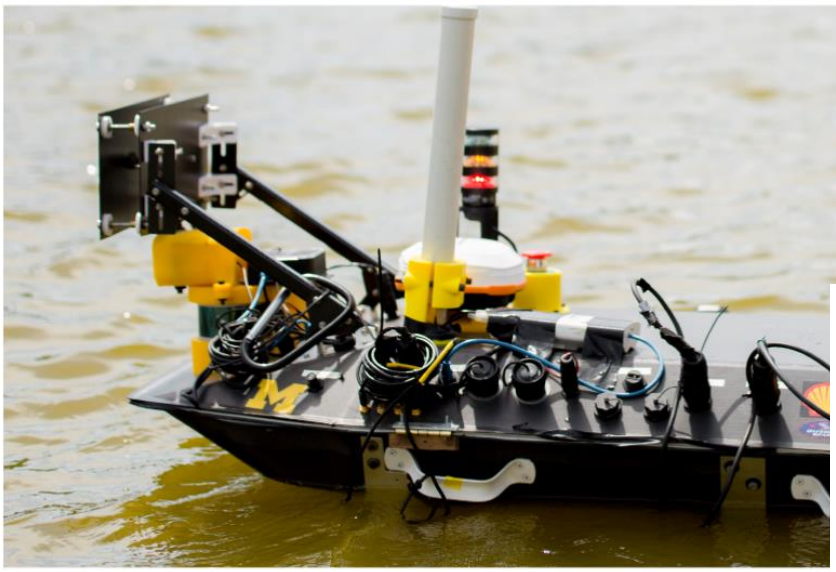
roboboat

OCEAN EXPLORATION



2023

TEAM HANDBOOK

Version 4.0 (February 2023)

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 Updates

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
V3	• Section 2.2: Updated all submission guidelines and added scoring metrics/guidance. • Section 2.4.2: Updated task image to include only 6 obstacle buoys. • Section 2.4.3: Add banner dimensions and link to banner design files and specifications location in Data Sharing. • Section 2.4.5: Updated task elements listed. • Section 2.5: Modified task locations on overall qualifying course layout and added course boundary along the shore-side of the course. • Section 2.6: Combined sections 2.6 and 2.7. • Section 3.1.1: Added the design documentation scoring breakdown. • Section 4.3.1: Clarified size requirements for extensions from hull during a run. • Section 5.2.2: Updated shipping plan template and requirements. • Section 5.4.1: Added selected conference hotel information. • Section 5.4.3: Added shipping instructions and destination. • Appendix B: Added Technical Design Report guidelines and scoring metrics/guidance.	24 January 2023
V4	• Section 2.4.5: Updated task image and elements – added buoys • Section 2.4.7: Updated task image • Section 3.1.2: Added Autonomy Challenge scoring breakdown • Appendix A: Added awards venue, Bradenton Convention Center	22 February 2023

Table 1. Document Version Log

SECTION 1: RoboBoat Overview

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).

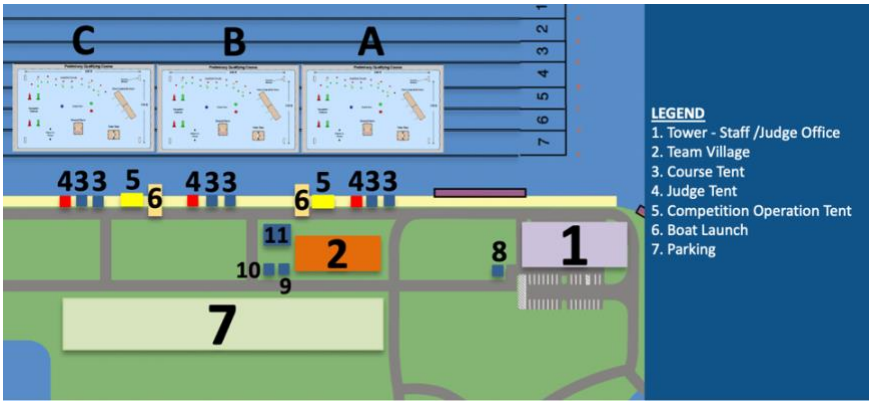


Figure 1: Preliminary Venue Layout

1.2 Competition Structure

RoboBoat 2023 includes the (1) Autonomy Challenge that demonstrates autonomous performance and safety; and (2) Design Documentation that 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 details including competition schedule, design documentation, and autonomy challenge.

2.1 Competition Schedule

The competition 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 A: Competition Schedule for the detailed competition schedule.

Date	Event	Location
10 February	Design Documentation (prior to on-site competition)	Online
22 March	Team Check-in / Orientation Vehicle Assembly + Safety Inspections	Nathan Benderson Park
23-25 March	Practice Course Open Qualifying Round Design Presentations	
26-28 March	Semi-Finals / 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 must include:

- Current team name and contact information
- Name, picture and contact information for each contributing member
- Vehicle photos and/or videos
- Supporting media, which may include:
    - 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

The website submission is worth a total of 200 points. Below are the scoring metrics the judges are provided to evaluate teams' websites.

Team Information Scoring Metrics (Maximum Points: 50)

31-50 points	Team website includes all required team information, including the team's name and contact information, and a list of team members and sponsors. All mentions of the vehicle are relevant to the current competition year.
16-30 points	Team website provides a brief introduction on the team, team members and sponsors. There is limited supporting media on the vehicle.
1-15 points	Team website introduces the team. There is no mention of the vehicle.
0 points	The required team information is not included on the website.

Vehicle Design Documentation Scoring Metrics (Maximum Points: 75)

51-75 points	Vehicle development and testing process is thoroughly documented with instructional and informative supporting media and historical recording. This could include: photographs, diagrams, videos, procedures (text + images), design documentation (text + images + video), or blogs for historical records.
26-50 points	Vehicle development and testing process is briefly documented. Limited supporting media is accessible.
1-25 points	Few pictures or videos of the vehicle, but no instructional or informative documentation included.
0 points	No visuals or documentation of the vehicle is available on the website.

Website Quality Scoring Metrics (Maximum Points: 75)

51-75 points	Website places a heavy emphasis on human factors. Layout is visually appealing, easily maneuverable, and does an excellent job of drawing user's attention to relevant content.
26-50 points	Website considers some user experience. Layout does an acceptable job of drawing user's attention. Users can navigate the site to find most information.
1-25 points	Layout and/or design makes it difficult to find information. Website does not have a user friendly display.
0 points	Website is busy and difficult to read; no guidance on maneuvering site.

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 and scoring metrics for this report are available in Appendix B: Technical Design Report.

