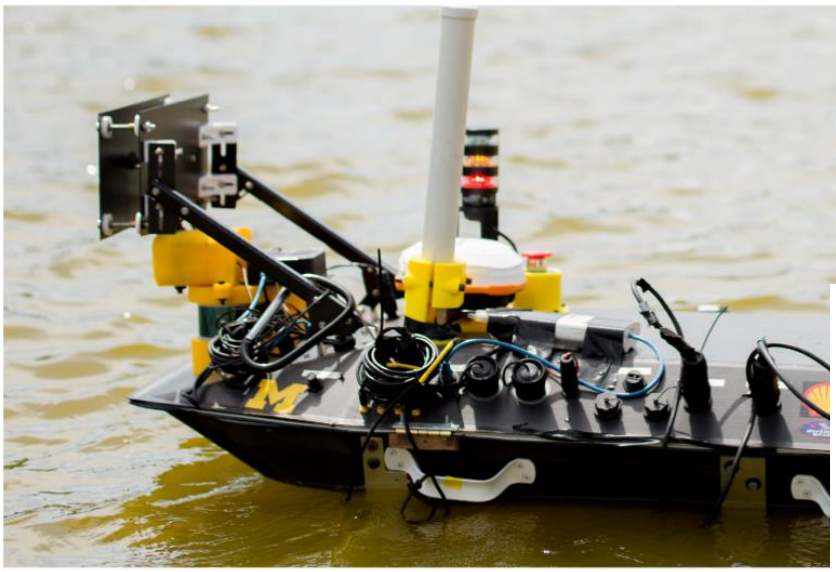
roboboat

OCEAN EXPLORATION



2023

TEAM HANDBOOK

Version 2 (December 2022)

Introduction

Welcome to the frontlines of innovation at the 2023 RoboBoat Competition!
This Team Handbook contains information that teams need to compete at the 2023 RoboBoat Competition. 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.

What is RoboBoat? RoboBoat is an international student program established to generate, cultivate, and enhance a community of innovators capable of making substantive contributions to the Autonomous Surface Vehicle (ASV) domain. The vision is achieved by providing a venue and mechanism, whereby practitioners of robotics and maritime autonomy come together at RoboBoat to share knowledge, innovate, and collaboratively advance the technology of ASV systems. Teams must also document their designs as described in this Team Handbook.

Why RoboBoat? The objective of RoboBoat is to build an international community of innovators – ranging from high school to higher education, capable of making substantive contributions to the maritime field and pushing development of small-scale (X-Class) Autonomous Surface Vehicle (ASV).

Why compete in RoboBoat? Participants of RoboBoat may expect to:

- Increase technical proficiency;
- Establish valuable professional connections; and
- Enjoy the satisfaction of learning and collaborating while advancing the technology of ASV systems.

The nominal winners are those teams that have scored the most points. The real winners are all those participants who have learned something lasting about working together to create an autonomous system that accomplished a challenging mission in a complex environment.

Maritime autonomous technology is critical to monitoring and healing our oceans. Developing the human resource to expand this effort is even more essential.

2023 ROBOBOAT ORGANIZERS

The 2023 RoboBoat Competition is hosted by RoboNation, in collaboration with the United States Office of Naval Research (ONR).

Table of Contents

Version	Changes	Date
V1	First release of RoboBoat 2023 Team Handbook.	26 October 2022
V2	• Updated dates to reflect finalized dates of event: March 22-28, 2023 • Section 4.3.3: Removed #1 and #2 statements requiring a visual feedback system and judges' display. Neither are required for RoboBoat 2023. • Section 5.3: Delayed deadlines a week due to new event dates. (Note: with the exception of the December 16 registration deadline)	02 December 2022

Table 1. Document Version Log

SECTION 1: RoboBoat Overview

RoboBoat 2023 *www.roboboat.org*

1.1 Dates & Venue

The 2023 RoboBoat Competition (RoboBoat 2023) will be conducted March 22-28, 2023 at the Nathan Benderson Park in Sarasota, Florida. Multiple courses will be used for the competition (Figure 1).

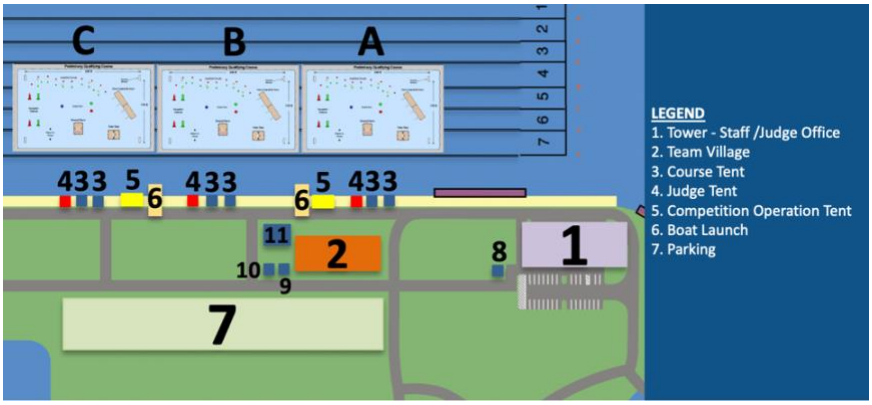


Figure 1: Preliminary Venue Layout

1.2 Competition Structure

RoboBoat 2023 includes the Autonomy Challenge and Design Documentation with the option for teams to compete. The competition includes:

- Autonomy Challenge demonstrates safety and performance; and
- Design Documentation presents each team's work and vehicle design.

1.3 Eligibility

Student teams from anywhere in the world are eligible to participate. All teams must build an ASV to compete and only enter one vehicle in the competition. *

**__First-year teams__ are eligible to participate in RoboBoat without an ASV. These teams are expected to participate in Design Documentation and send representatives on-site at the event as a learning experience. First-year teams are expected to indicate this option in their registration form.*

1.3.1 Eligibility Details & Team Composition

- Teams must be comprised of 75% or more full-time students. Student members are expected to make significant contributions to the engineering development cycle of their ASV.
- The majority of team members must be college or high school students. Teams may also include middle school students. Interdisciplinary teams are encouraged.
- Teams may be comprised of 25% or less alumni, industry, academic or government partners.
- A minimum of three (3) team members are required for safe operations on-site at RoboBoat.

1.4 Point of Contacts

RoboBoat Questions:	Registration Questions:	Technical Questions:	On-Site Logistics/Safety:
autonomy@robonation.org	support@robonation.org	roboboat.org/forum	events@robonation.org 850.642.0536

SECTION 2: Competition

This section includes general competition information for the 2023 RoboBoat Competition (RoboBoat 2023) including competition schedule, Design Documentation, and Autonomy Challenge.

2.1 Competition Schedule

RoboBoat 2023 includes:

- **Design Documentation:** Teams provide a variety of design documentation prior to and during the competition.
- **Autonomy Challenge:**
  - **Qualifying Round:** Teams assemble and test their ASV, participate in initial safety inspections, practice, and qualify for Semi-Finals in the water on the Practice Courses.
  - **Semi-Finals Round:** Teams complete runs to qualify for the Finals Round.
  - **Finals Round:** Teams complete runs on the Finals Course.

See Appendix B: Competition Schedule for the detailed competition schedule.

Date	Event	Location
03 February	Design Documentation (prior to on-site competition)	Online
22 March	Team Check-in / Orientation Vehicle Assembly + Safety Inspections	Nathan Benderson Park
23 March	Practice Course Open Qualifying Round Design Presentations	
24 – 27 March	Semi-Finals Round	
28 March	Finals Round Awards	

Table 2. RoboBoat 2023 Schedule

2.1.1 Daily Team Meeting (In-Person Teams)

Each competition day ends with a mandatory team meeting for in-person teams, conducted by the Technical Director. Team leads are required to attend. All participants are strongly encouraged to attend.

- **Daily Team Meeting:** Technical Director summarizes the day's events, describes any course changes for the following day, and teams are encouraged to provide feedback.

2.2 Design Documentation

Prior to the on-site competition, teams provide a variety of design documentation. During the competition, teams provide an oral presentation and their ASV is assessed by subject matter expert judges.

2.2.1 Delivered Prior to On-Site Competition

The following design documentation is delivered prior to the on-site competition. How to submit deliverables can be found in Section 5.2 Pre-Competition Requirements.

