4th International RoboBoat Competition

Sponsored by the AUVSI Foundation and the US Office of Naval Research

"The Four Elements"

8-12 June 2011

Founders Inn and Spa, Virginia Beach, VA

The goal of this competition is to provide an opportunity for students to experience the challenges of and develop skills in system engineering by accomplishing realistic missions with autonomous vehicles in the maritime environment and to foster ties between young engineers and the organizations developing Autonomous Surface Vehicle (ASV) technologies.

SCHEDULE*:

Event		Due Date
Intent to Compete Form and Payment Due	Thursday	31 March 2011
Journal Paper, Resume and Website Due	Monday	23 May 2011
Team Check-in & Orientation	Wednesday	8 June 2011 1700 hrs
Safety Inspections and In-water Practice Time	Thursday	9 June 2011
Static Judging and In-water Practice Time	Friday	10 June 2011
Qualifying Runs	Saturday	11 June 2011
Qualifying Runs (cont'd)	Sunday	12 June 2001
Finals	Sunday	12 June 2011
Awards Party (evening)	Sunday	12 June 2011

*subject to change

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1 GENERAL INFORMATION

1.1 Background:

The goal of this competition is to provide an opportunity for students to experience the challenges of and develop skills in system engineering by accomplishing realistic missions with autonomous vehicles in the maritime environment and to foster ties between young engineers and the organizations developing Autonomous Surface Vehicle (ASV) technologies. The competition is comprised of two parts: design and performance. The design part is based on an innovative system concept, rigorous engineering, and the well-crafted construction of a functional vehicle to perform the mission. The performance part is an in-situ demonstration of the vehicle's capabilities to execute specified mission tasks.

1.2 Teams:

To field a competitive vehicle, a range of cross-disciplinary skills will be required. This synergy is best accomplished by a team of people. Teams may be a combination of students, faculty, industrial partners, or government partners. Students may be high school, undergraduate and/or graduate students. Full-time students must compose at least 75 percent of each team. Full time students must be enrolled at their schools in full time status during winter and spring quarters/semesters immediately prior to the competition year. The student members of a team must make significant contributions to the development of the vehicle. One student member of the team must be designated as the "team leader". The team leader, and only the team leader, will speak for the team during the competition runs. Only the student component of each team is eligible for the cash awards.

1.3 Location and Facilities:

The competition will be held at the Founder's Inn and Spa's pond from 8-12 June 2011. Team check-in and registration will be at the hotel Wednesday 8 June 2011 beginning at 1700 hrs.

The Founder's Inn is a hotel in Virginia Beach, VA that has a large on-site pond. The pond has an average depth between 5-12 feet and features a water fountain (cannot be removed). Consider the water fountain as a natural obstacle and avoid it at all costs. See the competition pond on Google Maps.

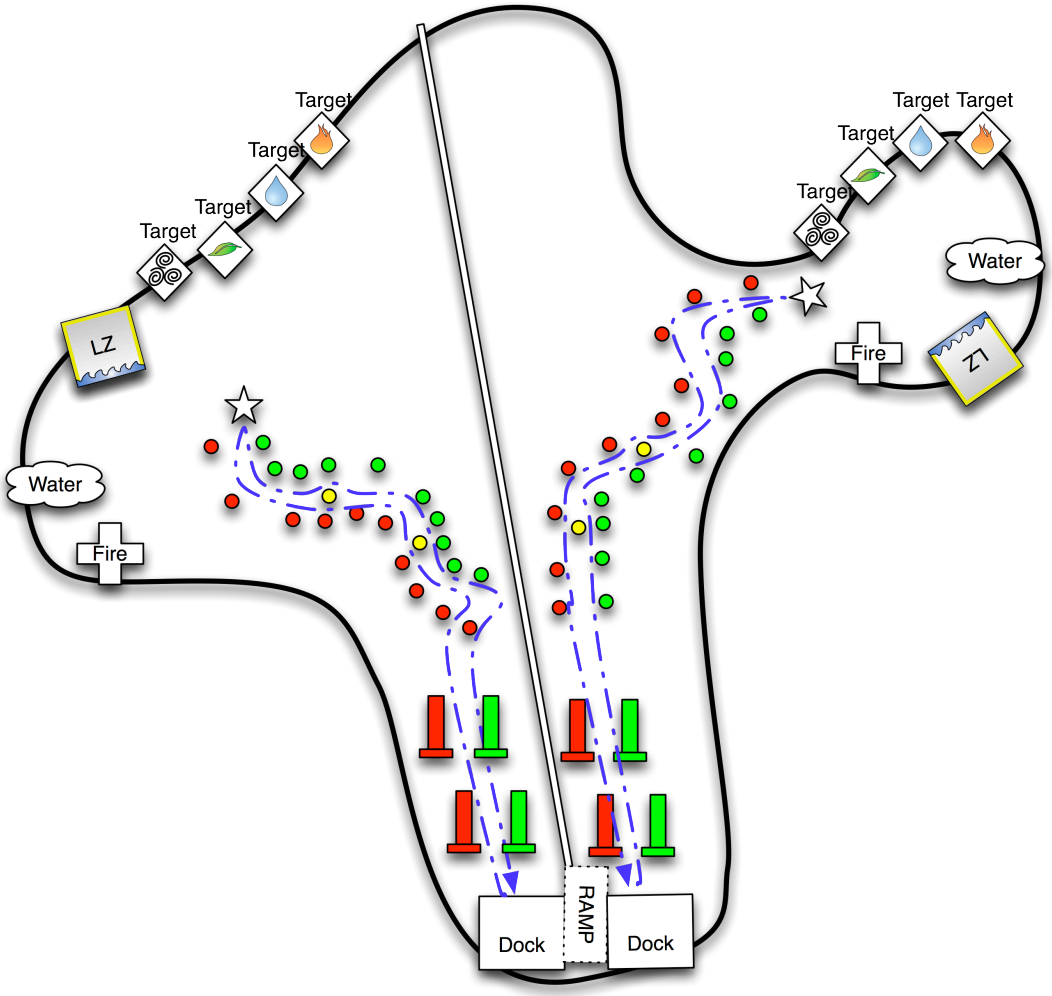
A tent (10 by 10 foot or equivalent space) will be provided at the location for each team to have a covered work area. Electricity and internet access will be provided in each tent. It is expected that students be at these areas during the day and have posters, promotional material, and resumes available since the site will be open to the public.