Team Introduction Video

Teams are required to create a video introducing their team members and highlighting their team personality. This video is meant to be a creative showcase of what makes each team unique, such as, the mission of the team or the team culture.

Format Requirements:

1. Video must be conducted in English or include subtitles in English.
2. Video must be no more than three (3) minutes in length.
3. Video may include graphics, vehicle performance, and/or simulation.
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.

The team introduction video submission is worth a total of 120 points. Below are the scoring metrics the judges are provided to evaluate teams' videos.

Video Quality Scoring Metrics (Maximum Points: 30)

21-30 points	Visuals immediately draws attention. Overall, the video is solid in frame (not shaky), correctly lighted, in precision focus, appropriately segmented, and visually clear in all respects. Transitions between segments are clear and smooth. The video is less than 3 minutes total runtime.
11-20 points	Good visual impression. Majority of video is clear, adequately lit, and places people and objects in recognizable scale and perspective. Video segments are generally of the appropriate length, transition well, and are related to each other. Use of video effects is good. Runtime is less than 3 minutes.
1-10 points	Frames and segments are shaky, distracting or poorly lit. Some segments are out of focus. Some heavy shadows are obscuring viewpoint. Visual effects are distracting rather than informative. Video exceeds 3 minutes in length.
0 points	No focus on visual quality. Video exceeds 3 minutes in length.

Information Organization Scoring Metrics (Maximum Points: 30)

21-30 points	Video is a complete introduction of the team makeup including team members, sub-teams, activities, mentors, and major sponsors. Organization of video information is logical and compelling.
11-20 points	Video information is scattered throughout video, leaving the viewer lacking complete understanding of project.
1-10 points	Video provides incomplete information regarding the team members, activities, or progress. The information presented is extraneous, confusing, or low quality.
0 points	No organizational strategy is apparent.

Clear and Effective Communication Scoring Metrics (Maximum Points: 30)

21-30 points	Effective and compelling use of video medium to communicate the introduction of the team. Easy for non-technical viewer to understand and support. [You're left wanting to learn more.]
11-20 points	Exhibits moderately compelling use of video medium to communicate the introduction of the team. Strong potential, moderately compelling, mostly understandable to non-technical viewer. [You're left strongly considering to learn more.]
1-10 points	Exhibits some ability to use video to attempt to introduce team and project overview. Difficult for viewer to understand and/or was not compelling. [You're left unenthused.]
0 points	Poorly used video medium to convey team introduction. Information was as not clearly understood and was not compelling. [You're left with little information.]

Creativity Scoring Metrics (Maximum Points: 30)

21-30 points	Team creativity and enthusiasm is clearly evident in the video. Appropriate use of humor is understated and well done. Video captures user's attention without diminishing or obscuring the information delivered. Effects of careful post-production editing are clear.
11-20 points	Some creativity has been used throughout video. The visual style and tone are consistent throughout video.
1-10 points	Little attempts made to include creative or imaginative ideas in video. Poor visual effects and enthusiasm for the project.
0 points	Little imagination or creativity is evident in production. Information is presented lacking enthusiasm.

2.2.2 Delivered During On-Site Competition

Design Presentation

Teams give a design presentation to a panel of subject matter expert judges. Each team must present what they plan to do on the course, and how that plan impacted their design and selections. This oral presentation must be conducted in English and may include visual aids. Teams must provide their own computer and adapters for an HDMI connecter to use the presentation display monitor. This presentation includes:

- Team Introduction Video (3 minutes)
- Presentation (15 minutes)
- Judge Question & Answer (5 minutes)
- Team & Judge Dialogue (7 minutes)

Teams receive an assigned 30-minute presentation time. After the presentation, teams should make themselves available for a team photo, and optional video interview. Please find the latest presentation schedule here: roboboat.org/2023.

The design presentation submission is worth a total of 200 points. Below are the scoring metrics with guidance provided to the judges during evaluations.

Scoring Metrics (Maximum Points: 200)

Competition Strategy 0-60 points	The team demonstrates a good understanding of rules, requirements, and autonomy challenges, and explains how the team developed their competition strategy. Team effectively describes metrics of success for the competition.
Design Rationale 0-60 points	The team's design approach clearly relates to their competition strategy. System, subsystem, and component testing as well as lessons learned are applied throughout the system development process.
Judge Questions & Dialogue 0-40 points	The team effectively uses evidence, experience, and research from project to inform responses to all questions and discussion.
Effective Communication & Professionalism 0-40 points	Presentation materials and team member knowledge effectively support the team's message. Team members are engaging, respectful, and professional while interacting in a positive manner with the judges and each other.

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

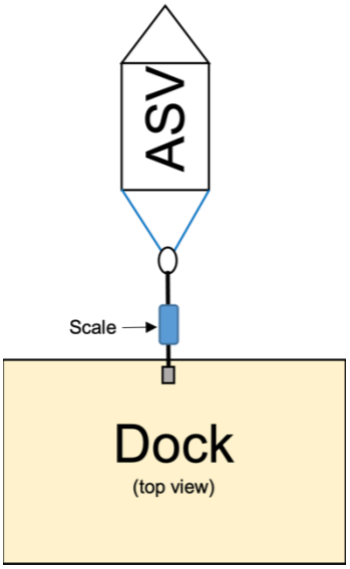


Figure 2: Thrust Measurement

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 2.5 Qualifying Round)

2.3.3 Semi-Finals / Finals Round

Teams who qualify for the Semi-Finals Round are assigned a time slot to conduct their Semi-Finals / Finals run. (Section 2.6 Semi-Finals / 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 / Finals Round.