Team Website

Teams are required to submit a website in English that documents their team, vehicle design, and competition approach, addressing the following areas:

1) Website Content: Layout and detailed contents of the website are left for the teams to develop; however, the team website should include:

- Team name and contact information
- Team name, picture and contact information for each contributing member
- Vehicle diagrams
- Instructional/Informative videos
- Procedures (text, images)
- Design decision documentation (text, images, videos)
- Blogs for historical records of build progress
- List of sponsors with logos

2) Website Quality: Websites are often the first impression of a project. Potential supporters such as supervisors, sponsors, or advisors must find the website visually appealing and easy to navigate. Development of the website should include careful consideration of user experience, including:

- Written in English, or English translation provided
- Clear prioritization of key content
- Site search functionality
- Basic design elements: contrast, repetition, alignment and grouping to organize/highlight content
- User accessibility, as defined by the W3C Web Accessibility Initiative: www.w3.org/WAI
- Cross browser compatibility for modern web browsers (Chrome, Firefox, Safari, MS Edge)
- A mobile friendly display

Technical Design Report (TDR)

Teams are required to submit a technical design report in English that describes the design of their ASV autonomy systems, propulsion system, and control systems, as well as strategies for their approach to the tasks. This paper should include the rationale for their design choices. Guidelines for this report are available in Appendix A: Technical Design Report.

Competition Strategy Video
Teams are required to create a video outlining their competition strategy. This includes an introduction, the tasks they plan to attempt, and their approach to complete each task.

Format Requirements:

1. Teams must abide by all applicable social distancing protocols.
2. Video must be conducted in English or include subtitles in English.
3. Video must be no more than eight (8) minutes in length.
4. Videos must be hosted by team:

   OPTION 1: Hosted on team's YouTube Channel.
   - Videos shared on the RoboNation YouTube Channel.
   - Must follow YouTube Rules & Policies, including appropriate music copyright management.

   OPTION 2: Host/Embed on Team Website.

2.2.2 Delivered During On-Site Competition

Oral Presentation
Teams give an oral presentation to a panel of judges. This oral presentation must be conducted in English and may include visual aids. This presentation requirements will be released at a later date.

2.3 Autonomy Challenge

These challenges showcase ASV performance through autonomous behaviors designed to represent research and real-world applications.

2.3.1 Mandatory Activities

To participate in the Autonomy Challenge, teams must demonstrate the following mandatory activities.

Static Safety Inspection
Prior to deploying in the water, the ASV must meet all safety requirements. At a minimum, the following areas are checked:

- Emergency Stop System (location of switches, on-board and remote functionality)
- Safety issues related to propellors or hazards
- All systems are properly secured

More details on system requirements are available in Section 4.3.1 ASV Requirements.

Weight and Thrust Measurements
Vehicles are weighed at the start of each day during the Qualifying Round and at the start of each run during the Semi-Finals and Finals Rounds. Teams transport the vehicle on their cart to the scale (similar to a veterinary scale, available at scaleline.com) for weight measurement. The stable scale reading weight is recorded.

Thrust is measured after the vehicle is deployed in the water either in manual or autonomous mode. The thrust value used is the highest scale reading that is stable for at least two seconds. Teams may opt to repeat their thrust measurement at each deployment.

Parameters	Points
ASV weight > 140 lbs.	**Disqualified!!!**
140 lbs > ASV + weight > 110	-250 - 5*(w - 110)
110 lbs > ASV + weight > 70	2*(110 – w)
ASV weight ≤ 70 lbs	80 + (70 - w)
Dimensions greater than: - three feet of width or - three feet of height - six feet of length	**Disqualified!!!**
Thrust (t) vs weight (w)	*100*(t / w)*

Table 3: Weight and Thrust Scoresheet

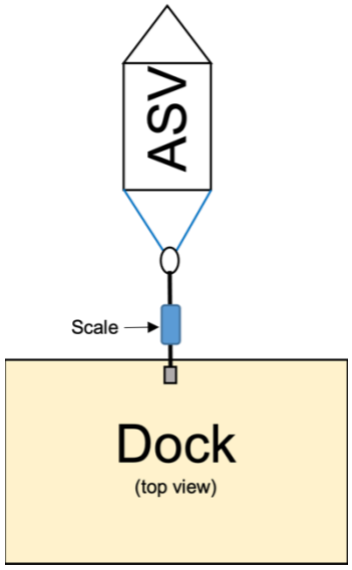


Figure 2: Thrust Measurement

2.3.2 Qualifying Round

Practice Courses are available for teams to practice, demonstrate proficiency, and qualify for the Semi-Finals Round. During this round, multiple courses are available, and each course includes all tasks. Teams may schedule times to practice or qualify on these courses. Multiple teams may be on a Practice Course at the same time. (Section 2.6 Qualifying Round)

2.3.3 Semi-Finals Round

Teams who qualify for the Semi-Finals Round are assigned a time slot to conduct their Semi-Finals run. (Section 2.7 Semi-Finals Round)

2.3.4 Finals Round

Upon completion of the Semi-Finals Round, the judges announce the top-scoring teams who progress to the Finals Round. The judges have the discretion to select the number of teams advancing to the Finals Round. (Section 2.8 Finals Round)

2.4 Task Descriptions

This section provides details of the RoboBoat 2023 Autonomy Challenge tasks. Teams are encouraged to develop a strategy approaching these tasks that best suits their ASV.

2.4.1 Task 1 – Navigate the Panama Canal

The Navigate the Panama Canal task is a navigation channel demonstration that demonstrates the basic autonomous control and sensing capabilities. The ASV must navigate through two pairs of red and green buoys in a fully autonomous manner. The entire ASV must pass through both sets of the gates, without touching the buoys. The ASV must start its autonomous navigation a minimum of 6 ft. before the first set of gates.

This task is mandatory for all teams who advance to the Semi-Finals and Finals Round.

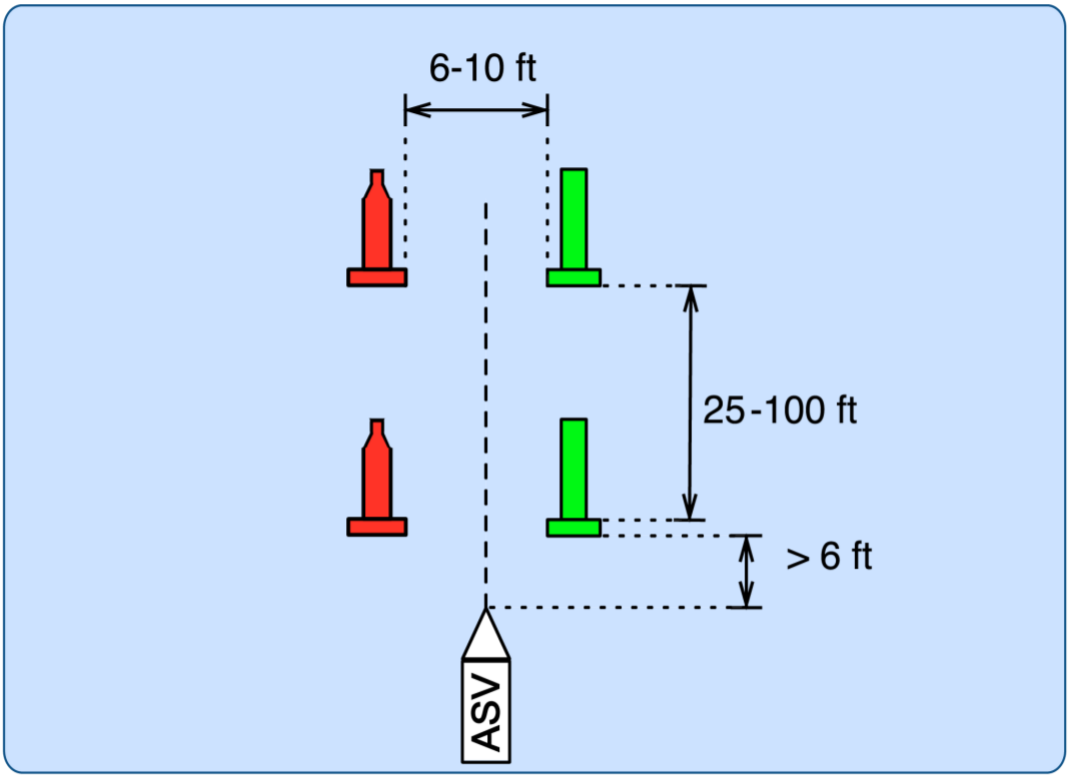


Figure 3: Navigation Channel Demonstration

Task Elements

Task elements for this task are detailed in Table 4 below.

Task Element	Description	Model No.	Color	Ht. Above Waterline	Base Diam.
Port Marker Buoy	Taylor Made Sur-Mark Buoy	950410	Red	39in	18in
Starboard Marker Buoy	Taylor Made Sur-Mark Buoy	950400	Green	39in	18in
Navigation Channel Demonstration buoys are supplied from Taylor Made, www.taylormadeproducts.com.					