1.4 Schedule:

Teams will register on Wednesday evening 1700 hrs 8 June 2011 for the mandatory orientation meeting. Practice will occur Thursday all day. Static judging (and more practice time) will take place on Friday. Qualifying runs will occur on Saturday and Sunday morning. Qualifying teams will compete in the Finals on Sunday afternoon. The Awards Party will take place Sunday evening, 12 June. The event will be held rain or shine. Times may vary due to schedule delays due to unsafe/bad weather.

2 MISSION

The 2011 mission consists of two (2) sets of tasks. The first set includes four mandatory tasks that have to be successfully completed in sequential order in order to proceed to the second set of tasks. The first set of tasks includes demonstrating your strength (via a propulsion test), demonstrate ability to navigate by passing the starting gate, demonstrate speed by reaching as quickly as possible and pass through the speed gate and go through the navigation channel. Then, if you successfully completed the mandatory tasks, you may proceed to the challenge stations. All challenge stations are optional and can be attempted in any order. You can retry any challenge station as many times as you want (or until your time runs out).
The challenge stations are themed after the four elements. The AIR station is a series of four (4) shore-based targets (each with the logo of one of the four elements). To complete the AIR station, you must identify the "hot" target and report it back using the protocol detailed later in this document. The WATER station is a simulated waterfall apparatus that has to be turned off by pressing a button. The EARTH station is an amphibious landing task where you must retrieve a treasure from a "ground" area. Finally, the FIRE station is a water-gun accuracy challenge where you must shoot water in a specific area to extinguish the fire on the target.
If you have attempted (whether you succeeded or not) all four challenge stations, you may earn points for completing the bonus task of coming back to the dock in autonomous mode.

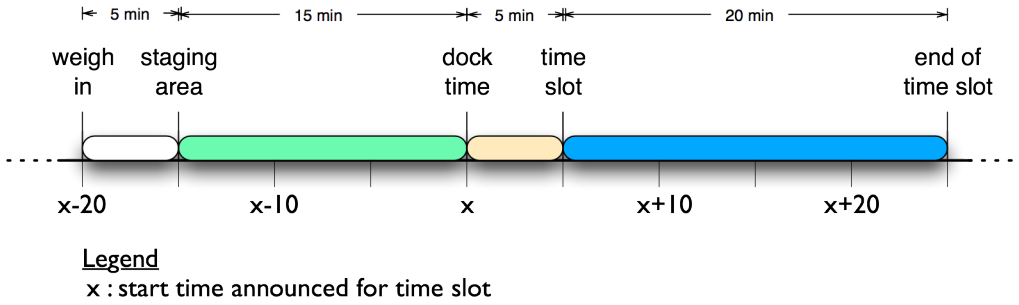


Map not to scale

2.1 Mission attempt

Each team will be allocated a contiguous block of time for each attempt at the mission. The following terms are used to define a "performance":

- '*time slot*': The contiguous block of time allocated to a team to attempt the mission.
- '*dock time*': Period of time prior to the *time slot* where the vehicle is in the water at the dock.
- '*start time*': The time at which the *dock time* of a team is scheduled to start
- '*run*': An run of the vehicle (in autonomous mode) trying to accomplish the mission.



The team and their vehicle are expected to be present in the staging area next to launching ramp fifteen (15) minutes prior to the *start time* in a mission ready state. Teams are expected to have completed a dry vehicle weight measurement prior to moving their vehicle in the staging area.

The *time slot* is preceded with five (5) minutes of dock preparation time. This *dock time* can be used for final preparation with the vehicle in the water and for strength/propulsion measurement. The *dock time* ends when the vehicle leaves the dock on its first autonomous *run* or when the five (5) minutes are elapsed.

For 2011, each *time slot* will be a contiguous block of twenty (20) minutes in which the team is allowed to make as many *runs* as they choose to. Every time a new *run* is attempted during *time slot*, all points accrued in the previous run(s) are voided. All vehicles must be remote-controllable to be brought back to the dock on their own. If a vehicle cannot be remote-controlled (due to failure, etc) the clock will keep running while the AUVSI staff will tow back the vehicle. Only in cases of failure of the mission obstacle(s) or on the explicit request of a judge will the *time slot* clock be stopped.

Unlike qualification and final *time slots*, during test *time slots*, teams are given a fixed block of time including time to have the vehicle in & out of the water and dock time in order to maximize number of *time slots* on test days. More details about test *time slots* will be provided at the orientation meeting.