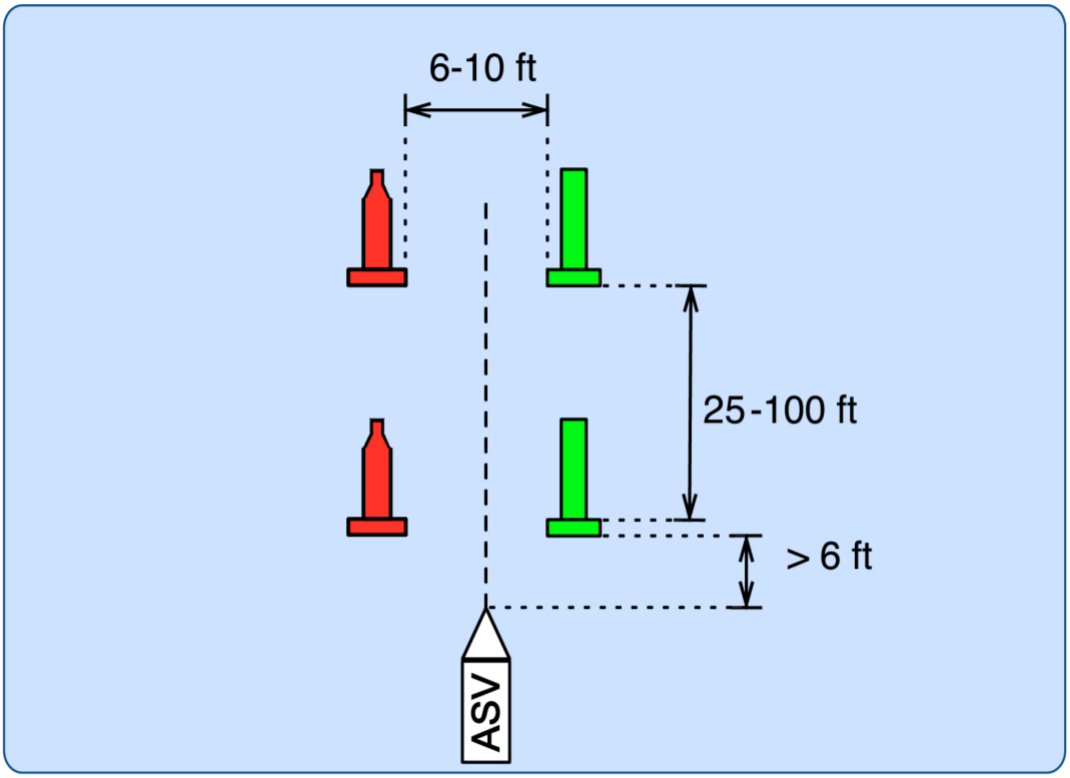


Figure 3: Navigation the Panama Canal Demonstration

Task Elements

Task elements for this task are detailed in the table 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.

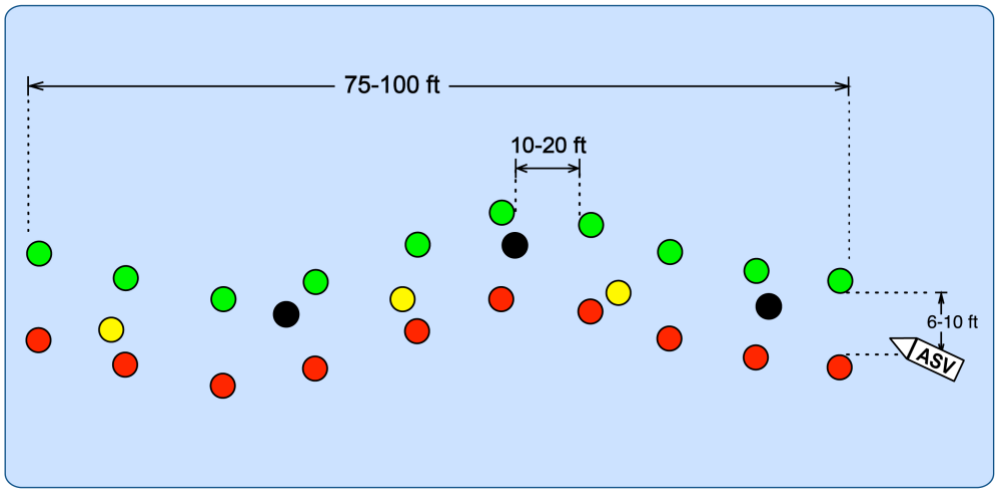


Figure 4: Example Magellan's Route / Count the Manatees & Jellyfish Task

Task Elements

Task elements for this task are detailed in the table below.

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.

Design files and specifications of the banners printed for each docking bay is available for download in the Data Sharing platform.

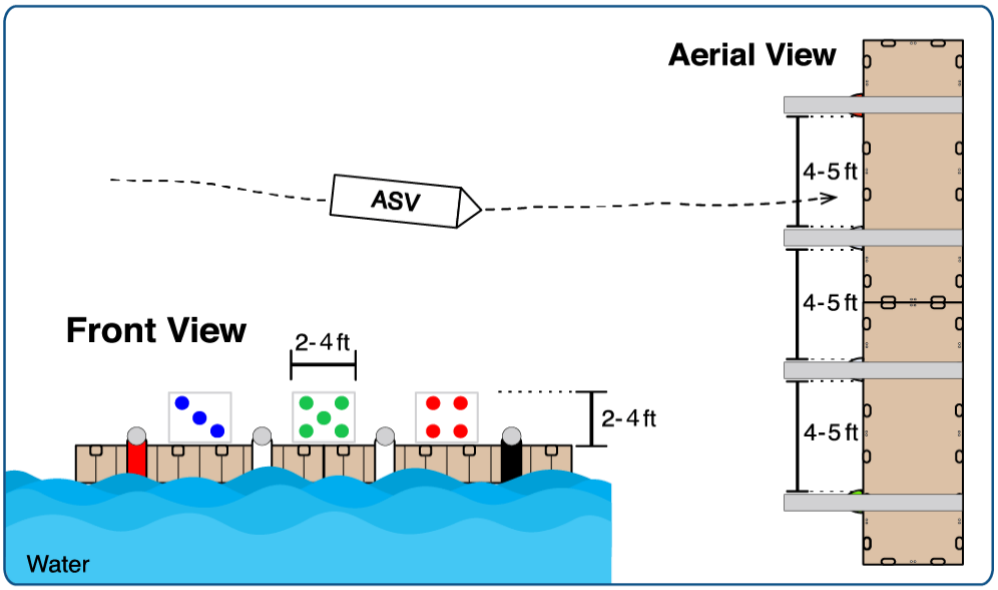


Figure 5: Example Beaching & Inspecting Turtle Nests Task

Task Elements

Task elements for this task are detailed in the table below.

Task Element	Description	Dimensions	Color
Floating Dock	2 connected 40" EZ Dock units	40" W x 10' L x 15" H	Beige
Color Display	Vinyl banner	24 in. x 24 in. *Design files and specifications can be found in Data Sharing*	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.

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).

