allowed to touch the ROV after the lane judge begins the countdown to start the run.
- The ROV is required to pass through each of the five obstacle course hoops in order starting at the hoop closest to the pool wall.
- The ROV must surface after clearing the hoop furthest from the pool wall. Surfacing is considered complete when any part of the ROV breaks the surface of the water.
- The ROV must re-submerge and head back to the pool wall by passing through each of the five hoops in reverse order.
- *End of run:* The run is complete when the ROV touches the pool wall while surfaced (any part of the ROV breaks the surface of the water). The run will be aborted if the allotted time expires even if the ROV has not completed the course.

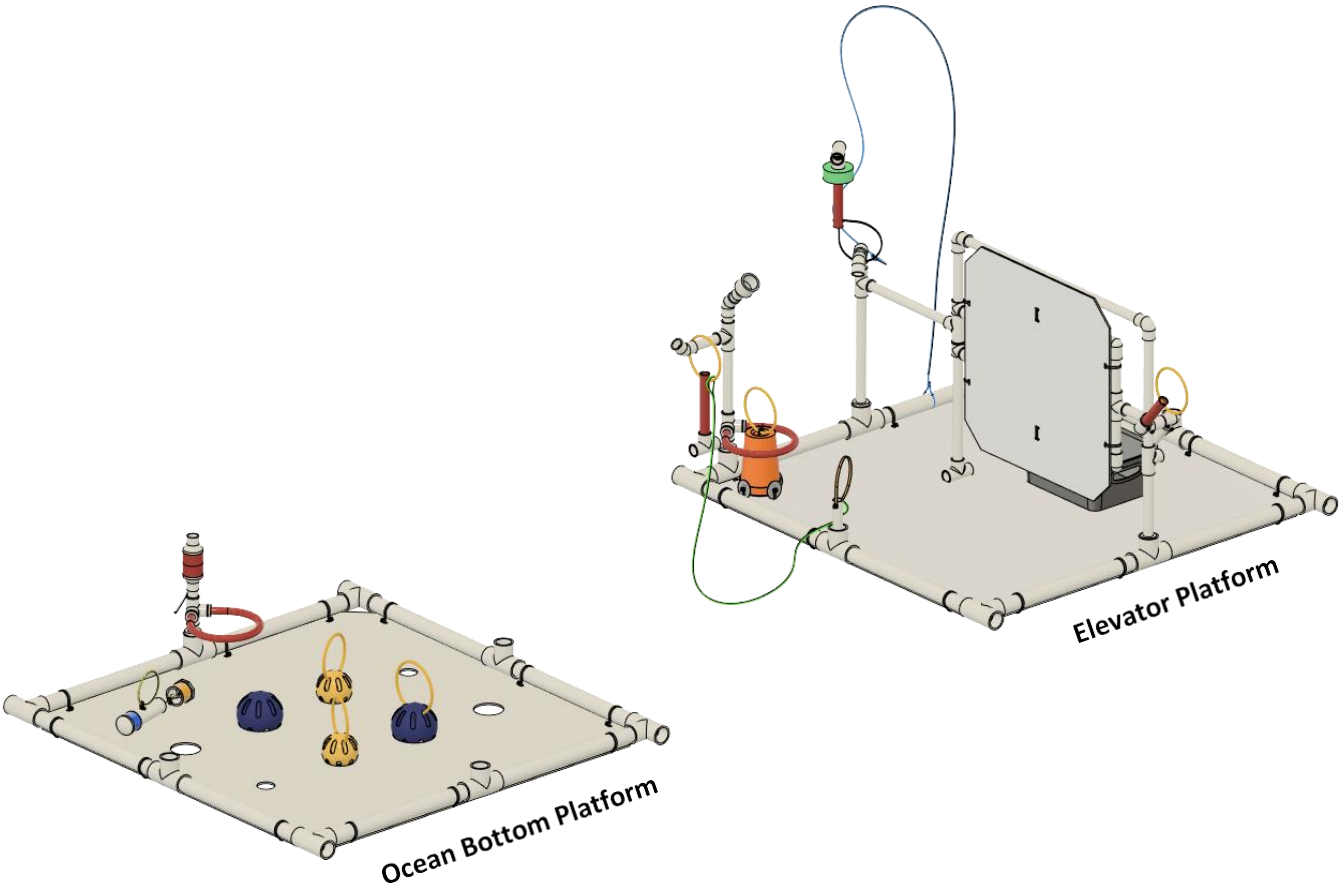
### 2.4.2. Scoring Overview

Teams are ranked based on time. The obstacle course scoresheet is available in Appendix B: Scoring Rubrics and Scoresheets

## 2.5. Mission Course

The Mission Course consists of six tasks across two task frames and will be suspended 5-6 feet below the water surface (see course layout on next page). Tasks are described in detail below and include:

- Task 1: Elevator Preparation
- Task 2: Temperature Sensor
- Task 3: Fluid Sample Collection
- Task 4: Gas Sample Collection
- Task 5: Rock Sample Collection
- Task 6: Prepare for Elevator Recovery