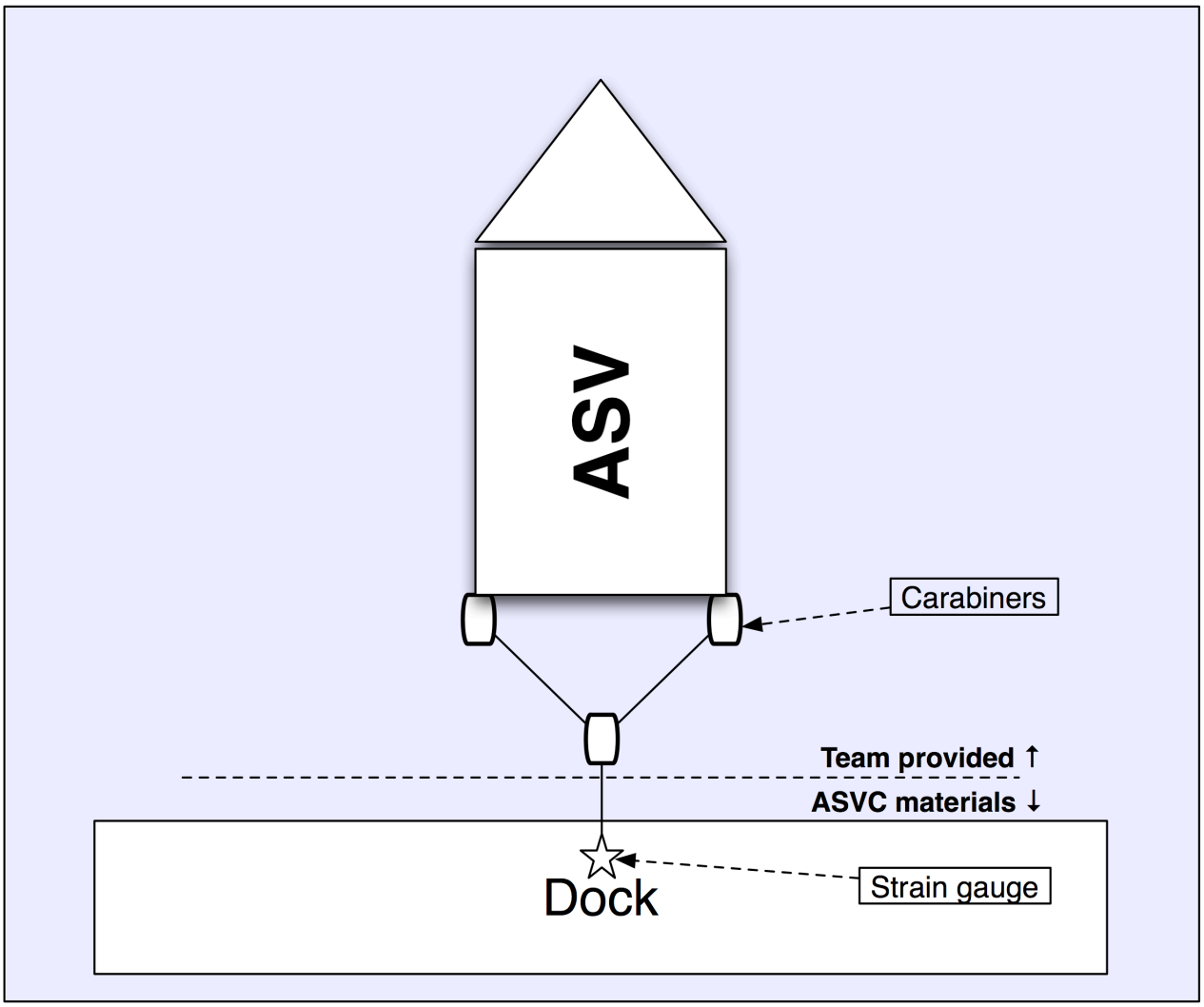
2.2 Two competition circuits

As illustrated in the mission diagram above, we will offer two (2) complete and mostly similar competition 'circuits'. Each side (based on the ~East-West division line) of the pond will contain a full competition circuit. If obstacles from each circuit less than 10 feet apart from each other, we will add a series a white Polyform A-2 buoys between the two circuits to create a dividing line. Any vehicle that ventures off its circuits or start interacting with obstacles from the other circuit will be killed (using the remote or physical kill switch). Test time slots can be scheduled on either side at the team discretion (and on availability). Qualification time slots will be distributed evenly on the circuits (either all teams have both time slots on the same circuit (while the other one is used for more test time slots) or all teams have one time slot on each circuit). Finals will be held in a single circuit for all teams (the other circuit will be unavailable during finals).

3 MISSION TASKS

3.1 Demonstrate your strength

The first task is to demonstrate the thrust generation capability of your ASV. To get the measurement, you will be required to attach a thrust measurement system to your vehicle. It is each team responsibility to provide their own harness for thrust measurement (the same harness can be left on the vehicle after the test to be used a emergency towing point). Your vehicle will then generate as much thrust as possible in 10 seconds. The value that will be used for scoring is the maximum sustained measurement (transient values when the harness is not fully stretched will be ignored). This task can be accomplished in a manned manner (you can use a remote, laptop or buttons on the ASV to start/stop this task). The figure below illustrates the recommended harness to use between the strain gauge and your ASV. Thrust test points can be carried over during a phase of the competition (test, qualifications or final) if no noticeable changes to the propulsion or battery system occurred. This task that can be completed as part of the '*dock time*'.



3.2 Demonstrate ability to navigate

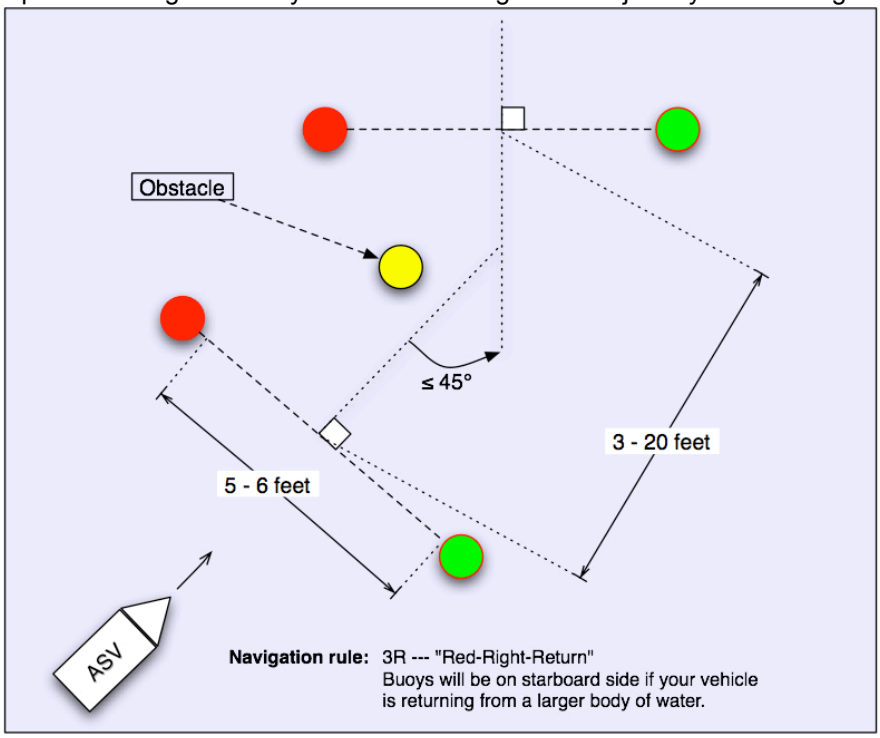
When leaving the dock in autonomous mode, your vehicle has to go directly through the starting gate (irrespective of whether the vehicle trajectory is in a straight line or not). You run will automatically end if your vehicle passes the starting gate line without going through the starting gate. The starting gate is in a fixed position and facing the dock approximately15-30 feet (7.5-9 m) away from the dock. The starting gate is a set of two (2) navigation buoys (Taylor Sur-Mark Marker buoys #950400 & #950410 – 49" in tall, 10-18" in diameter) approximately 6 feet apart from each other. In order to receive points for this task and to go on to the next task, your vehicle must go through the starting gate.

3.3 Demonstrate your speed

Once your vehicle passes through the starting speed gate, your vehicle must also go through the speed gate. Similar to the starting gate, the speed gate is a set of two navigation buoys (Taylor Sur-Mark Marker buoys #950400 & #950410 – 49" in tall, 10-18" in diameter) approximately 6 feet apart from each other. The speed gate will be 50-100 feet (15-30 m) away from the starting gate. Your vehicle will be timed on how long it takes to transit between the starting gate and the speed gate. In order to receive points for this task and to go on to the next task, your vehicle must go through the speed gate.