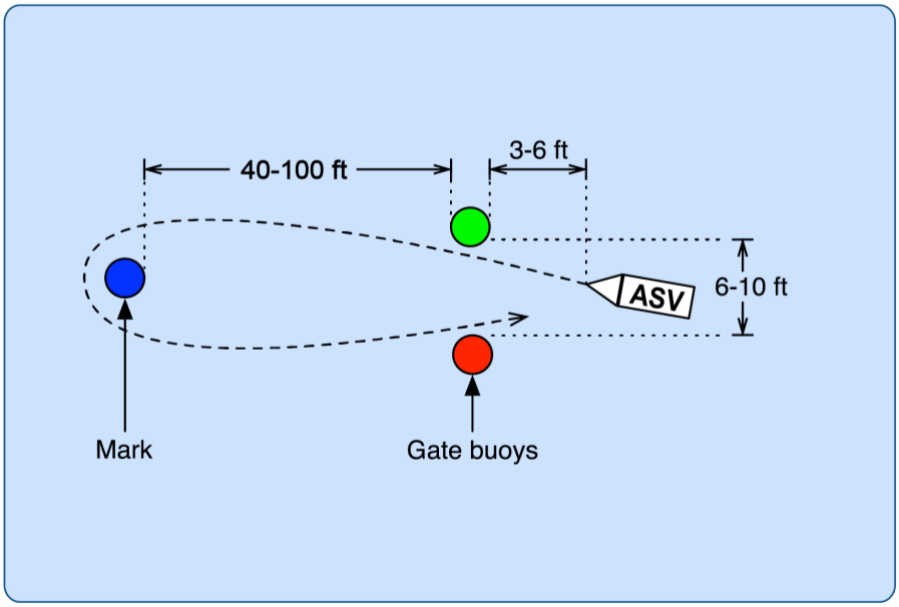


Figure 6: Example Northern Passage Challenge Task

Task Elements

Task elements for this task are detailed in the table below.

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.

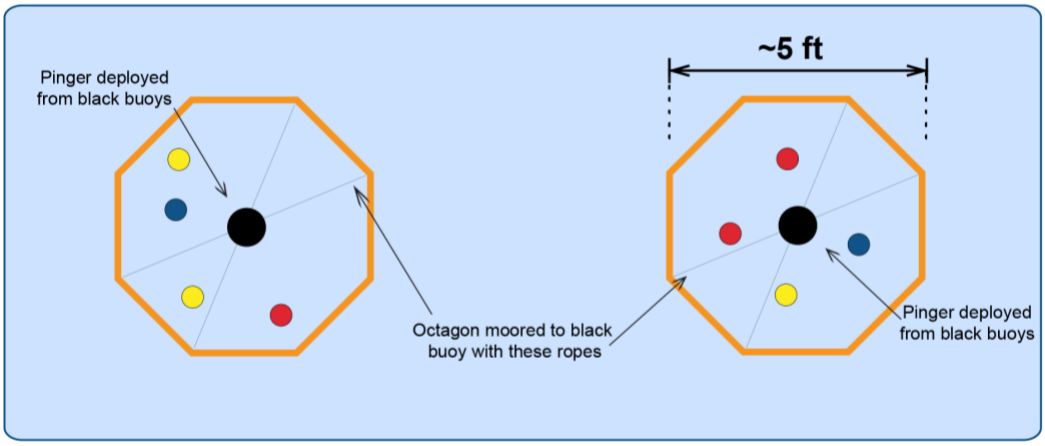


Figure 7: Example Ocean Cleanup Task

Task Elements

Task elements for this task are detailed in the table below.

Task Element	Description	Model No.	Color	Base Dimensions
Octagon	PVC Pipe covered in pool noodle foam		Orange	~ 5 feet
Racquetballs	FJBM Racquetball Squash Ball	Amazon	Red, Blue or Yellow	5.5 cm
Acoustic Pinger	Details provided in Appendix C			
Buoy	Black buoys to deploy pingers	Polyform A-0	Black	20.3 cm
This task is still under development.				
Ocean Cleanup buoys are supplied from Polyform US, shop.polyformus.com.				

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 Figure 8.

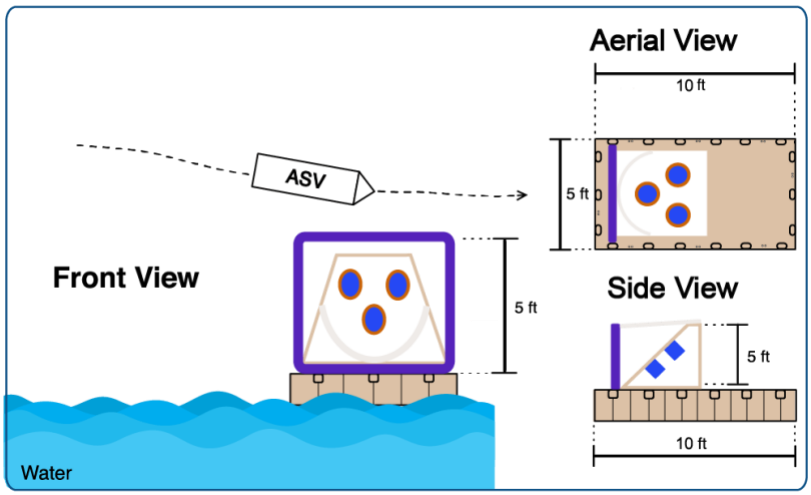


Figure 8: Example Feed the Fish Task

Task Elements

Task elements for this task are detailed in the table below.

Task Element	Description	Model No.	Color	Base Dimensions
Frame	PVC pipe covered in pool noodle foam	N/A	Purple	~5 x 5 ft
Targets/Holes	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
Floating Dock	60" EZ Dock	EZDocks	Beige	60" W x 10' L x 15" H

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.

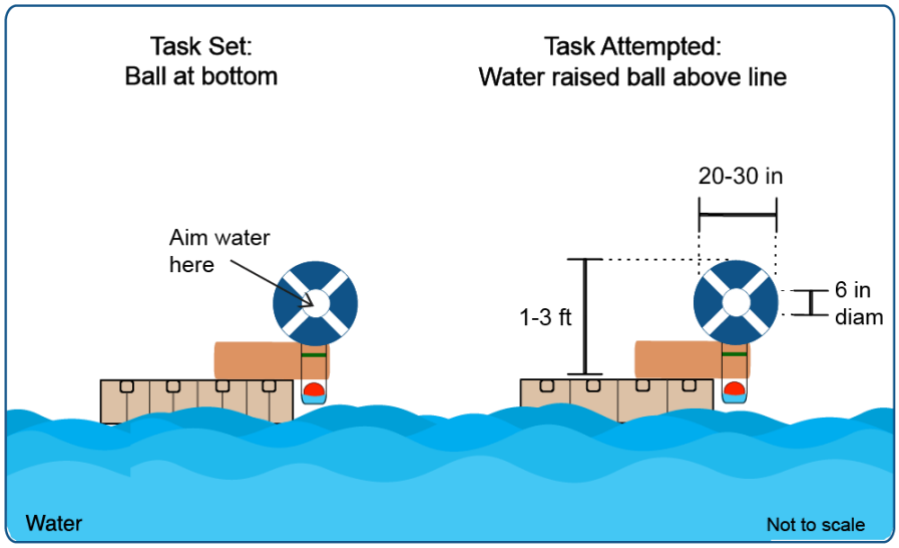


Figure 9: Example Ponce de Leon Task

Task Elements

Task elements for this task are detailed in the table below.