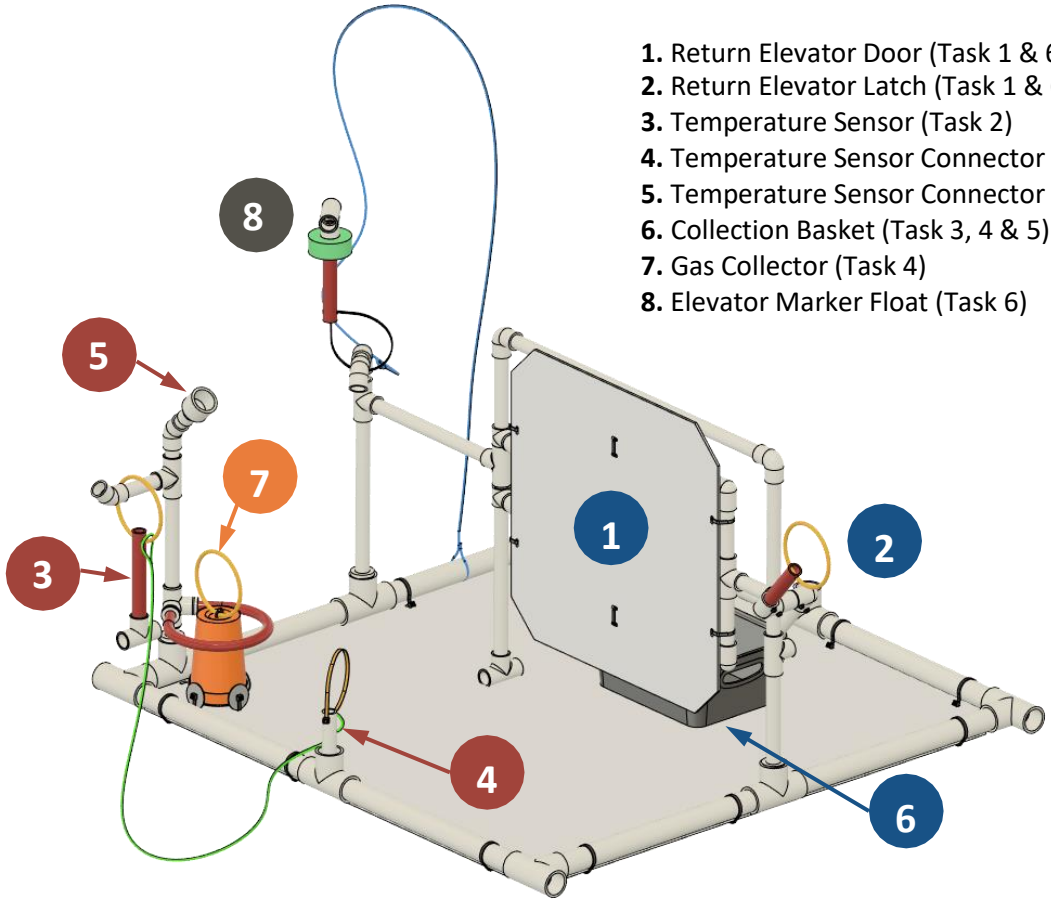

### 2.5.1. Navigation Overview

- *Start of run:* The ROV must be surfaced, within six inches (6”) of the wall, and under its own power. Team members are not allowed to touch the ROV after the lane judge begins the countdown to start the run.
- Objects falling past the suspended task frame are out of play and the ROV is not allowed to attempt to retrieve them.
- *End of run:* The run is complete when the ROV touches the pool wall while surfaced (any part of the ROV breaks the surface of the water). The run will be aborted if the allotted time expires even if the ROV has not completed the course.

The ROV may transport multiple objects simultaneously. Objects may be moved between platforms for staging without completing the task. (For example, the rock samples can be moved to the return elevator and placed in the basket after completing other tasks.)

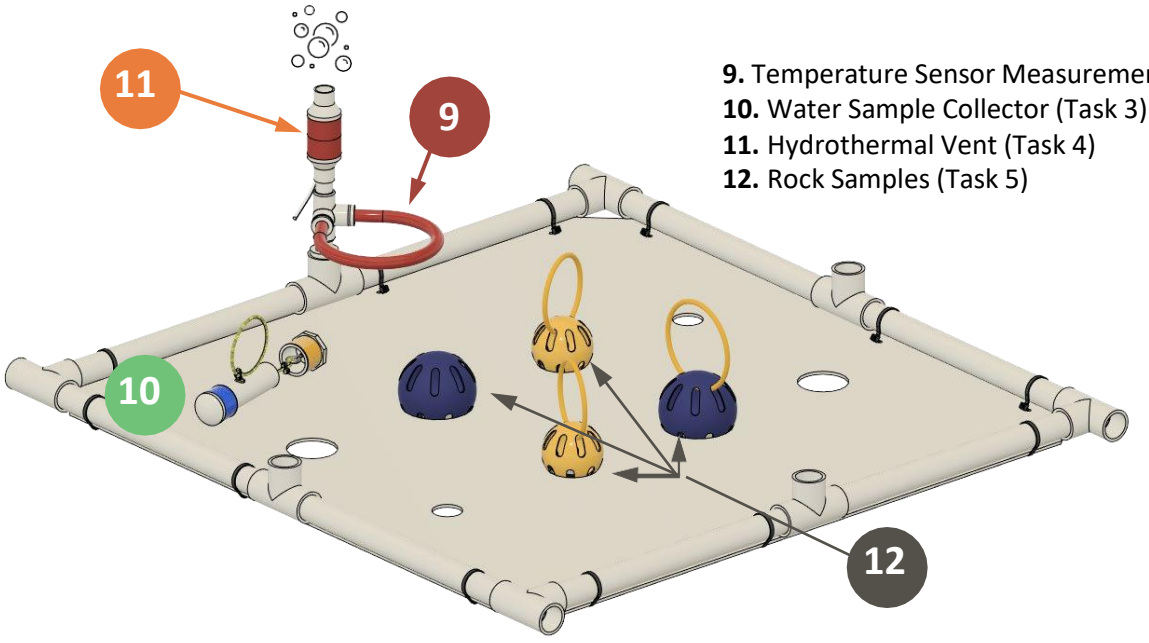
Tasks may be completed in any order with the following exceptions:

- To receive points for opening the elevator door, it must be opened before placing objects in the sample collection basket. If the team fails to open the door, they may still place objects in the basket; however, points will not be awarded for opening the door once an object is placed in the basket.
- Releasing the elevator marker float must be the last task completed. Points will not be awarded for the elevator marker float release if other tasks are completed after its release.




**1.** Return Elevator Door (Task 1 & 6)
**2.** Return Elevator Latch (Task 1 & 6)
**3.** Temperature Sensor (Task 2)
**4.** Temperature Sensor Connector (Task 2)
**5.** Temperature Sensor Connector Port (Task 2)
**6.** Collection Basket (Task 3, 4 & 5)
**7.** Gas Collector (Task 4)
**8.** Elevator Marker Float (Task 6)

Elevator Platform with Task




**9.** Temperature Sensor Measurement Area (Task 2)
**10.** Water Sample Collector (Task 3)
**11.** Hydrothermal Vent (Task 4)
**12.** Rock Samples (Task 5)

Ocean Bottom Platform with Task Elements

### 2.5.2. Scoring Overview

A maximum of 110 points can be earned on the Mission Course through successfully completing tasks with bonus points awarded for completion of the course under a time limit. Points are not official until verified by master scorekeeper.

**Task Points**

Tasks can be completed for a total of 100 points divided across the tasks as follows:

- Task 1: Elevator Preparation has a max of 5 points
- Task 2: Temperature Sensor has a max of 30 points
- Task 3: Fluid Collection has a max of 10 points
- Task 4: Gas Collection has a max of 15 points
- Task 5: Rock Collection has a max of 25 points
- Task 6: Elevator Recovery has a max of 15 points

Points will be earned at completion of each task action. If tasks are disturbed in subsequent actions, teams will still earn the points for completion.

**Time Bonus Points**

Teams may earn bonus points for successfully completing all tasks in less than 6 minutes. Bonus points are based on adjusted finished time including any time penalties incurred during the run. Bonus points are applied for:

- Finish times less than 4 minutes earn teams 10 points
- Finish times less than 6 minutes earn teams 5 points

**Rubric**

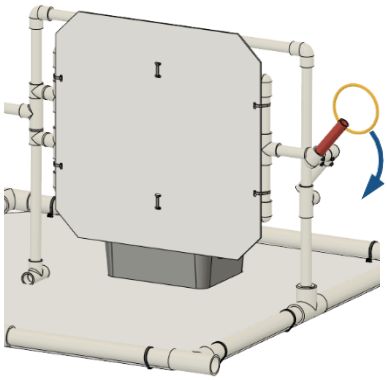
The mission course scoring rubric is available in Appendix B: Scoring Rubrics and Scoresheets

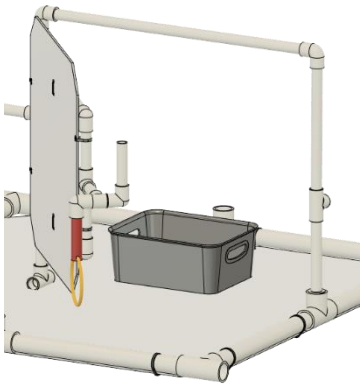
### 2.5.3. Elevator Preparation (Task 1)

The ROV must move a lever to open a door on the return elevator to expose the collection platform in preparation for sample collection (simulated in the image by a small basket).

**Scoring**

Teams will receive five (5) points upon successful completion of this task.