3.4 Navigate out of the harbor

The entrance of the navigation channel will be 10-30 feet away from of the speed gate. The navigation channel is delimited by eight (8) to ten (10) sets of red and green navigation buoys. The buoys used will be Polyform A-1 Red & Green buoys. The buoys will be placed in such a manner that you can use the 3R navigational mantra (red-right-return). Follow the navigation channel while avoiding the yellow buoys marking obstacles. The buoys used for the obstacle will be TaylorMade #165 Yellow Water Ski buoys. At the end of the channel, you will find a blue buoy 15" in diameter. The buoy used to mark the end of the channel will be a Polyform A-2 Blue buoy. From this buoy navigate following the provided magnetic bearing in degrees up (may change from day to day) to shore where you will find the challenge station for each element. In order to receive points for this task and to go on to the challenge station, your vehicle must go through at least 3 pairs of navigation buoys and follow the general trajectory of the navigation channel.



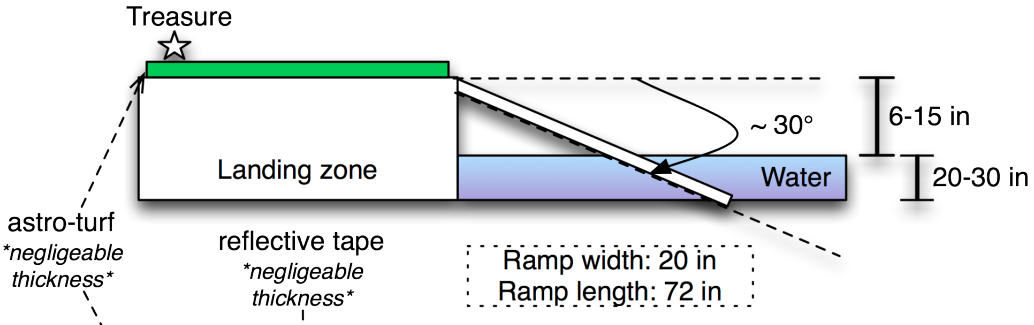
3.5 The challenge stations

All challenge stations are optional and can be attempted (or not) in any order. You will find four challenge stations in an area up to 100'-200' of shoreline (on each side) of the point where your vehicle lands after following the magnetic bearing.

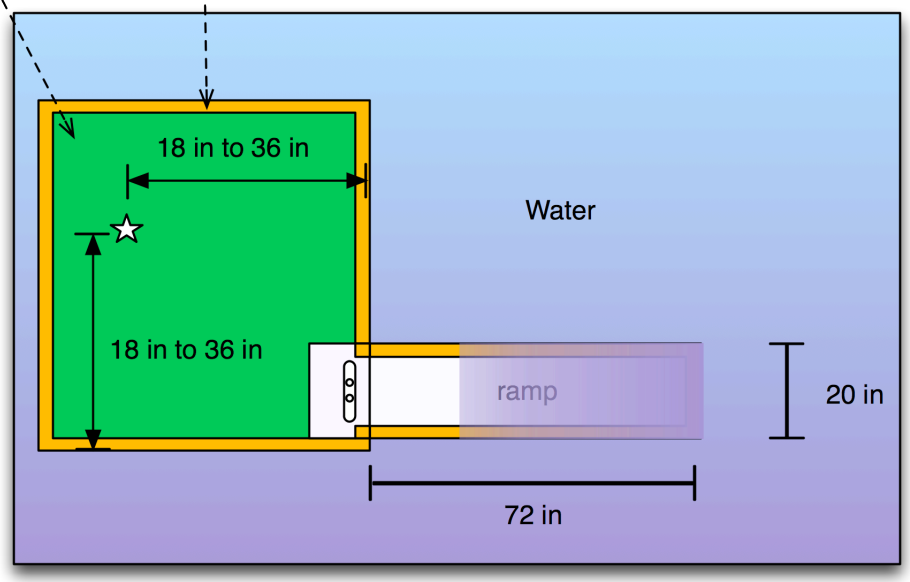
3.5.1 (Earth) Amphibious landing

Your vehicle may locate a landing zone and make contact with it. From there your vehicle, or subsystems deployed by your vehicle, will have to go up the landing zone incline (up to 30°?) and retrieve the Earth treasure. The treasure is a Head Penn Pink Championship XD Tennis Ball. The tennis ball will be held in place by a minimal amount of Velcro (hook - <1 cm^2). The landing zone will covered in green Astroturf and have dimensions of at least 3ft x 4ft (W x L). The edges of the landing zone will be covered in Neon Orange Duck Brand 868090 1.88-Inch wide reflective tape. The ramp on the landing zone will be a DoggyDock Original ramp. Black anti-slip traction tape may be added to the ramp to increase traction.
For this task, you may have your whole vehicle go out of water onto to the landing zone or deploy subsystems from your vehicle to retrieve the Earth treasure. Whether you deploy subsystems or have your full vehicle go on the landing zone, if you leave material on the landing zone after your vehicle departs from this station, you will forfeit all the points accrued for the amphibious landing task. Judges reserve the right to end a run if the vehicle leaves the landing zone without recuperating non-passive material left behind (ex: if the ASV leaves any device that may help navigation, may be used for telecommunications, etc)