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
Floating Dock	40” “Baby” EZ Dock	EZDocks	Beige	40" W x 60” L x 15" H
Most task elements (excluding clear pipe and dock) 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 below for 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 complete individual tasks on these courses with the Technical Director. Teams may attempt completion on individual tasks in any order.

Qualifying Round and task completion requirements is at the judges' discretion on-site at the competition.

Below is a preliminary course configuration for the Qualifying Round.

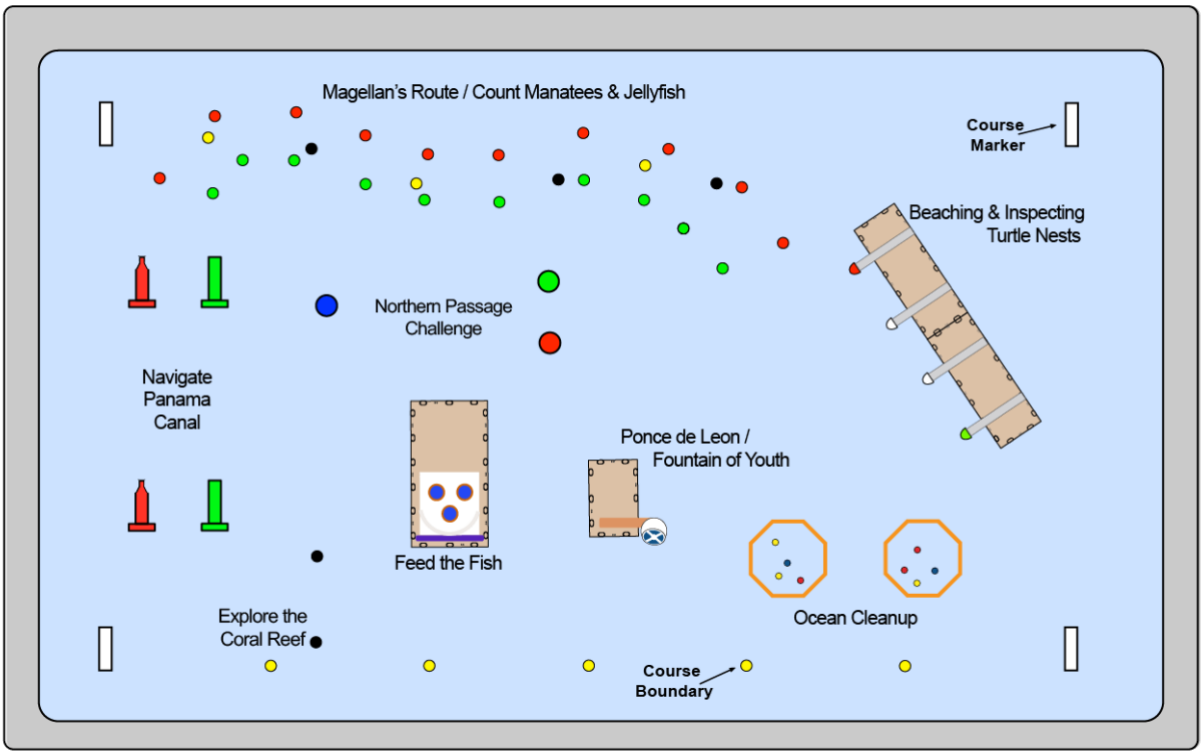


Figure 10: Preliminary Qualifying Course

2.6 Semi-Finals / Finals Round

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

During a Semi-Finals / 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.

The requirements for the Semi-Finals / Finals Round is at the judges' discretion on-site at the competition. The scoring breakdown can be found in Section 3.1.2.

SECTION 3: Scoring & Awards

3.1 Scoring

Scores are calculated by the judges; all decisions of the judges are final.

3.1.1 Design Documentation Scoring

Design documentation must be submitted in accordance with the requirements outlined in Section 2.2 and the deadlines listed in Section 5.3., to be eligible for full points. After the competition, the judges will issue overall standings in the design documentation portion of the competition.

The design documentation scoring breakdown is summarized in the table below.

Design Documentation	Potential Points
Website	200
Technical Design Report	180
Team Introduction Video	120
Design Presentation	200
Total Potential Points	**700**

3.1.2 Autonomy Challenge Scoring

The Autonomy Challenge occurs in three rounds: Qualifying Round, Semi-Finals, and Finals. For the Qualifying Round minimum performance criteria is specified and no points are awarded. Qualifying Round and task completion requirements is at the judges' discretion on-site at the competition.

For the Semi-Final and Final Rounds points are awarded, as outlined in this section. 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.

Task/Measurement	Performance Measures	Points	Potential Points
Weight measurement	Weight (W)	See Table 3	Vehicle Dependent
Thrust measurement	Generate pounds of thrust (in lbs) (Th)	100*(Th / W)	
Task 1 – Navigate the Panama Canal	ASV navigates through both gates		0,200
Task 2 – Magellan's Route	ASV maneuvers through gates (G), without striking buoys (S) (maximum buoy strikes: 3)	25*G – 25*S	0-250
	ASV maneuvers through gates, in one sequence	25*G	0-250
Task 3 – Beaching & Inspecting Turtle Nests	ASV enters any docking bay (points awarded once)		0,50
	ASV enters correct docking bay on first attempt		0,400
Task 4 – Northern Passage	ASV navigates through gate, without touching buoy		0,50
	ASV circles blue buoy, without touching buoy		0,100
	ASV exits through gate, without touching buoy		0,100
	Task completion time (T)	250-T	0-250
Task 5 – Ocean Cleanup *Teams are encouraged to collect as many balls as they can to use in Task 6.*	ASV makes contact with ball(s) (B),up to two	50*B	0,50,100
	ASV collects ball(s) (B) and drops, up to two	50*B	0,50,100
	ASV collects ball(s) (B) and stores, up to two	100*B	0,100,200
	ASV detects active pinger on first attempt		0,200
Task 6 – Feed the Fish	ASV launches ball		0,50
	ASV launches ball(s) (B) through frame	50*B	No limit
	ASV launches ball(s) (B) and successfully lands in any hole	100*B	
Task 7 – Ponce de Leon / Fountain of Youth	ASV shoots water near task platform		0,100
	ASV delivers water into target/bottle		0,150
	ASV delivers water into target/bottle, raising the ball to the green line		0,300
Task 8 – Explore the Coral Reef	Return to home after attempting tasks (#t)	100*#t	0-700
	Bonus for attempting all tasks and returning to home		0,100
	Seconds left on the clock (T)	1200-T	0-1200

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.