Table 4. Task Elements for Navigate the Panama Canal

2.4.2 Task 2 – Magellan's Route / Count the Manatees & Jellyfish

The Magellan's Route task demonstrates the ability for the ASV to sense and maneuver through a complex path, staying within the defined pathway, and avoiding contact with obstacles along the way. The task consists of multiple sets of gates designated by pairs of red and green buoys. The ASV passes between the sets of gates without touching the buoys and avoids intermittent yellow buoys (jelly fish) and black buoys (manatees), which may be various sizes, placed within the pathway.

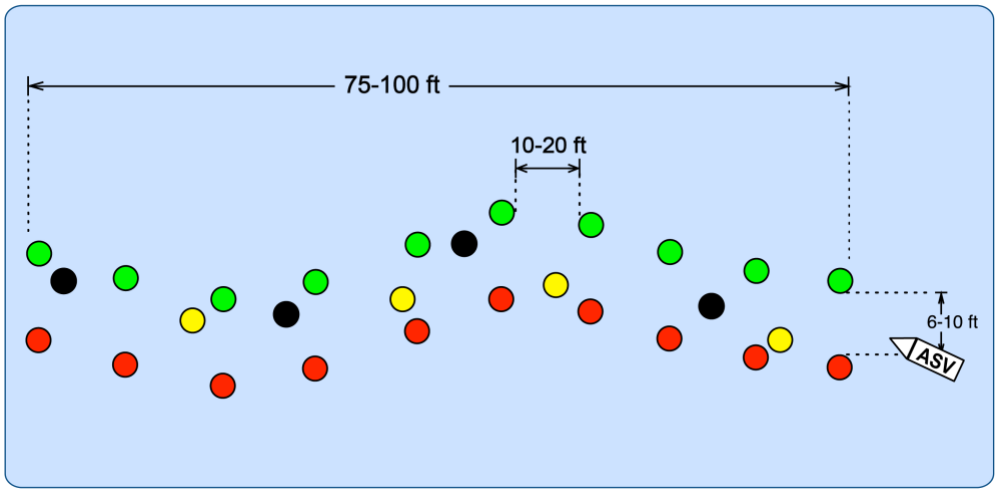


Figure 4: Example Magellan's Route / Count the Manatees & Jellyfish Task

Task Elements

Task elements for this task are detailed in Table 5.

Task Element	Description	Model No.	Color	Ht. Above Waterline	Base Diam.
Gate Buoy	Polyform A-0	A-0	Red	0.5 ft	20.3 cm
Gate Buoy	Polyform A-0	A-0	Green	0.5 ft	20.3 cm
Obstacle Buoy	Polyform A-0	A-0	Yellow	0.5 ft	20.3 cm
Obstacle Buoy	Polyform A-0	A-0	Black	0.5 ft	20.3 cm
Magellan's Route buoys are supplied from Polyform US, shop.polyformus.com.					

Table 5: Task Elements for Magellan's Route

2.4.3 Task 3 – Beaching & Inspecting Turtle Nests

The Beaching & Inspecting Turtle Nests task demonstrates the ability for the ASV to correctly sense, locate and maneuver into an assigned docking bay (nest). Teams are assigned a color before their time slot begins. The ASV must locate the bay matching this color and attempt to enter the bay. The ASV may make contact with the dock and will not be penalized. The ASV must then report the number of "eggs" (number of circles) in the nest.

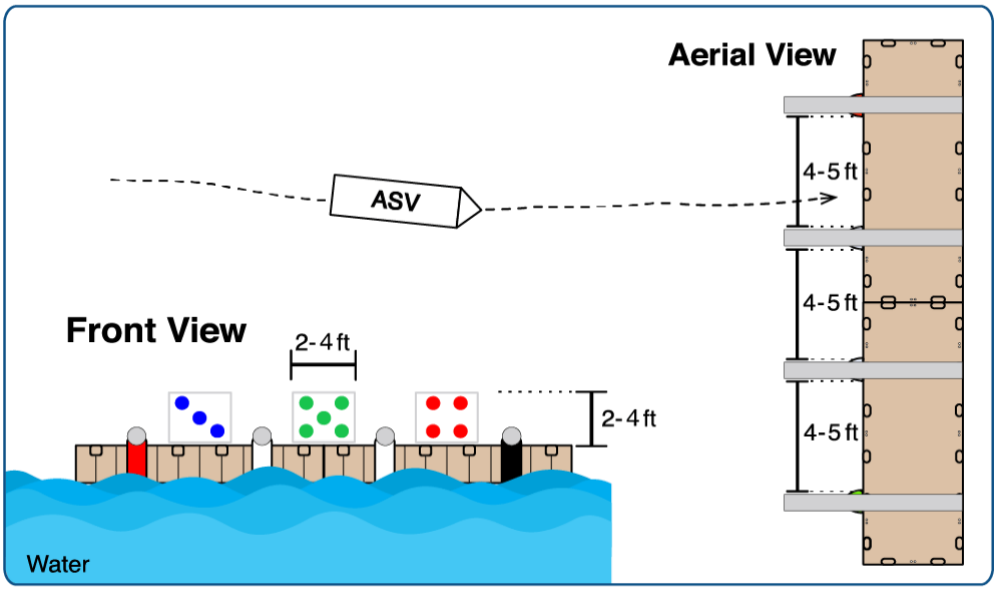


Figure 5: Example Beaching & Inspecting Turtle Nests Task

Task Elements

Task elements for this task are detailed in Table 6.

Task Element	Description	Color
Floating Dock	40 in. "Baby" EZ Dock	Beige
Color Display	Vinyl banner	Red, Blue, Green
Tines	PVC Pipe	White
Dock units are supplied from EZ Docks, www.ez-dock.com.		

Table 6: Task Elements for Beaching & Inspecting Turtle Nests

2.4.4 Task 4 – Northern Passage Challenge

The Northern Passage Challenge task demonstrates the ability for the ASV to sense the task elements with object recognition and decision making. This task demonstrates hull form efficiency coupled with its propulsion system, and the resulting maneuverability.

As quickly as possible, the ASV enters through gate buoys, goes around the mark buoy (counterclockwise or clockwise), and exits through the same gate buoys. The gate buoys are moored 6 to 10 ft apart, and the mark buoy is placed 40 to 100 ft, from the gate buoys.

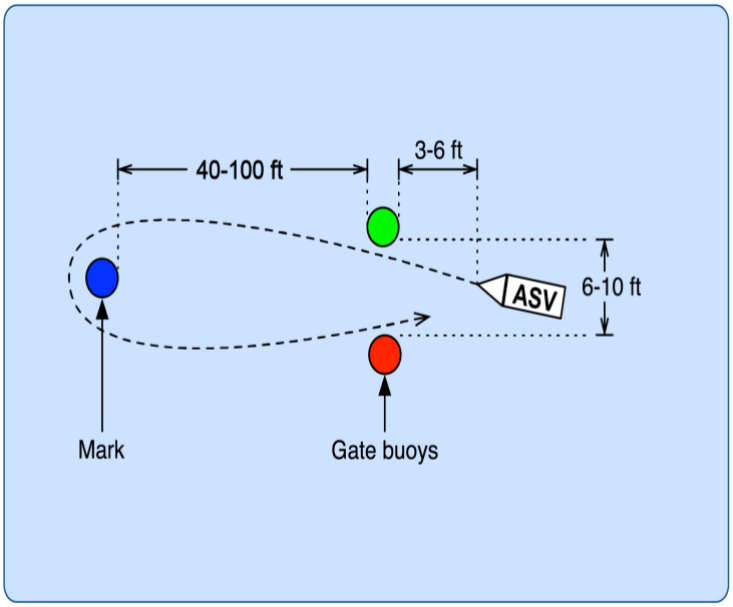


Figure 6: Example Northern Passage Challenge Task

This is a timed task. Time starts when the bow (front) of the ASV crosses the gate buoys (entry) and stops when the bow (front) of the ASV crosses the gate buoys (exit).

Task Elements

Task elements for this task are detailed in Table 7.

Task Element	Description	Model No.	Color	Ht. Above Waterline	Base Diam.
Gate buoy	Polyform A-2	A-2	Red	1 ft	36.8 cm
Gate buoy	Polyform A-2	A-2	Green	1 ft	36.8 cm
Mark buoy	Polyform A-2	A-2	Blue	1 ft	36.8 cm
Buoys are supplied from Polyform US, shop.polyformus.com.					