Side View

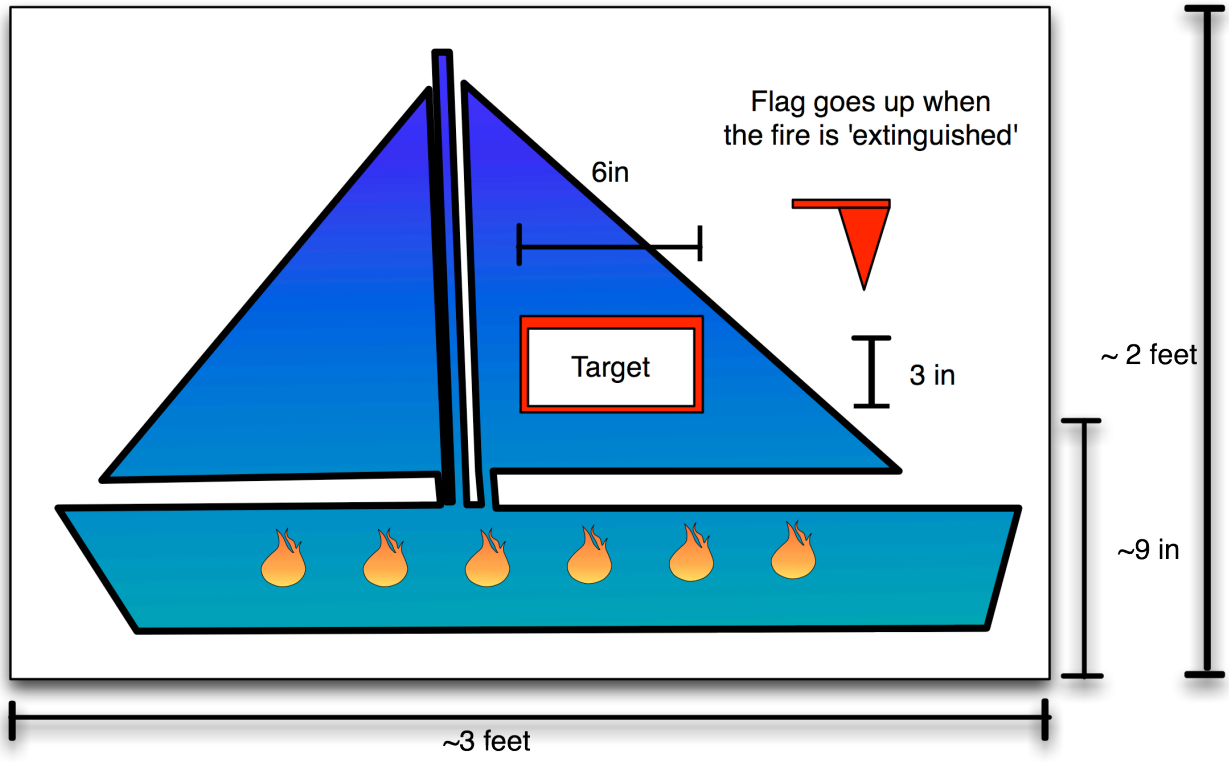


Aerial View



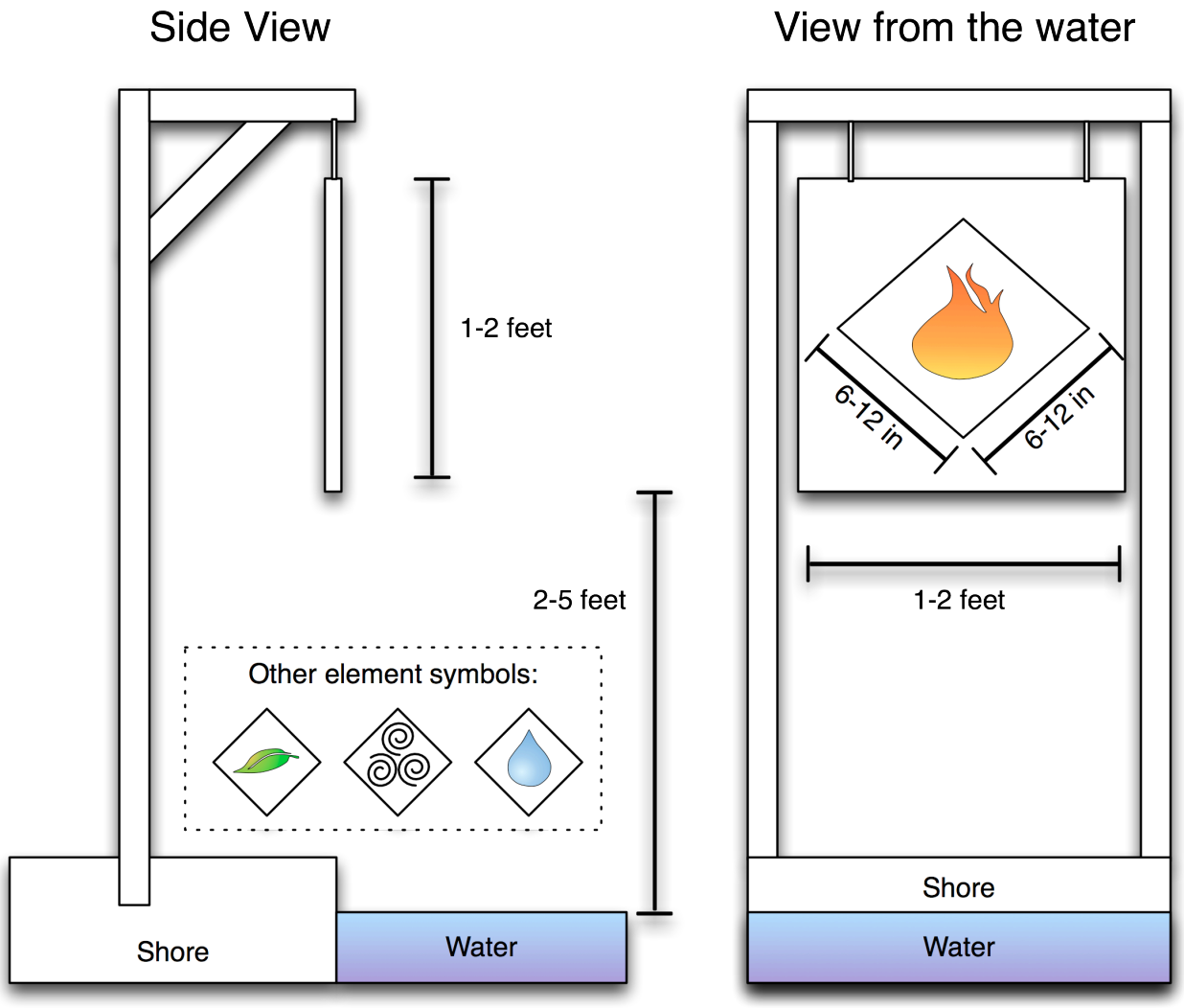
3.5.2 (Fire) Find the fire and extinguish it

Your vehicle may find a burning ship cutout. The cutout is a rectangular piece of plastic or organic material with the boat image below printed on it. There will be an opening ~3in x 6in surrounded by a 1 in thick red border. Using your vehicle's **water** cannon/gun (no paintball, rail guns, pellet guns or any other than a water gun) extinguish the fire by shooting water in the target. If your vehicle fires enough water in the target (approx 1/2 cup), the fire will be extinguished. A small red flag will be raised (similar to a mailbox flag) when you have extinguished the fire



3.5.3 (Air) Find and report the 'hot' target

Your vehicle may locate a set of four low flying targets between two (2) feet and five (5) feet above the water level. Each target will be marked with one of the four elements logo (a flame for fire; a leaf for earth; a water drop for water; three spirals for wind). The logo region of the target will made of a metal substance, while the rest will be a plastic or organic compound. Each target will be 2-12 feet away from the next one. One of the targets will be 'hot' (20C+ degrees warmer than the other ones). The targets will be directly facing the water and will be ground based (on the edge of the shore). Report which target is 'hot' and its GPS position to the base station. The competition organization will provide a 802.11n (backward compatible with a/b/g) dual-band (2.4Ghz & 5.0Ghz) wireless network for reporting the hot target. This network is expected to be used solely for reporting 'hot' target and not for other purposes (incl. telemetry, remote control, etc). The exact IP of the reporting server will be posted on the information whiteboard at the competition site. The communication protocol is detailed in the section below. Each reporting attempt will be logged and the number of tries made available to the judges. For points to be awarded for this task, you may attempt to report the 'hot' target up to 2 times. Any subsequent attempt will be logged but ignored for attribution of points.