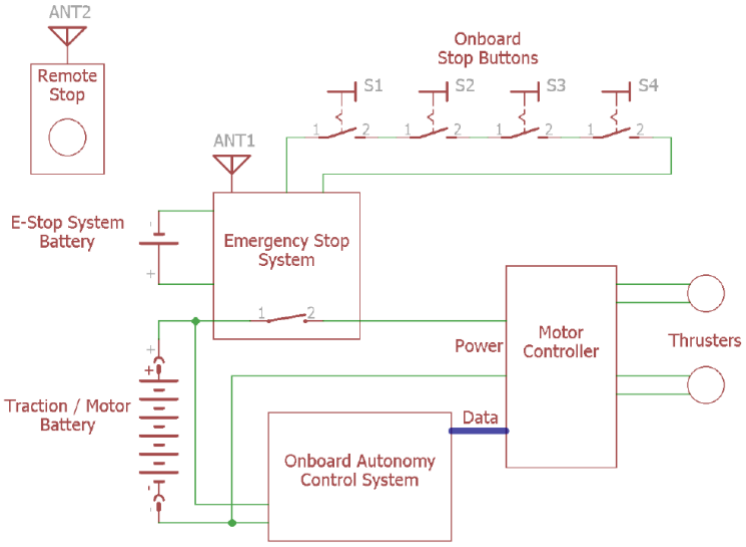


Figure 11: Example Emergency Stop Circuit

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". (Any extensions from the hull can exceed these dimensions during a run.)
- **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.

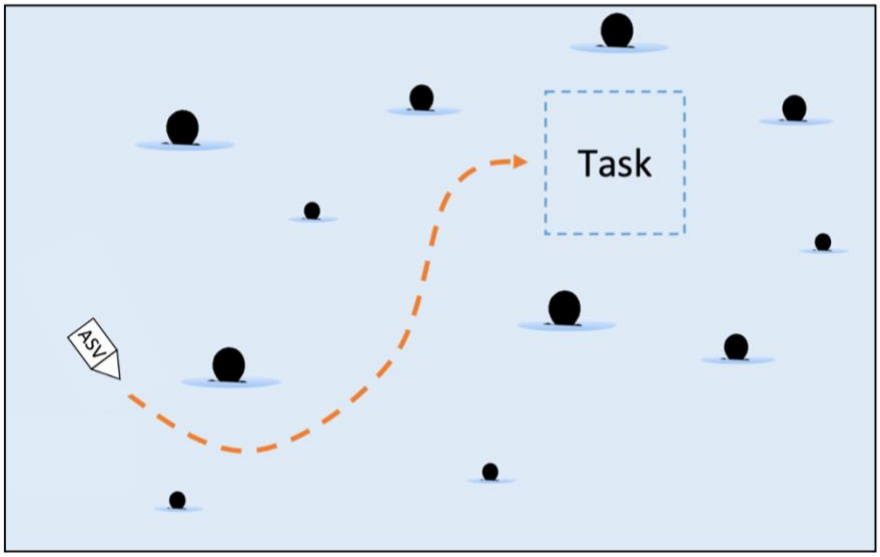


Figure 13: Obstacle Avoidance

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) Organization name
2) Team name
3) Shipping POC
4) Shipping POC mobile number
5) Shipping POC e-mail
6) Number of crates
7) Dimensions for each crate
8) Estimated shipping date
9) Shipping company
10) Type of shipment – Air, ground, ocean
11) Has initial pick-up or drop off been scheduled – include date of pick-up or drop off
12) Is this a dangerous good shipment? If so, has a dangerous goods shipment been arranged?
13) Have you scheduled your outbound shipment pick-up or drop off? Provide pick-up details (date/time) for any pick-up from the hotel.
14) Additional information for shipment, if needed.

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 has contracted with a local hotel to provide a special rate for RoboBoat teams. Teams are responsible for booking their own lodging for the event.

The selected hotel is the Hyatt Place Sarasota / Lakewood Ranch, located at 6021 Exchange Way, Bradenton, FL 34202.

Rooms include the following:

- Complimentary breakfast
- Complimentary Wi-Fi
- Complimentary self-parking
- Complimentary express check-out at 12:00 Noon
- Overnight pool use (Registered Teams ONLY) – March 22 - 27

Booking Method: Follow the e-booking link to easily make your hotel reservations online: https://sarasotalakewoodranch.place.hyatt.com.

1. Click above or copy and paste the link into your browser
2. Click "Book Now"
3. Enter Arrival & Departure Dates
4. Enter Group Code: **G-ROBN**
5. Click "Book Now" to complete the booking process

Cancellation Policy: Cancellations must be made by 3PM EST 48-hours prior to arrival to avoid a one-night room charge penalty.

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

Teams are responsible for coordinating the necessary shipping to ensure arrival of ASV and equipment. Any shipping questions can be directed to Cheri Koch at ckoch@robonation.org / 850.642.0536.

Shipping to the Competition

Shipments should be sent to the Hyatt Place Sarasota/Lakewood Ranch* using the shipping labels below. Shipments cannot arrive prior to March 20th. The Hyatt Place does not have a loading dock so all delivery trucks must have a lift gate.

**Only teams who are booked to stay at the Hyatt Place are approved to use this as a shipping location.*

Storage at the Hotel

Crates can be stored at the hotel from March 20 – 30. Any crates arriving before March 20 and/remaining beyond March 30 will be charged a storage fee.

Outbound Shipping – Begin working on your outbound shipping arrangements now! Batteries are exceptionally difficult to ship.