**Real-World Inspiration**

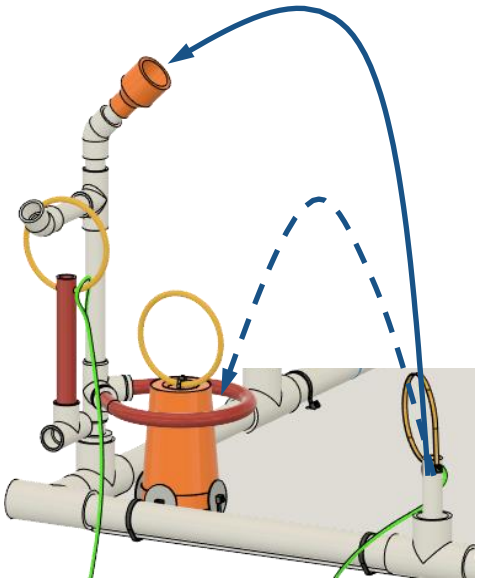
A lander is a mechanical platform used to carry payloads from the bottom of the sea to the researchers on the surface ("underwater elevator"). A lander makes the transit to the surface for an ROV and allows the vehicle to spend more time exploring the seafloor. This task represents preparing the lander to transport samples from the seafloor to the water's surface.

### 2.5.4. Temperature Sensor (Task 2)

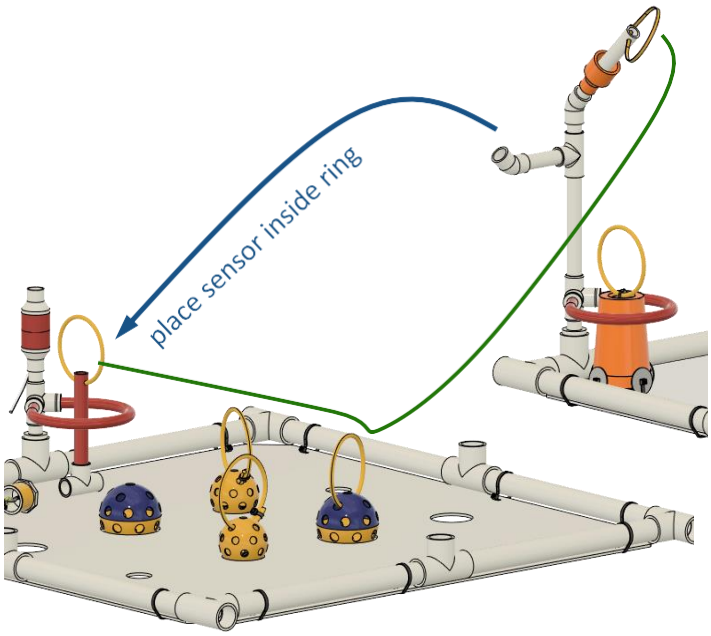
The ROV must retrieve the temperature sensor connector, deposit the temperature sensor connector, and then place the temperature sensor inside the hydrothermal vent ring.

Teams may select one of two options for depositing the temperature sensor connector:

- **Option A**: Plug the connector into the connector port (shown with the blue **solid line** below; higher difficulty)
- **Option B**: If teams are unable to plug the connector into the port, the connector may be placed in the holding ring below it (shown with the blue **dashed line** below; lower difficulty)



Temperature Sensor Connector Placement
Option A (**solid**) – Option B (**dashed**)




Temperature Sensor Placement

At the start of the run, the temperature sensor will be located on the Elevator Platform and must be moved to the temperature sensor measurement area on the Ocean Bottom Platform. The connector port and holding ring are both located on the Elevator Platform.

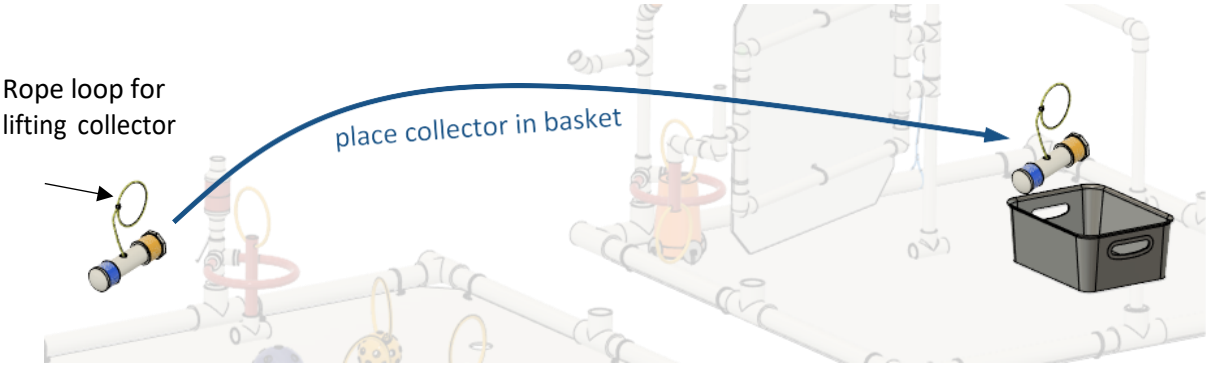
**Scoring**
A maximum of 30 points can be earned in this task. This is a multi-step task and teams will earn points for completing each step of the task, including:

- For retrieving and depositing the temperature sensor connector teams will earn:
  - Twenty (20) points for placing temperature sensor inside the connector port OR
  - Five (5) points for leaving the temperature sensor in the holding ring.
- Teams will receive ten (10) points for placing the temperature sensor inside the hydrothermal vent ring.

**Real-World Inspiration**
Temperatures near hydrothermal vents can reach up to 750°F (400°C), hot enough to melt some ROV parts. Measuring temperature is essential to helping scientists understand the formation, structure, and evolution of these unique habitats. Biologists use temperature data to learn about the animals' living environments and the range of temperatures they can tolerate. Chemists use it to make sure they are collecting the hottest fluid from a vent as well as to explain the vent's chemical composition deep below the surface.

### 2.5.5. Fluid Collection (Task 3)

The ROV must close the end cap on the water sample collector by lifting the collector by the attached rope loop. The ROV must then retrieve the water sample collector from the Ocean Bottom Platform and transport it to the storage basket on the Elevator Platform.




Water Sample Collector Closure and Placement

**Scoring**

A maximum of ten (10) points can be earned in this task. This is a multi-step task and teams will earn points for completing each step of the task. Teams will receive:

- Five (5) points for closing the water sample collector. Points will be earned by lifting the collector by the rope loop even if the caps do not fully close.
- Five (5) points for transporting the water sample collector and placing in the collection basket.