Table 7: Task Elements Northern Passage Challenge

2.4.5 Task 5 – Ocean Cleanup

The Ocean Cleanup task demonstrates the ability for the ASV to detect an active underwater pinger which designates the correct area from which to collect "debris" (racquetballs). The ASV may then use the collected "debris" as extra racquetballs in Task 6 – Feed the Fish. The active pinger is determined randomly at the start of each run. Collection areas are approximately 5 feet in diameter.

NOTE: The acoustic pinger for this task is the same that has been used in previous RoboBoat, RoboSub and RobotX competitions. However, these pingers are no longer in production. More information can be found in Appendix C.

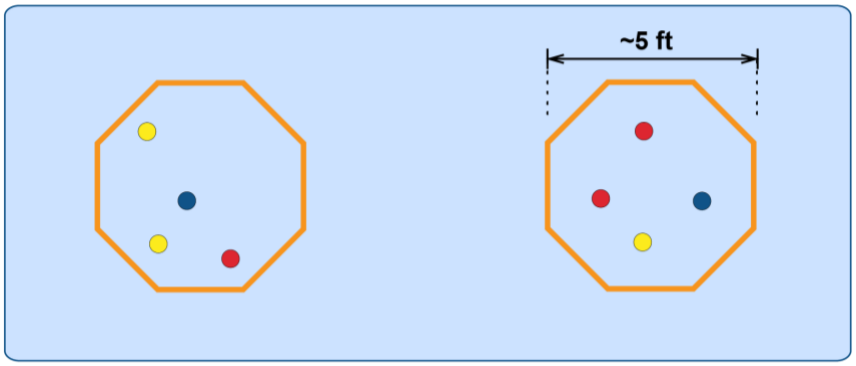


Figure 7: Example Ocean Cleanup Task

Task Elements

Task elements for this task are detailed in Table 8.

Task Element	Description	Model No.	Color	Base Dimensions.
Racquetballs	FJBM Racquetball Squash Ball	Amazon	Red, Blue or Yellow	5.5 cm
This task is still under development.				

Table 8: Task Elements for Ocean Cleanup

2.4.6 Task 6 – Feed the Fish

The Feed the Fish task demonstrates the ability for the ASV to sense and interact with its environment. The ASV must find the "feeding table" side of the task using the purple frame, and then deploy/sink "pellets" (racquetballs) through the frame and onto the feeding table, in any of the three holes. The ASV may make contact with the dock and will not be penalized. Racquetballs may only be delivered through the purple frame, the other sides of the task may be closed off with netting or another material, not shown in **Error! Reference source not found.**8.

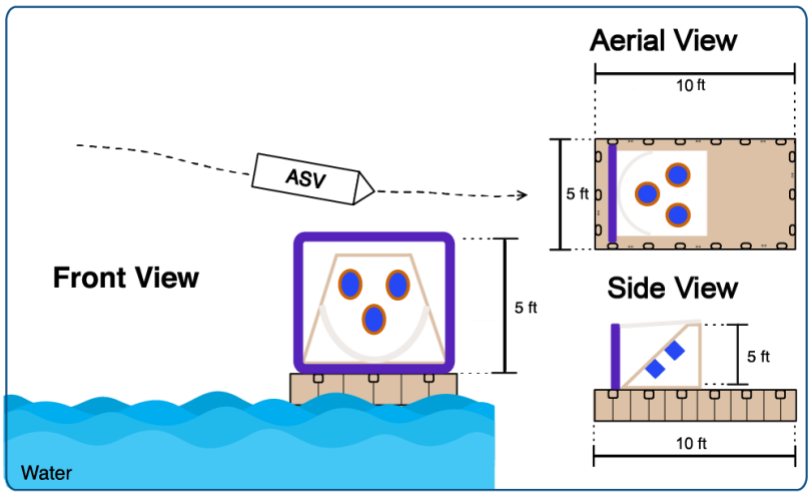


Figure 8: Example Feed the Fish Task

Task Elements

Task elements for this task are detailed in Table 9.

Task Element	Description	Model No.	Color	Base Dimensions.
Frame	5 ft. square frame	N/A	Purple	5 x 5 ft
Targets/Holes	Blue 5-gallon bucket	Lowes	Blue	
Base	Plywood	N/A		5 x 7 ft
Racquetballs	FJBM Racquetball Squash Ball	Amazon	Red, Blue or Orange	5.5 cm

Table 9: Task Elements for Feed the Fish

2.4.7 Task 7 – Ponce de Leon / Fountain of Youth

The Ponce de Leon task demonstrates the ability for the ASV to sense and interact while demonstrating precise control and aiming. The ASV must locate the target face of the task and deliver water through the center of it. The ASV must deliver enough water to raise the ball above the green line. The ASV may pump the water from the environment versus storing it on board the vehicle. The ASV may make contact with the dock and will not be penalized.

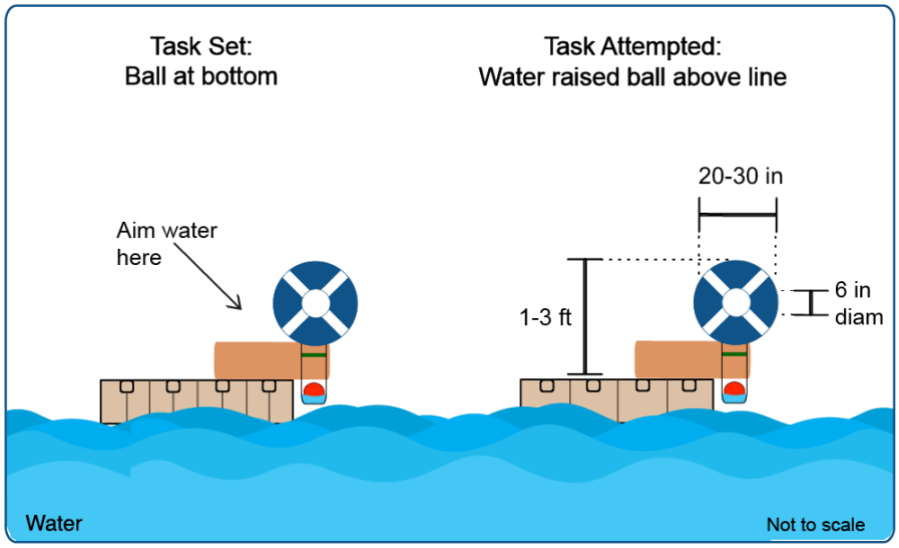


Figure 9: Example Ponce de Leon Task

Task Elements

Task elements for this task are detailed in Table 10.

Task Element	Description	Model No.	Color	Base Diam.
Elbow	90 degree Elbow Pipe	53037	White	6 in
Reducer	6 in x 4 in Reducer	23411	White	4 in
Reducer	4 in x 4 in Reducer	899460	White	4 in
Clear Pipe	96 mm x 100 mm Acrylic Pipe	Amazon	Clear	12 in
Tape	2 in x 50 ft Pipe Wrap Tape	1642024	Black	N/A
Cap	4 in x 4 in Cap PVC Fitting	23927	White	4 in
Most task elements (excluding clear pipe) are supplied from Lowe's, www.lowes.com .				

Table 10: Task Elements for Ponce de Leon / Fountain of Youth

2.4.8 Task 8 – Explore the Coral Reel

The Explore the Coral Reed task demonstrates the ability for the ASV to navigate back to the launch point while avoiding interaction with any obstacles.

The ASV returns through the gate created with two black buoys in autonomous mode after attempting Autonomy Challenge tasks. The ASV avoids all obstacles and task equipment (buoys, floating docks, etc.) on the way back. See Figure 10: Preliminary Qualifying Coursefor the preliminary course layout.

2.5 Qualifying Round

Three Qualifying and Practice Courses are available for teams to practice, demonstrate proficiency, and qualify for the Semi-Finals Round. These courses consist of all eight (8) tasks. Multiple teams may be on a Qualifying and Practice Course at the same time. Teams may schedule times to practice or qualify on individual tasks on these courses, with the Technical Director. Teams may attempt qualification on individual tasks in any order.

Qualifying Round and task proficiency requirements will be released at a later date.

Below is a preliminary course configuration for the Qualifying Round.