Shipments must be picked up from The Hyatt Place **BEFORE** the team departs or shipments must be dropped off at a local shipping facility. The Hyatt Place does not have a loading dock, so all trucks picking up shipments must include a truck with a lift-gate. If shipping from The Hyatt Place, pre-arrangements must be made with Cheri Koch or annotated in the shipping plan. All shipments must be pre-paid – **NO EXCEPTIONS.**

Local Shipping Outlets

Fed Ex Office Print and Ship Center
1901 S Tamiami Trail, Suite A
Sarasota, FL 34239

DHL Service Point – PostNet
11161 SR 70 E, Suite 110
Lakewood Ranch, FL 34202
(941) 751-2070

The UPS Store
8374 Market Street
Lakewood Ranch, FL 34202
(941) 907-2227

Hazardous Shipping: LIPO Batteries

FedEx Dangerous Goods
1-800-463-3339 x 81
Email: dghotline@fedex.com

FedEx Dangerous Goods Drop-off Location
(12 miles from Nathan Benderson Park)
Fed Ex Ship Center
4605 18th Street E
Bradenton, FL 34203

A pick-up for a dangerous goods shipment must be coordinated through FedEx prior to dropping off. Team must create a label and arrange a dangerous shipment prior to dropping off. This must be done Monday – Friday 9:00 am – 5:00 pm. It will be very difficult if not impossible to schedule this pick-up on the weekend, so make arrangements early!!!

Inbound Shipping Label

FROM: School Name
Address
City, State, Zip
Country

roboboat

Hyatt Place Sarasota / Lakewood Ranch
Attn: RoboBoat / School Name
6021 Exchange Way
Lakewood Ranch, FL, USA 34202

On-site Team POC Name: Phone:

Outbound Shipping Label

FROM:
School Name / Team Name
6021 Exchange Way
Lakewood Ranch, FL, USA 34202

School Name
c/o School POC
Address
City, State, Zip
Country

Team POC Name: Phone:

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.

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

Figure 15: Example Vehicle Carts

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. Now hosted in Discord!

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

LOCATIONS	**Nathan Benderson Park (NBP)**	5851 Nathan Benderson Circle Sarasota, FL 34235
	Hotel – **Hyatt Place Sarasota / Lakewood Ranch**	6021 Exchange Way Bradenton, FL 34202
	Bradenton Convention Center	1 Haben Boulevard Palmetto, FL 34221

DATE	TIME	EVENT	LOCATION
Tuesday, March 21	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	Hyatt Place
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	
	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
	8:00 pm – 9:00 pm	RoboNation Yoga	Hyatt Place – Meeting Room
	10:00 pm – 2:00 am	Overnight Pool Testing	Hyatt Place
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	Hyatt Place

DATE	TIME	EVENT	LOCATION
Saturday, March 25	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
	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
	8:00 pm – 9:00 pm	RoboNation Yoga	Hyatt Place – Meeting Room
	10:00 pm – 2:00 am	Overnight Pool Testing	Hyatt Place
Sunday, March 26	7:30 am	Facility Open to Teams	NBP
	8:00 am – 12:00 pm	Autonomy Challenge Semi-Finals / 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 / 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
Monday, March 27	7:30 am	Facility Open to Teams	NBP
	8:00 am – 12:00 pm	Autonomy Challenge Semi-Finals / Finals	NBP – Competition Courses
	12:00 pm – 1:00 pm	Break / Lunch	
	1:00 pm – 5:30 pm	Autonomy Challenge Semi-Finals / 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	Autonomy Challenge Finals	NBP – Competition Courses
	12:00 pm – 1:00 pm	Break / Lunch	
	1:00 pm – 5:00 pm	Autonomy Challenge Finals	NBP – Competition Courses
	7:30 pm – 10:00 pm	Awards	Bradenton Convention Center

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, strategies for their approach to the competition, and rationale for design choices. Teams must follow the TDR instructions provided below.

The deadlines for the TDR and other Design Documentation submissions can be found in Section 5.3. To be eligible for full points, teams must submit their TDR by the deadline.

The outline of each section of the paper includes a scoring metrics table with guidance on scoring considerations that are provided to the judges during evaluations.

B.2. Format

The format of the written paper shall adhere to the following guidelines:

- **6 page limit** (excluding References and Appendices)
- 8.5 x 11 in. page size
- Margins ≥ 0.8 in.
- Font: Times New Roman 12pt
- Header on every page including team name and page number
- Submitted in .pdf format

RoboNation Tip: It is recommended that papers be peer-reviewed prior to submission. For example, teams can utilize resources at their institution, fellow students, or professional editing services.

Optional Formatting: Teams may choose to follow the two-column format, editorial style for IEEE Conference Proceedings: www.ieee.org/conferences/publishing/templates.html.

Formatting Scoring Metrics (Maximum Points: 10)

9-10 points	Paper follows page limit, and all formatting guidelines are followed. The document is professionally organized. All required sections are included and easy to identify. All grammar, punctuation, and spelling are correct. The style follows that expected of a scientific paper submitted for publication.
7-8 points	Paper follows page limit and all formatting guidelines. The document clearly presents the required sections. The document may require some further editing to be considered publication ready.
5-6 points	Most of the formatting guidelines are followed and the purpose of the document can be determined. Some required material may be inadequately covered.
3-4 points	Enough of the formatting guidelines are followed to allow the paper to make sense. Typographical or other errors are present. There is an imbalance of text and graphics. Critical information is missing. Significant editing would be required to raise the professional level of the paper.

1-2 points	The paper demonstrates a limited attention to the formatting guidelines. Errors are present that make it difficult to discern the intent of the paper. Sections are missing or incomplete.
0 points	Formatting guidelines are not followed and the layout is unorganized.

B.3. Paper Contents

The TDR consists of the following mandatory sections: abstract, technical content, acknowledgements, references, appendix A, and appendix B.

B.3.1 Abstract

The abstract is a short summary of the main points in the paper. The abstract should summarize the linkage between overall competition strategy and system architecture, design, and engineering decisions.

Abstract Scoring Metrics (Maximum Points: 20)

17-20 points	Abstract is engaging, lists the scope of the work, and provides a thorough summary of the paper.
13-16 points	Abstract provides an explanation on the scope of the work and provides an adequate summary of the paper.
9-12 points	Abstract provides an explanation on the scope of the work and provides a limited summary of the paper.
5-8 points	Abstract provides a basic summary of the paper.
1-4 points	Abstract section is included but does not serve the intent of an abstract. The abstract is treated as an introduction and provides no summary of the paper.
0 points	No abstract is included.

B.3.2 Acknowledgements

Participating in the competition, as in all research projects, involves leveraging 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 efforts is important.

Acknowledgements Scoring Metrics (Maximum Points: 10)

9-10 points	Acknowledgements detail supporting personnel and their contributions as well as resources. Sponsors and their contributions are acknowledged.
7-8 points	Acknowledgements mention supporting personnel and their contributions as well as resources. Sponsors are mentioned.
5-6 points	Acknowledgements mention minimal supporting personnel and sponsors.
3-4 points	Acknowledgements indicate sponsors only.
1-2 points	Acknowledgements provide a general thank you but do not specify particular contributions.
0 points	No acknowledgements are included.