**Real-World Inspiration**

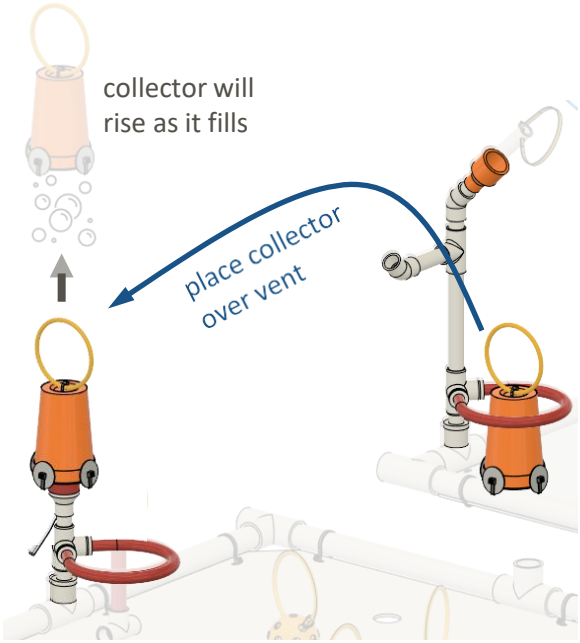
Hydrothermal fluid can contain dissolved sulfur, copper, zinc, gold, iron, helium and other chemicals from deep beneath the ocean floor. When it combines with near-freezing, oxygen-rich seawater, rapid chemical reactions are triggered that cause sulfides and other minerals to precipitate (rapidly transition from dissolved to solid).

The seafloor surrounding hydrothermal vents is a dense oasis of life, teeming with microorganisms such as bacteria and archaea that use the chemical-rich fluids as a source of energy (chemosynthesis) much like plants use sunlight and carbon dioxide (photosynthesis) in the surface ocean and on land. These microbes are the basis of a food web that includes remarkable life forms such as tubeworms, shrimp, clams, fish, crabs, and octopods.

Analyses of the fluids collected by ROVs around hydrothermal vents provide chemical and microbiological data that helps scientists understand the fluid-rock interactions beneath the surface and often leads to the discovery of never seen before species.

### 2.5.6. Gas Collection (Task 4)

The ROV must retrieve the gas collector from the Elevator Platform and place it over the hydrothermal vent on the Ocean Bottom Platform to collect a gas sample. The hydrothermal vent will be releasing small bubbles that will be visible on the surface of the pool, simulating the presence of a hydrothermal vent below. As the ROV holds the gas collector above the vent, the collector will fill with gas and rise to the surface. The ROV must hold the collector above the vent and may not release the gas collector until it begins to float upward.




Gas Collector Placement

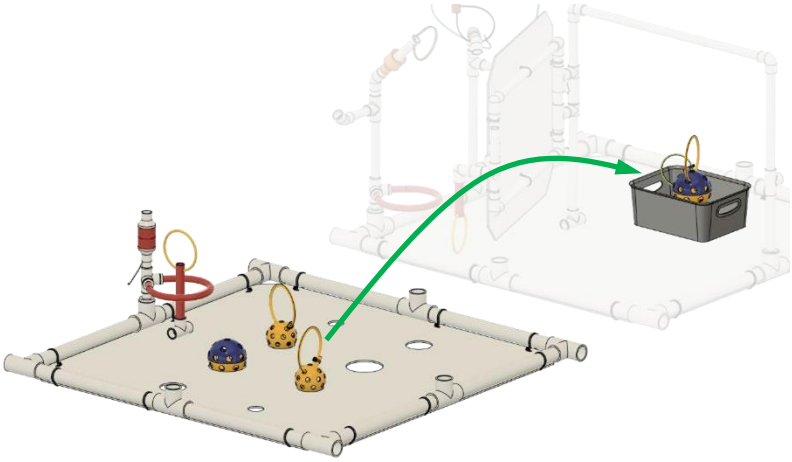
**Scoring**
A maximum of 15 points can be earned in this task. This is a multi-step task and teams will earn points for completing each step of the task. Teams will receive:

- Five (5) points for removing the gas collector from the ring on the Elevator Platform
- Ten (10) points for filling the collector with gas until the collector fills and floats. Once the collector begins to rise teams will earn the allotted points even if the collector flips and/or sinks.

**Real-World Inspiration**
Gases collected near hydrothermal vents are analyzed for, among other things, helium and carbon isotopes, which provide valuable information about the age and development of the vents as well as the origins of the gases in the crust and mantle.

### 2.5.7. Rock Collection (Task 5)

The ROV must retrieve rock samples from the Ocean Bottom Platform and transport them to the collection basket on the Elevator Platform.



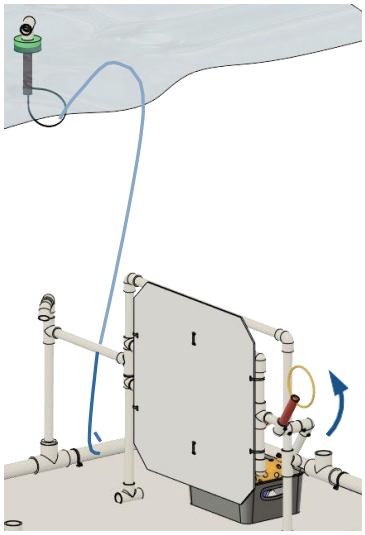
**Scoring**
A maximum of 25 points can be earned on this task. This is a multi-step task and teams will earn points for completing each step of the task. Teams will receive:

- Five (5) points for the successful retrieval of rocks with loops that are placed in basket (3 rocks available)
- Ten (10) points for the successful retrieval of the rock without loop that is placed in basket (1 rock available)

**Real-World Inspiration**
Rocks and life near hydrothermal vents are intertwined; life thrives on the surfaces of the underlying crust and within the vent chimneys. Samples are cataloged, extensively imaged and described, and then stored in a variety of ways for geochemical and biological analyses by researchers on shore.

### 2.5.8. Elevator Recovery (Task 6)

The ROV must close the door and lock the latch on the Sample Return Elevator so that samples are secured during the trip back to the surface. The ROV must then release the elevator marker float to make the sample return elevator visible to and recoverable by the researchers waiting for it on the ship.



**Scoring**
A maximum of 15 points can be earned on this task. This is a multi-step task and teams will earn points for completing each step of the task. Teams will receive:

- Ten (10) points for closing and latching the elevator door
- Five (5) points for releasing the elevator marker float

**Real-World Inspiration**

Although the ROV could carry samples back to the ship, it has limited carrying capacity and space. In addition, the ROV receives power from the ship via its tether, so it can stay submerged for days at a time. Instead of recovering the ROV to collect a relatively small number of samples each time, the Sample Return Elevator brings samples to the surface independent of the ROV. Engineers on the ship can then send a new elevator down for additional samples to continue the mission.

## 2.6. General Pool Event Rules

### 2.6.1. ROV, Spare Parts, and Adjustments

1. The team must use the same ROV that was presented at compliance for both pool events.
2. Each team must have their own ROV – teams are not allowed to share an ROV.
3. Teams are not allowed to share ROV attachments or devices.
4. Spare parts are allowed; however, spare ROVs are not allowed.
5. Any design or structural modifications made to the ROV after a compliance check requires the team to re-submit the ROV for a compliance check.
6. No parts or materials, except as noted in this section, may be added to or removed from the ROV between pool events. The ROV must compete in both pool events with the same attachments and parts connected. Violations will result in disqualification.
7. Attachments and parts may be *repositioned* (I.e., rotated or swiveled) between the two pool events. Attachments or parts may not be disconnected and relocated; they must remain connected to the same point on the ROV when they are repositioned.
8. The ROV may be worked on or adjusted during competition. This may include adjusting buoyancy by adding or removing buoyancy materials or adding materials like tape or cable ties necessary to secure parts. However, the run timer will continue.
9. Replacement of failed or damaged parts is permitted. Teams replacing failed or damaged parts must re-submit their ROV for a compliance check conducted by staff at the Triage or ROV Poolside First Aid Station.
10. Passing compliance checks does not guarantee the right to compete. Lead judges in the competition area have the final say on safety and compliance issues and may require teams that have already passed the compliance check to fix issues prior to competing.