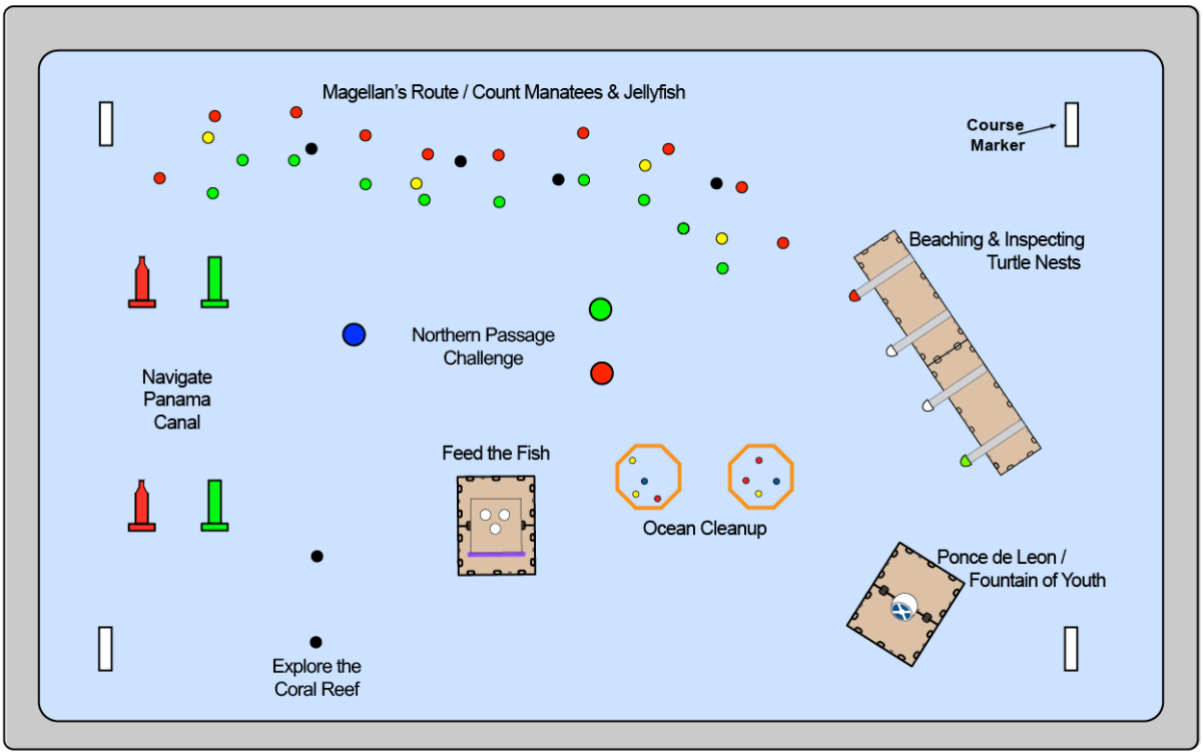


Figure 10: Preliminary Qualifying Course

2.6 Semi-Finals Round

Teams that qualify for the Semi-Finals will have access to the Semi-Finals Courses. These courses consist of eight (8) tasks: the mandatory navigation channel and tasks 2-8. Only one team may be on a Semi-Finals Course at a time.

During a Semi-Finals run the ASV must:

- operate autonomously throughout the entire run;
- enter the course through the gates in Navigate the Panama Canal task;
- attempt the remaining Tasks 2-7 of their choice, in any order; and
- return to start of course (Task 8) at the end of the run.

Semi-Finals Round and task proficiency requirements will be released at a later date.

2.7 Finals Round

Only successful Semi-Finals teams are eligible to compete in the Finals Round. The number of teams that advance to the Finals Round are determined by the judges, based on the Semi-Finals standings.

During a Finals run the ASV must:

- operate autonomously throughout the entire run;
- enter the course through the gates in Navigate the Panama Canal task;
- attempt the remaining Tasks 2-7 of their choice, in any order; and
- return to home (Task 8) at the end of the run.

Finals Round and task proficiency requirements will be released at a later date.

SECTION 3: Scoring & Awards

3.1 Scoring

All scores are calculated by the judges. All judge decisions are final.

3.1.1 Design Documentation Scoring

After the competition, the judges will issue overall standings in the Design Documentation portion of the competition.

3.1.2 Autonomy Challenge Scoring

All teams that meet the minimum Qualifying Round requirements will be eligible to compete in the Semi-Finals Round. Upon completion of the Semi-Finals Round, the judges will announce the top-scoring teams who will progress to the Finals Round. The judges have the discretion to select the number of teams advancing to the Finals Round.

After the competition, the judges will issue Autonomy Challenge overall standings. Any team accepted into the Finals Round will be ranked ahead of all teams that did not participate in the Finals Round. The online teams' Demonstration Video will not be scored/evaluated but may be eligible for special awards or recognition.

3.2 Awards

3.2.1 Final Standings

Teams are awarded prize money reflective of their overall ranking after scores are calculated. The first-place teams receive a RoboNation champion banner.

3.2.2 Judges' Special Awards

Throughout the competition, judges and staff are always on the lookout for exemplary behavior from teams to acknowledge with special awards.

SECTION 4: Rules & Requirements

4.1 Rules

1. Teams must build an ASV to compete and only enter one vehicle in the competition. (Section 4.3: Vehicle Requirements)
2. Teams that arrive at the competition failing to meet the vehicle requirements will not be permitted on the course, until the vehicle is modified to meet all requirements. (Section 4.3: Vehicle Requirements)
3. No combustion engines of any type may be used on the ASV.
4. Teams must be comprised of 75% or more full-time students. (Section 1.3: Eligibility)
5. First-year teams are eligible to participate in RoboBoat without an ASV. These teams are expected to participate in Design Documentation and send representation on-site at the event as a learning experience. First-year teams are expected to indicate this option in their registration form.
6. One student member of the team must be designated as the "team lead". The team lead must be conversationally fluent in English. The team lead, and only the team lead, will speak for the team during the competition runs.
7. Team leads are required to attend daily team meetings conducted by the Technical Director. (Section 2.1: Schedule)
8. Teams must remain onsite at the competition venue during the competition hours to be eligible for prizes.
9. Prior to entering the Autonomy Challenge courses, teams must demonstrate the ability to operate their ASV safely. (Section 2.3.1: Mandatory Activities)
10. At any point, the Technical Director Team may require a team to repeat the ASV Demonstration to re-deploy. (Section 2.3.1: Mandatory Activities)
11. Course boundaries are clearly identified. The ASV must stay within the course or task boundaries while attempting any tasks.
12. An Autonomy Challenge run will be terminated if the ASV interferes with course elements or crosses through a different course. This includes entangling, dragging, pushing, or damaging course elements or landscape.
13. All decisions of the judges are final.
14. RoboBoat organizers are not responsible for any damage to a team's ASV as the consequences of participating in the competition.

4.2 Safety

Safe operations are a priority for the RoboBoat staff. All considerations to maintain safety for operators and the surrounding environment must be made. These guidelines are the minimum requirements for all teams and their systems during the competition.

1. All Radio Frequency (RF) equipment must be operated within the rules and regulations of the host country. This includes, but is not limited to, frequency, transmitting power, antenna height, etc.
2. ASV power systems must follow the safety rules and regulations of the host country as well as the team's home country.
3. RoboBoat staff may suspend team operations at any time for safety considerations. The staff is not required to advise the team prior to the decision to terminate the run attempt. In all matters of safety, the decisions of the RoboBoat staff are final.

4.2.1 Safety Inspections

Before operating in the water, all systems must pass a safety inspection. This includes, but is not limited to:

1. A Safety Inspector completes a safety checklist, verifying successful operation of all safety features at each unmanned system launch.
2. Teams demonstrate compliance with all the requirements, to include identifying all actuators, and moving parts and their associated protection mechanisms (shrouds, etc.).
3. Verification of both kill switches' operation (remote and physical). This is repeated each time a team enters the water.

4.2.2 Battery Safety Requirements

Teams are required to understand and follow battery safety best practices on the battery chemistry selected by the team. Lithium-ion chemistry batteries may become damaged and create a hazard if misused/abused, representing the greatest risk to people, facilities, and the environment. The following safety rules and requirements must be followed:

1. Teams will be required to attend a mandatory battery safety briefing prior to the start of the competition.
2. Teams must submit battery specifications, Material Safety Data Sheets (MSDS), and proper disposal procedures, sourced from the battery manufacturer for all batteries.
3. Teams must keep a hard copy of the battery safety documentation for all batteries in Team Village (onsite) at all times, for reference.
4. Teams must bring a LiPo safe bag(s) adequate for the lithium batteries used. LiPo bag(s) must be available at the competition and the hotel.
5. Li-Po (Lithium Polymer) battery packs need cell level safety and balancing circuits and must be labeled HAZMAT when shipped.
6. Each team must understand and follow their own country's regulations as well as those of the host nation.
7. All batteries must be stored, used, and maintained in accordance with manufacturer guidelines.
8. Teams are required to inspect their batteries daily for signs of swelling, heat, leaking, venting, burning or any other irregularities.
    a. Lithium batteries that become too warm during use or have become swollen or malformed must be removed from use and reported to the Technical Director.
    b. Lithium batteries that do not hold a charge must be removed from use and reported to the Technical Director.
9. A team member must be present at all times to monitor charging batteries.
10. At the competition site, if any of the above battery conditions are observed students must immediately notify the Technical Director or RoboBoat staff and provide the battery specifications and safety information.
11. At the hotel, if a battery irregularity occurs at any time, students must notify RoboNation's Senior Events Manager, Cheri Koch immediately by phone at 850.642.0536 and provide the battery specifications and safety information.
12. Failed or failing Lithium-ion batteries must be handled in accordance with manufacturer's safety and disposal guidelines. In the absence of specific guidelines, batteries must be placed in a LiPo safe bag, which must then be placed in a bucket, covered with sand, and placed in a designated safety zone.
13. Teams cannot change or replace batteries when ASV is in the water or while standing on floating docks.