3.5.3.1 Communication protocol for reporting the 'hot' target

All messages are TCP messages (UDP will not be supported). The protocol is ASCII based and each command is terminated with a Linefeed (LF) character (ASCII value: 0xA). The protocol description below will use the value '\n' to represent the Linefeed characters The following commands are available:

Ping command:

Used for: Testing connectivity with reporting service
Sender sends: "PING\n"
Service response: "PONG\n"

Report command:

Used for: Reporting the 'hot' target and its position
Sender sends: "REPORT;<target name>@<gps>\n"
Service response: "SUCCESS\n" or "FAIL\n" or "ERROR\n"
Meaning of response: SUCCESS = reported accurately the hot target.
FAIL = reported the wrong target or GPS.
ERROR = the request is malformed.
Possible values for <targetname>: "WATER", "FIRE", "EARTH", "AIR"
Format for GPS positions (in WGS84 datum): "<LATITUDE>,<LONGITUDE>"
Note: Both latitudes and longitude are expected in decimal format.
Examples:

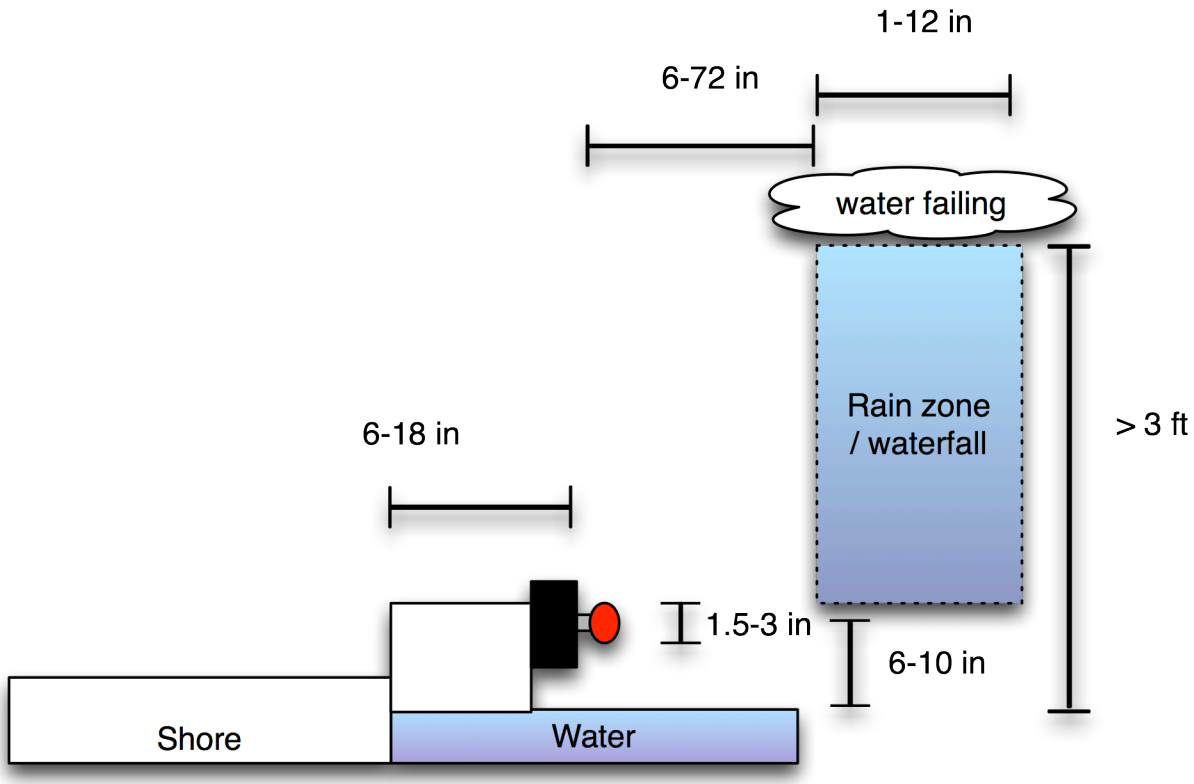
ASV: “PING\n”
Service: “PONG\n”
ASV: “REPORT;WATER@40.688888,-74.045111\n”
Service: “FAIL\n”
ASV: “REPORT;FIRE@36.802327,-76.191379\n”
Service: “SUCCESS\n”
ASV: “TIMELEFT\n”
Service: “ERROR\n”

Any other command issued will be answered with “ERROR\n”

Note: The quote “” characters are present to improve readability of this document but must not be included in the message sent and will not be included in service response.

3.5.4 (Water) Turn off the waterfall

Your vehicle may find a waterfall a few feet from the shore. Once the waterfall has been located, go through the waterfall to find a red Emergency Stop button and toggle it in order to stop the waterfall. The waterfall water debit will be limited to < 1 gallon/s over its whole area. Push the red button to stop the waterfall.



3.6 Return to the dock

If you have reached the challenge station and attempted at least 3 stations, you qualify for a bonus task! The bonus task is to return to the dock in autonomous mode going through the navigation channel passing through at least 3 sets of buoys and navigating in the general direction of the navigation channel. Note that the 3R Navigation mantra still applies, but since you will be returning, the red buoys will be on the starboard side of your vehicle.

4 OFFICIAL RULES

A completed *Intent to Compete* form, available on the website, must be submitted. The submission must be in English and is not considered official until the entry fee of five hundred ($500) U.S. dollars has been received by AUVSI. As the competition format cannot handle an unlimited number of entries, the organizers reserve the right to limit the total number of entries that are allowed to compete by declaring the competition closed to new entries before the deadline. As with all official information, this announcement (should it be necessary) will appear on the official website and/or forum.

During the competition, the vehicle must operate autonomously, with no control, guidance, or communication from a person or any off-board computer (except for Air station reporting task).