### 2.6.2. Auxiliary Equipment, Batteries, and Power Supplies

1. 12-volt direct current (VDC) power connections for the standard SeaPerch power cable alligator clips will be supplied for each competition lane. This power connection is for the ROV only; no auxiliary equipment may be connected to this power connection.
2. Teams may provide their own battery for the ROV.
3. Teams may provide an additional battery for auxiliary equipment such as cameras, advanced controllers, and electromechanical ROV attachments.
4. Team supplied batteries must not be larger than 6.5” long x 3” wide x 4” high and must be 12 VDC maximum with a 9-amp hour maximum rating.
5. Teams may not bring anything to the pool deck that requires 110-volt or any other alternating current (AC) power. Laptop computers are allowed if they are battery powered and do not need to be plugged into 110-volt power.

### 2.6.3. Diver Assistance and ROV Tether Handling

1. The ROV must move only under its own power. The tether may not be pulled to expedite the ROV’s navigation of the course.

2. If the ROV or tether becomes tangled on the course structure or is otherwise unable to move on its own power, a team member must notify the judge that they would like to try to free the ROV by pulling on the tether. Under this circumstance teams may gently pull on the tether; however, the run timer will continue. If the ROV is pulled by the tether, the ROV must be returned to the location that it was moved from before it may continue competing.
3. The team may ask the judge for diver assistance. If diver assistance is requested the judge will pause the run timer. The judge will restart the run timer when the diver arrives at the lane and begins assisting. There is no longer a two-minute diver assistance penalty. If the ROV is moved, it must be returned to the location that it was moved from before it may continue competing.

### 2.6.4. On Deck

1. Prior arrangements are required for waivers to any of the following rules to accommodate students' special needs. Any special accommodations must be made in advance of the starting date of the International SeaPerch Challenge by contacting seaperch@robonation.org.
2. All team members and spectators are expected to be respectful of other competitors, spectators, volunteers, judges, and staff.
3. Instructions from judges, volunteers, and event staff must be followed at all times on the pool deck. Those not complying with instructions from judges, volunteers, or event staff will be asked to leave the pool area and may risk disqualification of their team from the event.
4. Pool passes are required to enter the pool area.
5. A maximum of six (6) pool passes will be issued for each team. Any team with more than six members in the pool area without special accommodations risks disqualification from the event.
6. Only four (4) student team members are allowed at the competition lane. Only two (2) team members are allowed at the active course lane. The two (2) team members at the active course are considered the competing team members. The two (2) team members at the inactive course are considered non-competing.
7. Only competing team members are allowed to communicate with the judges.
8. The four team members at the competition lane may switch drivers at any time and as many times as they choose. The lane judge will not stop the timers.
9. The remaining two passes are for pool area spectators and can be used by other students (competing later in either the obstacle or mission course), parents, coaches, teachers, or chaperones.
10. Once a pool event run starts the pool area team spectator may not enter the competition lane.
11. The pool area team spectators must sit or stand behind the designated barrier ribbon.
12. Any student team members who are pool area team spectators may switch with the team members at the competition lane between the pool event runs (obstacle and mission course).
13. All team members must wear shoes with rubber soles while on the pool deck.
14. All team members may help with setup but must exit to their assigned spots before the course run starts. During this set-up period, teams should adjust the ROV's buoyancy and make any other necessary adjustments.

### 2.6.5. Equipment Failure

1. In the event of equipment failure between pool events, a team will be allowed to work on their ROV at an ROV First Aid Station or at Triage.
    a. The ROV First Aid Station is intended for *quick repairs* that can be accomplished in 15 minutes or less. The station will not be equipped with electrical power, so soldering is not allowed.
    b. After successful repairs, the team will reenter the competition queue in the front of the line.
    c. If repairs are not accomplished within the 15-minute time limit, the team must proceed to the pool check-in station and notify the staff that they require Triage. Teams completing repairs in

Triage will check-in at the pool check-in station and enter the staging area.

2. While competition staff will attempt to accommodate all participants, teams not completing repairs by the last pool event time slots may not be able to compete.
3. If an ROV or equipment malfunctions before attempting the first mission task or passing the first obstacle course hoop, the team may elect to stop their run without incurring a time penalty. The team will be allowed to make repairs as described in item 1 of this section.
4. If an ROV or equipment malfunctions after attempting the first mission task or passing through the first obstacle course hoop, the team may elect to stop their run. The judge will record the current run time and notify the lead judge. The lead judge or technical director will evaluate the issue and decide a course of action. If the team is allowed to make repairs and restart their run, they may incur a time penalty equal to their initial run time at the time they stopped their initial run.

### 2.6.6. Disputes, Challenges, and Redress Request

1. Sportsmanship is always expected.
2. Team members and advisors are responsible for the conduct of all members and adults accompanying the team. Unsportsmanlike conduct of registered student team members or chaperones is grounds for the disqualification of a team.
3. Teams may not raise questions concerning other competing vehicles or other teams' scores.
4. Only the two competing team members may approach or speak to lane judges. Exceptions to this rule are only allowed if prior arrangements have been made to accommodate special needs.
5. Team members, chaperones, or spectators may not speak to the divers.
6. Team members will verify the time on the scoresheet reflects the time on the stopwatch. If there is a discrepancy, a team member may ask the lane judge for a second opinion. Timing disputes such as a team member claiming the judge did not start or stop the stopwatch at the correct time are not allowable disputes.
7. Disputes should be resolved at the time the alleged grievance occurs. However, if students are not able to articulate the alleged grievance, they may ask to speak to the lead course judge. The lead course judge will provide a redress request card that will allow the student and adult team members to meet with the technical director or lead judge to resolve the dispute. *Decisions of the technical director or lead judge are final, and the same dispute will not be heard again.*
8. If an ROV or the course is inadvertently interfered with during the competition, the competing team members should alert the lane judge and ask for a ruling by the lead judge or technical director. These situations will be addressed on a case-by-case basis.

# SECTION 3: Design Documentation

*2024 North Africa SeaPerch Challenge*

## 3.1. Overview

The following design documentation is delivered prior to the on-site competition, due at the close of team registration, 11:59 PM Egypt, 20 Feb, 2024:

- Technical Design Report (Required)
- Meet the Team (Required)

## 3.2. Required Documentation

### 3.2.1. Technical Design Report (TDR)

A TDR succinctly describes your unique SeaPerch ROV and the engineering design process, providing insight into the iterative design process and allowing for data analysis that supports the final ROV design.

**Overview**

The TDR consists of seven mandatory sections and two mandatory appendices. Additional sections may be included; however, all reports must be limited to 5 pages (excluding *References*, *Acknowledgements*, and *Appendices*). Sections and appendices must appear in the order listed below. Reports must be written in English, typed, and submitted in PDF format.

**Scoring**

This submission is worth 100 points. Guidelines are available in Appendix A: Scoring Rubrics and Scoresheets.