4.2.3 Kill Switch (Emergency Stop) Requirements

The ASV must comply with the kill switch requirements detailed below. The ASV must have two emergency stop systems, also known as 'kill switches' or 'E-Stops'.

- On-Board: A hard-wired, on-board, emergency stop system.
- Off-Board: A wireless remote emergency stop, located off-board and on its own frequency and link.

Both systems must operate in a failsafe fashion (if any part of the system fails, system must enter emergency stop) and upon activation of either system (on-board or off-board), the switch must instantaneously disconnect power from the vehicle's thruster units. An example of how to implement this is shown in Figure 11. System should be designed such that power, to the thrusters, cannot be restored until the emergency switch is reset.

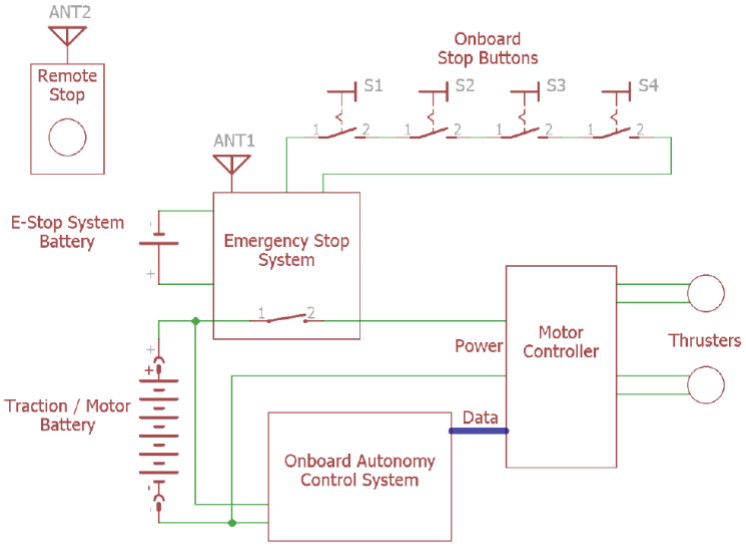


Figure 11: Example Emergency Stop Circuit

The Technical Director team will conduct a detailed engineering and safety inspection including a team demonstration of the proper operation of all emergency systems. Teams must be prepared to discuss the design and implementation of their fail-safe systems in detail, if requested.

Onboard Emergency Stop System

All ASVs must have an onboard emergency stop capable of being actuated by personnel from a support craft. For personnel safety, the switch may be triggered from a distance by a wooden or plastic pole/paddle. Keeping this in mind, teams should select rugged and reliable components for their safety system.

Emergency Stop Button

A large, red button should be installed in such a way that safety personnel, from the support craft can easily actuate the button. The engage/disengage button should be red in color and have a 'press to activate and twist/pull to reset' feature. This button, momentary contact switch or not, should cut power to the thrusters immediately on actuation. The thrusters must remain in a powered-down state until the judge gives permission for the team to reinitialize the system. An example of a suitable button is shown in Figure 12 and can be found at www.mcmaster.com.

Figure 12: Example Kill Switch

Wireless Emergency Stop

All ASVs must be equipped with a portable, handheld, Wireless Emergency Stop controller. This controller must immediately (less than 1 second) disconnect power to the vehicle's thruster units when activated. This system must also meet the host country RF guidelines for frequency and transmit power.

4.3 Vehicle Requirements

The following is a list of minimal requirements for a vehicle to be permitted access to a course. **Teams that arrive at the competition failing to meet the vehicle requirements will not be permitted on the course, until the vehicle is modified to meet all requirements.**

4.3.1 ASV Requirements

- **Autonomy**: Vehicle shall be fully autonomous and shall have all autonomy decisions made onboard the ASV.
- **Buoyancy**: The vehicle shall be positively buoyant.
- **Communication**: The vehicle cannot send or receive any **control** information while in autonomous mode (to and from Operators Control Station).
- **Towable**: The vehicle must have a multi-point tow harness installed at all times to allow staff to attach a rope and tow the vehicle through the water. Underslung harnesses will NOT be permitted.
- **Energy source**: The vehicle must be battery powered. All batteries must be sealed to reduce the hazard from acid or caustic electrolytes. The open circuit voltage of any battery (or battery system) may not exceed 60Vdc.
- **Kill Switch**: The vehicle must have at least one 1.5 inch diameter red button located on the vehicle that, when actuated, must instantaneously disconnect power from all motors and actuators. (Section 4.2.3 Kill Switch Requirements)
- **Wireless Kill Switch**: In addition to the physical kill-switch, the vehicle must have at least one remote kill switch that, when actuated, must instantaneously disconnect power from all motors and actuators. If the remote kill switch system is powered off, vehicle must default to a state in which power is disconnected from all motors and actuators. (Section 4.2.3 Kill Switch Requirements)
- **Propulsion**: Any propulsion system may be used (thruster, paddle, etc.). However, all moving parts must have protection. For instance, a propeller must be shrouded.
- **Remote-controllable**: The vehicle must be remote-controllable (tele-operated) to be brought back to the dock. If the remote controller is turned off (or power is interrupted), vehicle must default to a state in which power is disconnected from all motors and actuators. Controlling vehicle through a laptop is discouraged.
- **Safety**: All sharp, pointy, moving or sensitive parts must be covered and marked.
- **Size**: The vehicle must fit within a six feet, by three feet, by three feet "box".
- **Surface**: The vehicle must float or use ground effect of the water. Mostly submerged/flying vehicles are forbidden for use as primary autonomous platform.
- **Weight**: The entire maritime system shall weigh less than 140 lbs.
- **Payload**: The vehicle must have a place to mount a GoPro (or similar) camera with an unobstructed view from the front of the vehicle.

4.3.3 System Management & Monitoring Requirements

1. Each team's ASV must include an Operator Control Station (OCS) capable of controlling and monitoring the system.
   a. The OCS must have the ability to start and stop autonomous operations.
   b. The OCS must have the ability to remotely kill the platform as described in Section 4.2.3 Kill Switch Requirements
   c. The ASV must stop operating if it goes out of range from the OCS.
   d. Teams are responsible for providing robust and reliable communications between the OCS and ASV to attempt the Autonomy Challenge tasks.
   e. All shore-based equipment used by the team during in-water runs must be contained to the team's designated operating tent and table.

4.4 Obstacle Avoidance

The ability to avoid obstacles is a core capability for unmanned systems. Each buoy on the course represents an object to be avoided or approached in some way. In addition, obstacle buoys may be placed throughout the operating areas in an effort to provide a more representative real-world challenge.

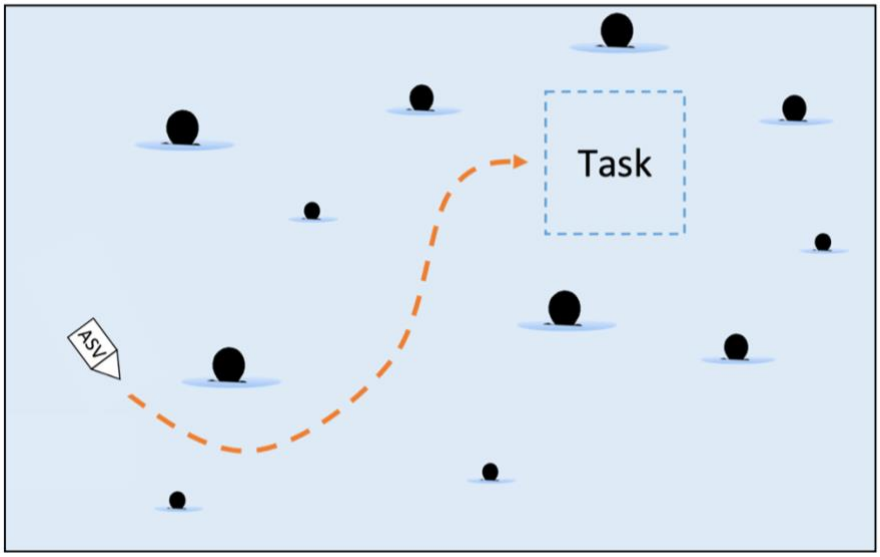


Figure 13: Obstacle Avoidance

SECTION 5: How to Compete

5.1 Register to Compete

All teams are required to register to compete using the Registration form found on the RoboBoat website, RoboBoat.org/2023. This registration collects each team's point of contact information, demographics, and the Pre-Competition Requirements outlined in Section 5.2.