B.3.3 References

As with any technical publication, original ideas and content not generated by the paper's authors should be properly cited. The references should follow the IEEE Conference Proceedings citation style.

References Scoring Metrics (Maximum Points: 10)

9-10 points	All sources are thoroughly documented. The IEEE citation style is correctly utilized.
7-8 points	Some sources are noted and documented. The IEEE citation style is utilized.
5-6 points	Limited sources are documented and the IEEE citation style is utilized.
3-4 points	Minimal sources are documented and/or citations are not correctly listed.
1-2 points	Limited sources are documented but there is no adherence to the IEEE citation style.
0 points	No sources or citations are documented.

B.3.4 Technical Content

The technical content of the paper outlines the goals determined for the competition, and strategy for the system design and the testing approach. This portion of the paper should not include detailed descriptions of components as it can distract from understanding the team's underlying strategic thinking, design and engineering decisions, or novel contributions.

B.3.4.1 Competition Goals

The paper must include details on the team's goals for the competition, including the plans for approaching the course and how the vehicle design relates to this approach. The course consists of multiple tasks with associated points for accomplished behaviors. The only required task is navigating through the start gates. Teams may choose to attempt the other tasks and complete the tasks in any order. The more tasks a vehicle is designed and engineered to accomplish, the more complex the overall vehicle system will be.

Consider the trade-offs between system complexity and reliability. For example, teams have a limited number of working hours to prepare for the competition; this time could be spent adding additional capabilities or testing and improving the reliability of an existing capability. As system complexity grows, changes in subsystems can propagate in unmanageable ways when time is limited. Based on history and the system engineering talents of the team, include a description the team's strategic vision.

Competition Goals Scoring Metrics (Maximum Points: 50)

41-50 points	Detailed description of the team's strategic vision and how the vehicle design compliments their goals. Detailed discussion on trade-off studies between system complexity and reliability during design development process.
31-40 points	The team's goals are clearly evident but not discussed in detail. Trade-off studies evident but lacking details.
21-30 points	Brief mention of team's strategic goals and/or trade-off studies.
11-20 points	Document hints at a goal for competition and/or trade-off studies.
1-10 points	Discussion of the team's vision is incoherent; rationale for competition goals is not discussed.
0 points	No mention of competition goals.

B.3.4.2 Design Strategy

Given the strategy for success at the competition and the approach to managing complexity, the paper must include a description of the system design to meet the goals they established for the competition. Justification for design choices should be clear. Discuss how components and sub-systems were selected and integrated on the vehicle. For teams that are working with a previously designed vehicle, discuss how the design meets the current competition strategy and any modifications needed at the component, subsystem, and/or integrated system levels. Describe the experience in making both architectural/design decisions and system engineering decisions.

This section should **not** include detailed component descriptions and/or specifications not of original design. The latter should be described in Appendix B.

Design Strategy Scoring Metrics (Maximum Points: 40)

31-40 points	Provides in-depth explanations on design strategy and clearly identifies creative aspects of system. Creative design methodology is justified with required calculation steps and visual aids. Content clearly exhibits a Systems Engineering approach.
21-30 points	Provides explanations on design strategy and identifies creative aspects of system. Creative design methodology is justified with calculation steps and visual aids. Content hints at a Systems Engineering approach.
11-20 points	Provides some information on design strategy and creative aspects of system. Creative design methodology is supported with a few calculations. Content could be justified as a Systems Engineering approach.
1-10 points	Provides limited information on the creative aspects of system. Creative design methodology is hypothesized. No evidence to support application of Systems Engineering principles.
0 points	Creative aspects of design are not described.

B.3.4.3 Testing Strategy

Testing and experimentation is a crucial step to preparing and innovating a system design that strongly correlates with a competitive performance in the arena. The paper must include the approach to a testing strategy, including various test plans, both in-water and in simulation. There is a strong correlation between in-water testing time and competitive performance in the arena.

Consider the time needed to thoroughly test to meet the determined goals. Additionally, consider the demands of design and engineering with those of testing and experimentation.

Testing Strategy Scoring Metrics (Maximum Points: 40)

31-40 points	Testing approach is presented in great detail, to include test strategy and plans. Component testing, sensor and control systems testing (bench tests and in-water) done in accordance with a test plan.
21-30 points	Testing approach is presented with sufficient detail, to include test strategy and plans. Documentation shows limited components, sensors and control system testing (bench tests and in-water).
11-20 points	Testing approach is presented but not in detail. No mention of components or sensors testing.
1-10 points	Testing is done to a certain degree. No components and sensors are tested independently. There are no test plans.
0 points	No mention of testing or connection with the system design.

B.3.5 Appendices

B.3.5.1 Appendix A: Component List

This appendix documents a list of all components utilized in the system design. In cases where components were developed by the team versus purchased off the shelf, this information should be included. Additionally, if commercial off the shelf equipment were significantly modified this should be noted. Under the column marked "Specs" a web link to the manufacturer's specifications may be provided. This standardized table will help document and track trends in component (hardware and software) usage and team metrics.

Component	Vendor	Model/Type	Specs	Custom/Purchased	Cost	Year of Purchase
ASV Hull Form/Platform						
Waterproof Connectors						
Propulsion						
Power System						
Motor Controls						
CPU						
Teleoperation						
Compass						
Intertial Measurement Unit (IMU)						
Doppler Velocity Logger (DVL)						
Camera(s)						
Hydrophones						
Algorithms						
Vision						
Localization and Mapping						
Autonomy						
Open-Source Software						

B.3.5.2 Appendix B: Test Plan & Results (Optional)

Based off the testing approach outlined in the paper, this appendix showcases the test plan that was developed and the detailed results that came out of testing. Teams should present their plans for testing, including algorithm testing in a virtual environment, component testing in a laboratory setting, sub-system testing in a relevant environment, and full system testing in a pseudo-competition environment. Test set up should be included and results presented. Any design modifications or changes in competition strategy as a result of testing should be discussed.

While this appendix is not required, excellence seen in this section can be eligible for a special judges' award.

The appendix may include detailed documentation covering the following areas:

- *Scope:* Objectives and test cases (this may also specify what was not included in tests)
- *Schedule:* Start/end dates and deadlines
- *Resource and Tools:* Resources and tools needed to conduct tests and assess results
- *Environment:* Description of the test environment, configurations, and availability
- *Risk Management:* Outline potential risks that could occur throughout testing
- *Results:* Detailed outcomes of test cases

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.