- *Abstract* – 10 points max
- *Task Overview* – 10 points max
- *Design Approach* – 26 points max
- *Experimental Results* – 14 points max
- *Reflection & Next Steps* – 10 points max
- *Acknowledgements* – 4 points max
- *References* – 8 points max
- *Budget* – 4 points max
- *Writing Skills* – 8 points max
- *Paper format* – 6 points max

**Contents**

*Abstract (1/2 page)*

A well-written abstract should concisely explain the key points or essence of your paper and quickly explain to the reader what the paper is about. *Task Overview (1/2 page)*

This section should include an overview of the task(s) your ROV will attempt and should discuss the characteristics and features of the tasks that affected the final design. Avoid directly quoting course descriptions or problem statements for real-world applications and instead use your own words to describe what your ROV will/would do within the application.

*Design Approach (2 pages)*
Given the tasks described in the previous section, describe your team's strategy and approach to developing a novel SeaPerch design. Novelty may occur at various levels of the design and build process including specific components, collections of components, or even team approaches to the process. Focus attention on the creative aspects of your system and how your team conceived of, refined, and implemented these ideas. Describe your experience in making design decisions and how prospective ideas were considered among the team. Include engineering and scientific terms and concepts to demonstrate the team's understanding of the challenges of constructing and operating an underwater ROV.

*Experimental Results (1 page)*
This section should describe various tests accomplished in-water and/or in simulation. What were your results? How did these tests impact your team's subsequent design(s)? Include images, charts, and figures to demonstrate your results.

*Reflection & Next Steps (1 page)*
Reflect on this season's experience. What did you learn? Were there aspects of the project that you particularly enjoyed or that challenged you? How do you think that your new knowledge or experience will assist you in future endeavors? Include a discussion of next steps for the team and/or the team's ROV.

*Acknowledgements (no page limit)*
Participating in the competition involves identifying resources and support beyond the efforts of individual team members. This support can take many forms, such as technical advice, labor, equipment, facilities, and monetary contributions. Acknowledging those who have supported your efforts is important.

*References (no page limit)*
As with any technical publication, original ideas and content not generated by the paper's authors should be properly cited. While there are many citation styles, the American Psychological Association (APA) style guide should be used. Use in-text citations, where appropriate.

This information may be utilized during compliance checks to determine appropriate competition class and should reflect the total materials cost of your ROV. Parts that are 3D printed will be costed out at $0.05 per gram.

| Component | Vendor | How was component used? | Cost (in USD) |
|---|---|---|---|
| | | | |
| | | | |
| | | **TOTAL COST OF SEAPERCH COMPONENTS** | $ |

### 3.2.2. Meet the Team

Connecting with your community is important. We want to get to know you! This is your chance to introduce us to your team and team's personality.

**Overview**

Reach out and share your team or school's logo, an overview of what your team is all about, and social media information so we can share it with the SeaPerch community.

**Scoring**

This is not a scored event. We will include this information on the 2024 North Africa SeaPerch Challenge webpage.

**Contents**

Teams will be asked to submit the following information:

- Team Name, organization, and location
- Team logo/icon (submitted as PNG image)
- One paragraph (100 words max) team bio/overview
    - *PLEASE NOTE: Team bios will not be edited to correct any spelling and/or grammatical errors before posting, so put your best foot forward and proofread your entry carefully.*
- Image or drawing of the team's SeaPerch ROV design
- Competition Class (i.e., Middle School Stock Class, High School Stock Class, Open Class)
- Overview of SeaPerch Design: Provide a high-level explanation of your SeaPerch design
- Number of years your team has participated in the SeaPerch program (this should include years that you have been involved in building a SeaPerch and/or competed in a SeaPerch competition)
- Number of times your team has competed at the International SeaPerch Challenge including your anticipated participation at the 2024 Challenge (i.e., Put 1 year if this is your 1st year)
- Complete the statement "Our SeaPerch is unique because..."; highlight what you think makes your design innovative
- Complete the statement "Our biggest takeaway this season is..."; focus on your team's experience and what you learned from working together on your design
- Website link*
- Organization's social media link (Facebook, Twitter, Instagram, LinkedIn)*

*Acknowledgement certifying that photographs or videos given as part of this entry only include team members who have submitted a Photographic Release Form signed by a parent/guardian.

# SECTION 4: Team Video

*2024 North Africa SeaPerch Challenge*

All participating teams will submit a team video to be shared with SeaPerch North Africa Community in our Social media platforms. The Video is delivered prior to the on-site competition, due at the close of team registration, 11:59 PM Egypt, 1 Feb, 2024:

- Team Video (Required)

## Video Content

Prepare a 3-minute video introducing your team. Videos must answer the following questions:

- What is your name and your team name?
- How did you find out about the challenge?
- Why did you decide to join the challenge?
- What positive changes occurred after participating?
- What was the most unexpected challenge you faced and how did you overcome it?
- How did each team member contribute, and how did their contributions impact the team's success?

## Video Format Requirements

1. Video must be no more than five (3) minutes in length.
2. Video may include visuals like graphics, vehicle performance, or simulations.
3. Videos must be submitted in .MP4 format.
4. Find a quiet place for recording with minimal background noise.
5. Choose a suitable location for shooting the video.

# SECTION 5: On-Site Team Pitching

*2024 North Africa SeaPerch Challenge*

Each team will be required to perform a 5-minute pitch presenting their work, the pitch will be followed by 10 minutes of Q&A for evaluation by the judging panel.

**Overview**

Each team will be asked to present a pitching to a judging panel within 5 minutes, and the judges have 10 minutes for questions and evaluation.

- The competition will provide a data show for presenting.
- The team can use any software or hardware requirements to help them in the purpose of the pitching.
- The team may present in Arabic or English with no additional score.

**Scoring**

This submission is worth 20 points. Guidelines are available in Appendix E: On site Pitching Scoresheets.

**Contents**

- **Problem/ opportunity:** in which the team describes the problems that they solve in the competition
- **Your solution description:** in which the team gives an overall description of your solution
- **Solution features:** in which the team shows their vehicle features to solve the problem and how the solution is special.
- **Progress status:** in which the team shows the progress of their solution, vehicle,
- **Future plan:** in which the team give a brief on where they are going to forward in the development of the solution
- **The team:** by showing the team members, their field of experience and their roles in the team

# Appendix A: Pool Course Scoresheet – Mission Course

*2024 North Africa SeaPerch Challenge*

## TOTAL SCORE: _____

*Score is not official until verified by master scorekeeper*

| | |
|---|---|
| **JUDGE NAME** _____ | **TEAM NUMBER** _____ |
| **LANE #/TIME:** _____ | **TEAM** _____ |
| **REVIEW INITIALS** _____ | **ORG./SCHOOL** _____ |
| Team member to initial after verifying times | **CLASS/DIVISION** |

| Task Description & Scoring Guidelines | Points Earned |
|---|---|
| **TASK 1: Elevator Preparation**<br>- Open elevator hatch: 5 points ☐ | *Max. 5 points* |
| **TASK 2: Temperature Sensor**<br>- A: Plug connector into connector port: 20 points<br>- B: Alternate – Leave connector in holding ring: 5 points<br>***Only A or B can be completed***<br>- Place sensor in hydrothermal vent ring: 10 points ☐ | *Max. 30 points* |
| **TASK 3: Fluid Collection**<br>- Lift and close collector: 5 points<br>- Transport collector and place in basket: 5 points ☐ | *Max.10 points* |
| **TASK 4: Gas Collection**<br>- Remove collector from ring: 5 points<br>- Fill collector with gas: 10 points ☐ | *Max. 15 points* |
| **TASK 5: Rock Collection** ☐☐☐<br>- Retrieve rocks with loops and place in basket: 5 points each<br>- Retrieve rock without loop and place in basket: 10 points ☐ | *Max. 25 points* |
| **TASK 6: Prepare for Elevator Recovery**<br>- Close and latch Elevator Hatch: 10 points<br>- Release Elevator Marker Float: 5 points ☐ | *Max. 15 points* |
| **Finish Time:** *(Enter actual stopwatch time)* | ____:____:____<br>**(M) (S) (1/100)** |
| **Bonus points based on adjusted finish time.**<br>*Bonus points are awarded **only if all tasks are completed.*** Finish time is less than: 6 min: 5 points 4 min: 10 points | *Max.10 points* |