Registration Fees
To complete the RoboBoat 2023 registration, teams must pay the registration fee of **$750 USD**.

First-Year Teams
First-year teams are eligible to participate in RoboBoat without an ASV. These teams are expected to participate in Design Documentation and send representation on-site at the event as a learning experience. First-year teams are expected to indicate this option in their registration form.

5.1.1 Data Sharing Access Requirements

During the registration process, teams must provide a generic email account and a team acronym that is used in the Data Sharing project (Section 5.6). The generic email can be associated with any email provider. An example of the Generic Email is: roboboat-team@outlook.com. The team acronym must be within 2-10 characters, abbreviating the team's school or organization. Examples of the team acronym are: RN or ROBOTEAM.

Access is given to teams that complete the Registration form. Only official registered teams maintain access to the Data Sharing project for the RoboBoat 2023 season.

5.2 Pre-Competition Requirements

These requirements are collected prior to participation on-site at the competition, during the registration process.

5.2.1 Team Information Package

Teams are required to submit a team roster including all participants that support the RoboBoat 2023 effort, liability waivers, forms, and other contact information.

5.2.2 On-Site Requirements

All teams are required to submit the following required documentation prior to participation on-site at the competitions.

Battery Safety Requirements
Teams are required to submit battery specifications, Material Safety Data Sheets (MSDS), and proper disposal procedures, sourced from the battery manufacturer for all batteries. More information can be found in Section 4.2 Safety.

Shipping Plan
Teams are required to submit a shipping plan to facilitate shipment receipt/handling at the competition hotel. Shipping guidelines can be found in Section 5.4.3 Shipping. This shipping plan must include:

1. Box/Crate count (How many total boxes/crates are in the shipment?)
2. Weight of each box/crate
3. Dimensions of each box/crate
4. Name of shipping company used
5. Pick-up Address
6. Return Address
7. Name and contact information for Team Shipping Point of Contact
8. Battery specific provisions for shipments that include batteries.
   (Note: Shipping guidelines for lithium batteries differ by country and by shipping company. Check with your shipping company to determine requirements for shipping new batteries vs. used batteries AND make sure that you are familiar with your shipper's facilities, operating hours, and requirements shipping your vehicle / batteries back home after the competition.)

5.2.3 Design Documentation Package

Teams are required to submit the team website, report, and video of their Design Documentation prior to being on-site at the competition. Guidelines can be found in Section 2.3 Design Documentation.

5.2.4 Optional Community & Outreach

Teams are invited to outline their educational outreach efforts. This activity is not scored; however, it will be shared online for the community and can be eligible for special awards and recognition. Teams may submit a description (500 word limit) of their activities and any supporting documents.

5.3 Timeline

Date/Deadline	Event
25 October – 16 December 2022	Registration
01 February 2023	Full Refund Cancellation Deadline
03 February 2023	Pre-Competition Deadlines: • Team Information • On-Site Requirements
10 February 2023	Pre-Competition Deadlines: • Design Documentation • Optional Community & Outreach
12 February 2023	50% Refund Cancellation Deadline
22 – 28 March 2023	RoboBoat 2023

5.4 Logistics

5.4.1 Travel + Lodging

Teams are responsible for coordinating their own lodging and travel plans.

Lodging—Hotels

RoboNation will work to contract with a local hotel to provide a special rate for RoboBoat teams. Teams are responsible for booking their own lodging for the event.

International Travel
Invitation Letter – During the registration process, international teams are given the opportunity to request an invitation letter issued by RoboNation.

VISA Process – It is recommended for international teams to acquire a B-1 Visitor VISA to attend the competition. However, if the team has plans for any other activities besides the competition, they may choose to investigate other types of visas. Explore the different types of visas: travel.state.gov.

5.4.3 Shipping

RoboNation will coordinate a shipment location for RoboBoat teams. These details will be shared at a later date.

Any additional shipping questions can be directed to Cheri Koch at ckoch@robonation.org / 850.642.0536.

Equipment Arrival
Teams should arrange shipments should arrive no earlier than 3 days prior to event.

Equipment Outbound Pick-Up
Teams should arrange shipments to ensure their package(s) is picked up / dropped off BEFORE the team departs to return home. RoboNation and the hotel staff are not responsible for ensuring that team's outbound shipment gets picked up.

Local Shipping Outlets

Fed Ex Office Print and Ship Center
8320 Lockwood Ridge Rd.
Sarasota, FL 34243
941.907.2227

Sarasota Pack Ship – USPS, UPS, Fed Ex, DHL
935 N. Beneva Rd. Suite 609
Sarasota, FL 34232
941.955.0098

The UPS Store
8374 Market Street
Bradenton, FL 34202
941.907.2227

Hazardous Shipping: LIPO Batteries
Fed Ex Dangerous Goods
1.800.463.3339 x 81
Email: dghotline@fedex.com

Fed Ex Drop Off Location for Dangerous Goods
4605 18th Street E.
Bradenton, FL 34203
Note: There is no direct phone line – this is drop off/pick up only
941.955.0098

5.4.4 On-site Logistics

Team Village
Each team is provided with a 10' x 10' working area in a tent that includes two tables / 6 chairs, one electrical outlet (120V 60 Hz 15A), and a wireless internet connection. The Team Village is a tent with sidewalls that resides on a flat grassy field surface. Although the covered workspace is weather resistant, teams are discouraged from leaving sensitive electronics/equipment exposed in the tent.

Teams should conduct development, maintenance, and repair of their systems in their designated area in Team Village. Batteries may be charged during the day at the Team Village but may not be left charging overnight.

Team Course Operating Areas (Shoreline)
Teams are provided with an area along the shoreline near the course areas where they are able to set up their shore equipment. Each course has a 10' x 10' tent-covered area with a single table per tent, 120V 60Hz 15A power, and a hard-wired Ethernet connection to the Technical Director network. The power provided is for Operator Control Station (OCS) use only and shall not be extended to any platforms on the beach. This space is shared between all teams utilizing the course.

Power
The United States uses a 120V 60Hz 15A electrical outlet plug. Usually three pins, two parallel blades (one wider than the other), and an offset semi-round pin. The wider blade is Neutral, the shorter blade is Hot/Line and the third pin is Ground**.**

Figure 14: US electrical outlets

Vehicle Transit
Teams must provide a cart to move the vehicle around the competition site.

- Cart must be manually propelled on site, no motorized carts.
- Cart's handle must be solid, no rope or chain.
- Cart's width must be less than thirty-six (36) inches.
- Carts are recommended to have six (6) inch (or more) diameter rubberized wheels.

Suggested carts: garden cart, available at homedepot.com; or dump cart, available at homedepot.com.

Figure 15: Example Vehicle Carts

Vehicle Deployment and Recovery
Vehicles are deployed and recovered in the water on their cart, using a portable rollout mat. The temporary walkway is similar to the Mobi-mat, available at shop.mobi-mat.com. The cart will get wet as it's submerged during deployment and recovery. RoboBoat staff are responsible for recovering any lost vehicles. All reasonable efforts to recover a lost vehicle will be made, but the recovery of a lost vehicle cannot be guaranteed. All teams recognize by entering the competition, they risk damage to, or the loss of, their vehicle.

Open to the Public
This event is open to the public. Consider the high possibility that a potential future employer or sponsor may also be there to observe the event.

5.5 Communications

5.5.1 Pre-Competition Communications

RoboBoat teams have a variety of opportunities to interact with each other and the RoboBoat staff.

Team Time Meetings
Leading up to the on-site competition, there are regularly held virtual meetings where teams are asked to have a team representative join. These Team Time meetings are hosted by the RoboBoat organizers and technical team to provide teams with competition updates and the opportunity to ask questions.