Teams must submit a journal paper and a website for evaluation by the judges. The journal paper should describe the design of the vehicle and the rationale behind the design choices. This paper length is limited to 10 pages long including all figures, references, and appendices. If the paper exceeds 10 pages, the judges may decide to ignore the content of the exceeding pages. Each journal paper must include an abstract of no more than 250 words. The journal paper and abstract must be formatted for standard 8.5 × 11-inch paper, with margins of at least 1 inch on all sides, and all text must be in 12-point or larger font. Each page must bear a footer with the page number and the team name. The journal paper will be evaluated as described below in the section on scoring. The journal paper must be received in Portable Document Format (PDF) via email to the AUVSI Administrative/Logistics point of contact (see front page of the rules) and posted on the competition forum. Teams that do not meet the deadline may be subject to penalties (including disqualification).

Each vehicle will be subject to static judging before being allowed to compete. During the static display time, judges, public, press, and other organization representatives will listen to a presentation from each team. Audio/Video equipment will be provided in the static judging area (ie: powerpoint (or equivalent) and multimedia presentations are encouraged). The judges will evaluate each vehicle for technical merit, safety, and craftsmanship as described below in the section on scoring. Each team is required to have at least one member attending their vehicle throughout entire competition. Teams are strongly encouraged to make a poster describing the vehicle. The posters can be set up next to the vehicle during the static display period. Representatives of the press and of other organizations will be encouraged to visit each team during this period.

There will be a qualifying round in which all teams will have the opportunity to compete. After the qualifying round, the judges will convene and tally their scores. The judges have the discretion to select the number of teams entering the finals. Teams will be accepted into the finals in rank order from the qualifying round. The point totals and rankings for the teams not selected are then frozen. For the final round, all point totals are set to zero. The final standing of teams selected for the finals will be determined by the points their vehicles score in the final round based on the Performance Measures alone. Any team that is selected to be in the finals will finish ahead of all teams not selected. After the competition, the judges will issue overall standings

A vehicle time slot is a single, contiguous block of time (time will not be stopped to bring the vehicle back to the dock) but the clock may be stopped if the course is significantly altered by the elements (at judges or technical director discretion). The team can attempt a run (or retry) as long as there time left in the time slot. In addition to the 20 minutes of run time, each team is granted a five minutes dock preparation time period. If the vehicle is launched before the end of the 5 minutes dock time period, the remainder of the dock time will be forfeited. At the end of the dock time, the 20 minute of run time will be started whether the vehicle has been launched or not. Once a vehicle has been stopped, if a new run is attempted, all points accrued in the previous run will be forfeited. **The time limit is subject to change depending on the number of contestants and may be modified for the final round.**

If a vehicle experiences significant interference from a piece of equipment (line, chase boat, anchors, etc) or if the competition course is degraded by the elements (damaged, flipped over or adrift element of the course) the team leader may ask, at that time, the vehicle returned to the dock, and for the judges to add back to the clock their best estimate of the time used in that run up to the point of interference. If the team leader does not make this request in a timely manner (as determined by the technical director or his designee) then the option is lost. Interference with a natural obstacle, gate, buoy, marker, any challenge

station, or target object does not qualify for this option, and a vehicle interfering with those items may be disqualified at the judges' discretion.

The vehicle run ends when any of the following occur:

- The time limit for performance period ends.
- The judges order the end of the mission.
- The team leader requests the end of the mission.
- The ASV leaves the marked competition zone
- The ASV looses its camera payload

5 SCORING

Table I: Static judging scoring sheet

Subjective Measures	Max. Points
Utility of team website	50
Technical merit (from journal paper)	50
Written style (from journal paper)	50
Technical accomplishment (from static judging)	75
Craftsmanship (from static judging)	75
Team uniform (from static judging)	10
Discretionary static points (awarded after static judging)	40
Total	350

Table II: Performance judging scoring sheet

Performance Measures	Max. Points
Weight	See Table I
Generate F pounds of thrust (thrust measurement lbs)	(F / weight) * 100
Pass through the starting gate	100
Navigate from Starting to the Speed gate in T seconds	250 - T
Enter navigation channel	50
Navigate through X buoy set in the channel	X x 50
Avoid N obstacles in the navigation channel	N x 100
Earth station	3000
Air station	500
Fire station	1000
Water station	1000
Be the only team/vehicle to attempt a challenge station (bonus) *	500
Return to dock	500
Finish All Tasks with T minutes Left on Clock (whole + fractional)	T x 100

* = If a team is the only team to have attempted a specific challenge station during a stage of the competition (qualification or final), they will be awarded 500 bonus points for that station irrespective of whether or not they succeeded. It is left to the judges' discretion to determine the specifics of what constitute an attempt (distance from the obstacle, whether it was intentional or not, etc) but completing a station is obviously considered an 'attempt'.

The mandatory tasks (thrust measurement, starting gate, speed gate, navigation channel) must be completed in order to accrue points. The challenge stations can be attempted in any order during a run within the time slot time limit.

6 SEQUENCE OF EVENTS DURING THE COMPETITION

6.1 Static Display Period

Each team will present a presentation to the judges during the static judging period. Teams are strongly encouraged to take advantage of the standard A/V equipment (projector) that will be available. Additionally, members of the public, the press, and representatives of other organizations will be encouraged to view the vehicles and talk with team members. Each team will present to the judges during scheduled time periods. The judges may work in small groups or individually. Static judging times will be announced by the judges, are final and will take precedence over any allocated time slot for in-water testing.

6.2 Practice Runs

The technical director or the designee will schedule practice time slots on an ad hoc basis during the two practice days. It is our intent to provide as much practice time in the arena as is practical and to ensure minimal idle time for the arena. Each vehicle must successfully pass the safety inspection before it will be allowed into the arena. If the vehicle propulsion system or if any other major components are altered, a new safety inspection will be required. Please plan to arrive in the staging area at least 10 minutes prior to your run to do a safety inspection.

6.3 Time Slots Announced for Competition Runs

Qualification time slots will be selected by teams based on their ranking using a combined score based on the static judging score (see Table I). The team that is in first place will have first choice, etc. Ties will be broken by a coin toss or random draw. Time slots may be exchanged between teams if both team leaders agree and at the discretion of the judges and AUVSI officials.

6.4 Qualifying Round of the Competition

Each qualifying team will be assigned a time slot to perform the mission. Vehicles will be put into and taken out of the water by tournament officials. The performance will continue until the competition time limit has expired, or the team leader requests the end of the mission, or the judges order the termination of the run. The judges may order termination of the mission at their discretion. Once the judges order the end of the mission, no further points may be scored. The judges' decision on the termination of the run is final. If the time limit is not exceeded, the team leader may opt to go for another run and thus waive all the points accrued in the previous run. Each team will be given 1 (one) try at the thrust measurement per slot time. Thrust measurement can only be done before attempting any other tasks. The thrust measurement operation can be a manned one (i.e.: command given by a team member to the vehicle using a remote or laptop. Competition officials will operate physical buttons). As soon as the thrust measurement is completed, the vehicle must be returned to autonomous mode. The thrust measurement can be completed as part of the 'Dock Time' portion of a time slot (if there '*dock time*' is not yet elapsed).