**Notes:** _____

# Appendix A: Pool Course Scoresheet – Obstacle Course

*2024 North Africa SeaPerch Challenge*

| | |
|---|---|
| **JUDGE NAME** _____<br>**LANE #/TIME:** _____<br>**REVIEW INITIALS** _____<br>Team member to initial after verifying times | **TEAM NUMBER** _____<br>**TEAM** _____<br>**ORG./SCHOOL** _____<br>**CLASS/DIVISION** |
| **Run 1**<br>☐ **Course completed**<br>**Finish Time:** *(Enter actual stopwatch time)*<br>_____:_____:_____<br>**(M) (S) (1/100)** | **Run 2**<br>☐ **Course completed**<br>**Finish Time:** *(Enter actual stopwatch time)*<br>_____:_____:_____<br>**(M) (S) (1/100)** |
| | **Best Time:**<br>_____:_____:_____<br>**(M) (S) (1/100)** |

**Notes:** _____

# Appendix A: Technical Design Report Scoring Rubric

*2024 North Africa SeaPerch Challenge*

| Scoring Guidelines: |
|---|
| **Missing Components** *(0 points)*<br>Requirements missing does not meet minimum requirements. |
| **BASIC** *(2 points)*<br>Meets basic requirements. Average. (60-75%) |
| **SATISFACTORY** ***(3 points)***<br>Meets all requirements with additional content. (85%) Above Average. |
| **ROBUST** *(4 points)*<br>Exceeds requirements with additional content, material, formatting. Superior (95%) |

**TOTAL SCORE:** _____

**TEAM:**_____

**JUDGE:**_____

| 1. Abstract | 0 | 1 | 2 | 3 | 4 | Points |
|---|---|---|---|---|---|---|
| **Limited to ½ page** | Exceeds page limit. | | Within page limit. | | | |
| **Report summarization** | Does not summarize main points of the report. | | Includes a basic overview of the report. | | Includes a robust overview of the report. | |
| **Unique ROV design and/or design process** | No discussion of ROV design or process. | | Basic overview of design and/or process with some focus on unique traits. | | Robust discussion of unique design and process. | |
| | | | | | TOTAL **ABSTRACT** SCORE (10 POINTS MAX (of 100)): | |

| 2. Task Overview | 0 | 1 | 2 | 3 | 4 | Points |
|---|---|---|---|---|---|---|
| **Limited to ½ page** | Exceeds page limit. | | Within page limit. | | | |
| **Overview of the competition tasks** | No overview of competition tasks. | | Basic overview of obstacle or mission course. | | Robust discussion of all tasks for both courses. | |
| **Design approach justification** | No discussion of task influence on design. | | Basic discussion of how tasks impacted design. | | Robust, detailed discussion of design justification. | |
| | | | | | TOTAL **TASK OVERVIEW** SCORE (10 POINTS MAX (of 100)): | |

| 3. Design Approach | 0 | 1 | 2 | 3 | 4 | Points |
|---|---|---|---|---|---|---|
| **Limited to 2 pages** | Exceeds page limit. | | Within page limit. | | | |
| **Team's approach to the engineering design process (EDP)** | No overview of team approach to EDP. | | Basic discussion of team's approach to EDP. | | Robust discussion of team's strategy to EDP. | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Design iterations** | No discussion of design iterations. | | Basic discussion of design iterations. | | Robust discussion and analysis of design iterations. | |
| **Conceptual drawings and/or graphics** | No drawings or graphics. | | Includes graphic(s) with basic context within report. | | Includes high-quality graphics with context and labels that enhance the report. | |
| **Final design** | No discussion of final design. | | Basic discussion of final design features. | | Robust discussion of final design features and decisions with supporting reasons. | |
| **Novelty of ROV design or approach** | No discussion of design or approach novelty. | | Basic discussion of design or approach mentions novelty. | | Robust discussion and analysis of novelty of ROV design and approach. | |
| **Scientific and engineering terms** | No engineering terms. | | Includes 2-4 engineering terms. | | Includes 5+ engineering terms in text that include context and enhance the section. | |
| | | | | | TOTAL **DESIGN APPROACH** SCORE (26 POINTS MAX (of 100)): | |

| **4. Experimental Results** | **0** | **1** | **2** | **3** | **4** | **Points** |
|---|---|---|---|---|---|---|
| Limited to 1 page | Exceeds page limit. | | Within page limit. | | | |
| In-water and/or simulated testing overview | No discussion of testing. | | Basic overview and/or discussion of testing conducted. | | Robust discussion and analysis of testing models utilized. | |
| Impact of testing on subsequent designs | No discussion of testing impact on design. | | Basic discussion of how multiple designs were impacted by testing. | | Robust discussion and thorough analysis of testing impact on multiple design iterations. | |
| Test results | No test results included. | | Basic discussion of test results. | | Robust analysis of test results supported by graphs and charts. | |
| | | | | | TOTAL **EXPERIMENTAL RESULTS** SCORE (14 POINTS MAX (of 100)): | |

| **5. Reflection & Next Steps** | **0** | **1** | **2** | **3** | **4** | **Points** |
|---|---|---|---|---|---|---|
| Limited to 1 page | Exceeds page limit. | | Within page limit. | | | |
| Reflection on the design process | No reflection on the design process. | | Basic reflection on the design process. | | Robust/thoughtful reflection & analysis of the design process. | |
| Next Steps | No discussion of next steps. | | Basic discussion of next steps for ROV and/or team. | | Robust overview of detailed future plans for ROV and team. | |
| | | | | | TOTAL **REFLECTION & NEXT STEPS** SCORE (10 POINTS MAX (of 100)): | |

| 6. Acknowledgements | 0 | 1 | 2 | 3 | 4 | Points |
|---|---|---|---|---|---|---|
| Acknowledgement of support | Not included in report. | | | | Supporters recognized in report. | |
| | | | | | TOTAL ACKNOWLEDGEMENTS SCORE (4 POINTS MAX (of 100)): | |

| 7. References | 0 | 1 | 2 | 3 | 4 | Points |
|---|---|---|---|---|---|---|
| References follow APA format | Does not follow APA format. | | | | Follows APA format. | |
| Includes references to support report | No references or citations. | | 2 references are cited in the report text. | | At least 4 references are cited in the report text. | |
| | | | | | TOTAL **REFERENCES** SCORE (8 POINTS MAX (of 100)): | |

| 8. Budget | 0 | 1 | 2 | 3 | 4 | Points |
|---|---|---|---|---|---|---|
| Includes itemized budget | Section not included in report. | | | | Section included in report. | |
| | | | | | TOTAL **BUDGET** SCORE (4 POINTS MAX (of 100)): | |