RoboBoat Discussion Forum
All questions, comments, and suggestions should be posted on the RoboBoat Discussion Forum. Teams are encouraged to actively participate in the online community and monitor it for the latest news and updates regarding all things RoboBoat.

5.5.2 On-site Communications

Team Lead
Each team must designate a student team member as their team lead. The team lead is the only person allowed to speak for the team. The team lead is the only person permitted to request vehicle deployment, run start, run end, or vehicle retrieval. The team lead must be conversationally fluent in English to communicate with RoboBoat staff. Teams who do not have members fluent in English should contact RoboBoat staff as soon as possible.

Technical Director Team
The RoboBoat Technical Director Team consists of:

- Technical Director
- Safety Inspectors
- Course Managers

Other RoboBoat Staff
The RoboBoat Staff are identified with "Staff" on the back of their RoboBoat shirts.

5.5.3 RoboBoat Website

The official competition website is www.RoboBoat.org/2023. This website includes all official documents and a detailed list of the registered RoboBoat 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.

5.6 Data Sharing

A Data Sharing project has been established for registered teams competing in RoboNation's RoboBoat, RoboSub, and RobotX competitions. This project aims to increase collaboration between teams and to provide access to shared resources and test data to validate and debug the reliability and robustness of teams' machine vision algorithms. Access information is provided in the team registration process, outlined in Section 5.1 Register and Intent to Compete.

For more information on Data Sharing, visit the RoboNation Data Sharing website: RoboBoat.org/data-sharing.

SECTION 6: Glossary & Acronyms

6.1 Glossary

Phrase	Definition
Practice Courses	These courses are designed to provide opportunities to demonstrate proficiency in one task at a time. They contain an instance of each task.
Team Lead	Designated spokesperson for each team.
Technical Director Team	Technical team that runs the courses, safety inspections, set-up, and tear-down.
RoboBoat Staff	RoboBoat support personnel.
Judge	Subject Matter Experts that observe and score the Autonomy Challenge and Design Documentation.
Sponsor	Organizations that provide support to RoboBoat.

6.2 Acronyms

Acronym	Definition
ASV	Autonomous Surface Vehicle
N/A	Not available
OCS	Operator Control Station
RGB	Red, Green, Blue
RF	Radio Frequency
TD	Technical Director
TDR	Technical Design Report

Appendix A: Competition Schedule

** These dates are tentative and are still being finalized with the venue.*

LOCATIONS	**Nathan Benderson Park (NBP)**	5851 Nathan Benderson Circle Sarasota, FL 34235
	Hotel (Details to be shared at a later date)	

DATE	TIME	EVENT	LOCATION
Tuesday, March 14	All Day	Team Travel Day & Hotel Check-in	
Wednesday, March 22	All Day	Team Travel Day & Hotel Check-in	
	1:00 pm – 1:30 pm	Team Check-in	NBP
	1:30 pm – 2:30 pm	Team Orientation	NBP – Team Village
	2:30 pm – 5:00 pm	Safety Inspections / Team Village – Team Move-in	NBP – Team Village
	5:30 pm – 6:00 pm	Daily Team Meeting *(Mandatory: 1 team representative)*	NBP – Team Village
	10:00 pm – 2:00 am	Overnight Pool Testing	TBD
Thursday, March 23	7:30 am	Facility Open to Teams	NBP
	8:00 am – 12:00 pm	Safety Inspections & Autonomy Challenge Practice	NBP – Competition Courses
	10:00 am – 2:00 pm	Media Day	NBP
	12:00 pm – 1:00 pm	Break / Lunch	NBP
	1:00 pm – 5:30 pm	Safety Inspections & Autonomy Challenge Practice	NBP – Competition Courses
	5:30 pm – 6:00 pm	Daily Team Meeting *(Mandatory: 1 team representative)*	NBP – Team Village
	7:30 pm	Facility Closed to Teams	NBP
	10:00 pm – 2:00 am	Overnight Pool Testing	Hotel
Friday, March 24	7:30 am	Facility Open to Teams	NBP
	8:00 am – 12:00 pm	Autonomy Challenge Practice & Qualifying	NBP – Competition Courses
	9:00 am – 4:00 pm	Presentations & Team Photographs	NBP – Finish Tower
	12:00 pm – 1:00 pm	Break / Lunch	
	1:00 pm – 5:30 pm	Autonomy Challenge Practice & Qualifying	NBP – Competition Courses
	5:30 pm – 6:00 pm	Daily Team Meeting *(Mandatory: 1 team representative)*	NBP - Team Village
	7:30 pm	Facility Closed to Teams	NBP
	10:00 pm – 2:00 am	Overnight Pool Testing	Hotel

DATE	TIME	EVENT	LOCATION
Saturday, March 25	7:30 am	Facility Open to Teams	NBP
	8:00 am – 12:00 pm	Autonomy Challenge Practice	NBP – Competition Courses
	9:00 am – 4:00 pm	Presentations & Team Photographs	NBP – Finish Tower
	10:00 am – 3:00 pm	RoboNation's STEM Demo	NBP – Team Village
	12:00 pm – 1:00 pm	Break / Lunch	
	1:00 pm – 5:30 pm	Autonomy Challenge Practice & Qualifying	NBP – Competition Courses
	5:30 pm – 6:00 pm	Daily Team Meeting *(Mandatory: 1 team representative)*	NBP – Team Village
	7:30 pm	Facility Closed to Teams	NBP
	10:00 pm – 2:00 am	Overnight Pool Testing	Hotel
Sunday, March 26	7:30 am	Facility Open to Teams	NBP
	8:00 am – 12:00 pm	Autonomy Challenge Semi-Finals	NBP – Competition Courses
	9:00 am – 12:00 pm	Presentations & Team Photographs	NBP – Finish Tower
	10:00 am – 3:00 pm	RoboNation's STEM Demo	NBP – Team Village
	12:00 pm – 1:00 pm	Break / Lunch	
	1:00 pm – 5:30 pm	Autonomy Challenge Semi-Finals	NBP – Competition Courses
	5:30 pm – 6:00 pm	Daily Team Meeting *(Mandatory: 1 team representative)*	NBP – Team Village
	7:30 pm	Facility Closed to Teams	NBP
	10:00 pm – 2:00 am	Overnight Pool Testing	Hotel
Monday, March 27	7:30 am	Facility Open to Teams	NBP
	8:00 am – 12:00 pm	Autonomy Challenge Semi-Finals	NBP – Competition Courses
	12:00 pm – 1:00 pm	Break / Lunch	
	1:00 pm – 5:30 pm	Autonomy Challenge Semi-Finals	NBP – Competition Courses
	5:30 pm – 6:00 pm	Daily Team Meeting *(Mandatory: 1 team representative)*	NBP - Team Village
	7:30 pm	Facility Closed to Teams	NBP
	10:00 pm – 2:00 am	Overnight Pool Testing	Hyatt Place
Tuesday, March 28	7:30 am	Facility Open to Teams	NBP
	8:00 am – 12:00 pm	Qualifying Overflow Runs / Last Chance Qualifications	NBP – Competition Courses
	12:00 pm – 1:00 pm	Break / Lunch	
	1:00 pm – 5:00 pm	Autonomy Challenge Finals & Livestream	NBP – Competition Courses
	7:30 pm – 10:00 pm	Awards	*Location Released Later*

Appendix B: Technical Design Report (TDR)

B.1. Paper Preparation Overview

Each team is required to submit a TDR that describes the design of their vehicle, as well as strategies for their approach to the tasks. The TDR should also include rationale for design choices. Detailed instructions will be provided at a later date.

Appendix C: Acoustic Beacon Specifications

Each team that plans to attempt the Ocean Cleanup task may build a localization system compatible with the competition beacon system. The beacon type and configuration are described in this appendix for reference so that teams may acquire a comparable unit for testing.

C.1. Beacon Model

The beacon selected for use is the Benthos ALP-365. This model has a selectable frequency between 25 and 40kHz with a 0.5kHz increment. It also has multiple options for repetition rate.

Beacon specifications can be found at: robotx.org/benthos-locator.
NOTE: These beacons are no longer in production and are unavailable for purchase. RoboNation is working to replace the beacon system in future competition years.

Figure 16: Benthos ALP-365 Beacon

Beacons are activated as described in the applicable task descriptions. The frequency and pulse rate of the beacons in each field may change daily; this information will be made available to teams on site. The full range of frequencies (25 – 40 kHz) and pulse rate (0.5 Hz to 2 Hz) is used throughout the competition.

During the competition there are multiple units active at any time, with at least one in each course. To mitigate interference issues, each active beacon is separated by at least 2 kHz in frequency. The beacons are also controlled such that they send out a pulse at time intervals in sequence with the other courses.