| 10. Writing Skills | 0 | 1 | 2 | 3 | 4 | Points |
|---|---|---|---|---|---|---|
| Organization and Readability | Report is inconsistent and difficult to follow. Organization severely impacts readability. | | Report is easy to follow with some graphics. Each section includes organized discussion. | | Report is concise, cohesive, easy to understand and supported by context and graphics. | |
| Spelling and Grammar | Significant spelling or grammatical errors (5+) | | Several spelling or grammatical errors (2-3) | | No spelling or grammatical errors. | |
| | | | | | TOTAL **WRITING SKILLS** SCORE (8 POINTS MAX (of 100)): | |

| 11. Paper Format | 0 | | 3 | | 6 | Points |
|---|---|---|---|---|---|---|
| Follows all formatting guidelines:<br>5 pages max (excluding sections 6-7 and appendices)<br>Page size: 8.5”x11”<br>Margins ≥ 0.8 in.<br>Times New Roman 12pt<br>Single Spaced<br>Footer with team name and page # on all pages | Does not meet all formatting guidelines. Exceeds 5 pages. | | Meets most formatting guidelines. | | Meets all formatting guidelines. | |
| | | | | | TOTAL **PAPER FORMAT** SCORE (6 POINTS MAX (of 100)): | |

# Appendix A: On site Pitching Scoring Sheet

*2024 North Africa SeaPerch Challenge*

## TOTAL SCORE: _____

*Score is not official until verified by master scorekeeper*

| | |
|---|---|
| **JUDGE NAME** _____<br>**LANE #/TIME:** _____<br>**REVIEW INITIALS** _____<br>Team member to initial after verifying times | **TEAM NUMBER** _____<br>**TEAM** _____<br>**ORG./SCHOOL** _____<br>**CLASS/DIVISION** |

| Criteria | Details | Max Points | Team Points |
|---|---|---|---|
| **1- Organizing** | - *Formatting*<br>- *Use of Images*<br>- *Animation* | *2* | |
| **2- Presenting** | *Presenting Skills* | *2* | |
| **3- Evaluation** | *Responding to questions* | *5* | |
| **4- Problem Statement and solution** | *Describe the problem clearly* | *2* | |
| **5- Features** | - *Describe the technical features*<br>- *Mechanical system*<br>- *Control system* | *4* | |
| **6- Progress status** | *Solution progress* | *3* | |
| **7- Future Plan** | | *2* | |
| ***Total Points*** | | *20* | |

**Notes:** _____

_____

# Appendix B: ROV Compliance Checklist

*2024 North Africa SeaPerch Challenge*

No parts or attachments (except buoyancy material) may be removed or added after the compliance check, but attachments may be repositioned.

Design must follow Competition Classes and Design Rules.

**TEAM NUMBER** *(if used)* _
**TEAM** _
**ORG./SCHOOL** _
**CLASS/DIVISION** _
**JUDGE** _

## Design compliance

### Stock and Open Classes

- ☐ Requires only one standard power source for propulsion. Battery limited to one 12VDC, 9Ah max battery no larger than standard SeaPerch battery.
- ☐ Uses no more than one additional external battery of 12VDC, 9Ah max no larger than standard SeaPerch battery for auxiliary equipment
- ☐ Uses only standard SeaPerch kit motors or exact replacement for propulsion

### Stock Class Specific

- ☐ Maximum of 3 standard motors for propulsion
- ☐ ROV meets maximum $25 (value) budget limit for modifications

## Safety

- ☐ No exposed live wires on controllers, SeaPerch ROV or tether cable
- ☐ No sharp edges or potentially hazardous parts
- ☐ Motors are sealed (waterproofed)
- ☐ Power cable has insulated covers on alligator clips or terminals

## Construction

- ☐ No loose parts that could potentially fall off during competition
- ☐ Tether cable is secured to ROV

As team captain/coach, I agree to assure that my team will not make modifications to the ROV system after the compliance check.

Team Captain or Coach's Name: _____

Signature: _____

# Appendix D: Competition Classes Overview

*2024 North Africa SeaPerch Challenge*

The 2024 International SeaPerch Challenge will include three (3) competition classes. These classes are updated from past years so please review the chart below carefully. **Please note, stock classes are limited to PVC, CPVC, and PEX pipe for the ROV frame and may not include 3D printed frames.** Frame parts are any parts that add structural integrity to the frame or connect frame parts together. 3D printed parts may not extend the frame to attach other 3D printed parts. This will be considered a frame part.

| Rules | Middle School Stock Class | High School Stock Class | Open Class |
|---|---|---|---|
| **BUDGET*** | | | |
| The total cost of modifications to the final ROV must be $25 or less | X | X | |
| The cost of modifications may exceed $25 | | | X |
| **MATERIALS** | | | |
| Frame built using only PVC, CPVC, PEX pipe and fittings. Any size pipes and pipe fittings may be used. Pipes and pipe fittings may be modified using hand and power tools, but may not be machined using CNC or other automated process. | X | X | |
| Frame may include 3D printed or additive manufactured parts as well as other materials, and may be made using CNC machinery or other automated process. | | | X |
| Attachments and non-frame parts (i.e., hook, gripper, propeller shroud) may be made from various materials to include 3D printed or additive manufactured parts. For stock classes, the majority of the parts used must be pipes and pipe fittings. Using a single pipe fitting with 3D printed motor mounts is classified as open class. | X | X | X |
| **POWER SUPPLY** | | | |
| Must design for and utilize a 12-volt power source | X | X | X |
| May utilize a second power source (no more than 12-volts) to power auxiliary equipment | X | X | X |
| **MOTORS** | | | |
| All motors must be waterproofed | X | X | X |
| Must use ONLY stock SeaPerch motors (Jameco Electronics 232022) for propulsion** | X | X | X |
| Additional non-stock motors may be used for non-propulsion uses | X | X | X |
| May include more than 3 thrusters (i.e., motor and propeller assembly) | | | X |

| Rules | Middle School Stock Class | High School Stock Class | Open Class |
|---|---|---|---|
| **CONTROLLERS** | | | |
| Must only use simple on/off switches for thruster controls | X | X | |
| May use power conditioning or pulse-width modulation (PWM) controls for thruster controls | | | X |
| May use PWM, microcontrollers, or other devices for non-thruster controls | X | X | X |
| May use a fixed or variable resistor to reduce voltage | X | X | X |
| **STRUCTURE/SIZE** | | | |
| Must fit through 18” diameter hoop | X | X | X |
| **COMPETITION CRITERIA** | | | |
| ROV must not be modified after compliance check (except for buoyancy) | X | X | X |
| The same ROV must be used for both pool events | X | X | X |
| Team may include a student in 8$^{th}$ grade or below | X | | X |
| Team may include a student in 9$^{th}$ grade or above | | X | X |

*Budget Guidelines include:

- Donated material will be assessed at what the cost would be to procure the material.
- Spare parts and tools are not included in this budget.
- Materials used on earlier prototypes are not included in this budget. Only materials and supplies used on the competition ROV and controllers that are not part of the standard SeaPerch ROV kit should be included.
- Proof of budget compliance must be made available to the judges upon request.
- 3D printed parts will be costed out at $0.05 per gram.

** Thrusters used for propulsion are thrusters that directly exert force against the water causing the ROV to move in any direction.