6.5 Final Round of the Competition

After the preliminary round, the judges will tally their scores. Teams will be accepted into the finals in rank order from the preliminary round. The judges have the discretion to select the number of teams entering the finals that they deem appropriate. We anticipate three to five teams competing in the finals. The finals round will be conducted in the same manner as the preliminary round. Judges and AUVSI staff have discretion to modify the time duration allocated during the final round to have the final format fit with obligations (televised video feed time, publicized final round start and end time, etc) as long as every team is allocated the same amount of time.

7 ASV REQUIREMENTS

7.1 General Requirements

The operating (mechanical, electrical, and software) systems of the ASV must be constructed and assembled by the student members of the team. The vehicle hull may be fabricated by the student team or pre-built. The vehicles being entered into the competition must meet certain conditions to ensure that each vehicle is of the same relative class and to insure a level of safety. Water immersion resistance (or minimally water splash-resistance) is very strongly recommended.

7.2 Vehicle Requirements

Each team may enter only one vehicle into the competition. The competition judges will physically inspect each vehicle. The judges may prevent any vehicle that they deem to pose an unreasonable safety hazard from competing until the team satisfactorily resolve the issue. AUVSI and the host organization, their employees and agents, as well as the organizing committee, are in no way liable for any injury or damage caused by any vehicle, nor for any damage or injury caused directly or indirectly by the susprension/disqualification of a vehicle.

7.2.1 Weight and Size Constraints

Each vehicle must fit within a six-foot long, by three-foot wide, by three-foot high "box" (1.83 m x 0.91 m x 0.91 m) when in action ready state. Table 1 shows the bonuses and penalties associated with a dry vehicle's weight in air. It is acceptable for the vehicle dimensions to be modified while the vehicle is in action, but the vehicle must return to its action ready state dimensions before coming back to the dock.

Table 1. Size and weight constraints on ASVs entered into the 2011 competition

	Bonus	**Penalty**
ASV Weight > 140 lbs (ASV Weight > 63.5 kg)	N/A	**Disqualified!!!**
140 lbs ≥ ASV Weight > 110 (63.5 kg ≥ ASV Weight > 50 kg)	N/A	**Loss of** 250 + 5 (lb – 110) 250 + 11(kg – 50)
110 lbs ≥ ASV Weight > 70 (50 kg ≥ ASV Weight > 32 kg)	**Bonus of** 2(110 – lb) 4.4(50 – kg)	N/A
ASV Weight ≤ 70 lbs (ASV Weight ≤ 32 kg)	**Bonus of** 80 + (70 – lb) 80 + 2.2(32 – kg)	N/A

7.2.2 Surface Requirements

The entry must be an autonomous surface vehicle, meaning the vehicle must remain in contact with the surface of the water at all times or within the ground effect of the water in cases of hovercraft. Airborne/flying and totally submerged vehicles are not acceptable. Circumvention of this rule such as use of a flying vehicle dragging a tether in the water, or an underwater vehicle with a tethered float is not permitted. The vehicle must be able to float in a non-powered state with most of its volume outside of the water. There is an exception to this rule for the 2011 Earth Challenge Station. The vehicle is allowed to leave direct contact with the water to go retrieve the Earth treasure. However, the vehicle must be in direct water contact prior to attempting the Earth Challenge Station and again before leaving the station.

7.2.3 Propulsion Requirements

The entire propulsion and energy system must be self-contained on the vehicle. All vehicles must be battery or sail powered (no hydrogen, nuclear or combustible based power system). All batteries must be sealed to reduce the hazard from acidic or caustic electrolytes. All batteries must be housed in waterproof containers. Batteries may not be charged inside of sealed vessels at any time while on the site of the

competition and/or while engaged in the competition. The open circuit voltage of any battery in a vehicle may not exceed 60 VDC. If any other means of power is being used, please contact the organizing committee for a safety evaluation. The specific method of propulsion is not limited (propellers, paddles, jets, etc); however, for safety sake, please check with judges if there is any potential for danger. For all propeller based propulsion system, a propeller shroud is required. If a team has any questions or concerns, they are encouraged to contact the organizing committee before the beginning of the competition.

7.2.4 Speed Requirements

The maximum ASV speed is 10 knots with respect to the ground. The vehicle must also demonstrate the ability to stop with respect to the water for safety reasons.

7.2.5 Camera Payload Requirements

The vehicle must be able to support a payload in a watertight case, up to size 7 x 5 x 4 inches and weighing up to 3 lbs, which will be supplied by the competition committee during the competition. Antennas will be sticking up from the top of the payload case (up to 6 inches long). The back and bottom of the payload will be covered in Velcro (male). The weight of this payload is not included in the vehicle's official weigh-in. The payload must be securely fastened to the vehicle with an unobstructed view of the "forward" direction and the antennas must be unobstructed. Loss of the payload at any time will immediately end the run. The payload is of passive nature and requires no power or cooling from the vehicle, and will supply no signals or data to the vehicle.

7.2.6 Emergency Stop (E-Stop) Requirements

The vehicle must have at least two forms of emergency stop: one physical and one wireless. For either form of E-Stop, the vehicle must automatically disconnect the power to all actuation mechanisms (including but not limited to propulsion system) and to the water gun. Once the physical E-Stop is used, even momentarily, the vehicle must stay deactivated until physically reset (no wireless reset). The wireless E-Stop should be able to deactivate the vehicle remotely from at least 250 feet away from the vehicle. The wireless system must be completely independent from the main computer (must still work in case of complete main computer failure). The physical E-Stop must be either an electrical or mechanical system (cannot be done in software). The physical E-Stop must be a red button of at least 1 inch in diameter that can be easily reached on the vehicle.

7.2.7 Remote Control Requirements

In addition to all E-Stop requirements, all vehicles must have a remote control system that must minimally allow the vehicle to be brought back to the dock without physical intervention. The remote control system must be able to control the vehicle from at least 250 feet away. At all times during a run, the remote control must be handed over to a designated AUVSI official, judge or staff. If at any point in time during the run, the team leader desires to use the remote control to manipulate its vehicle, he must notify the AUVSI staff member in the chase vehicle and then the AUVSI official, judge or staff member holding the vehicle will give the remote control back to the leader and signal the end of the run.

7.2.8 Autonomous Control Requirements

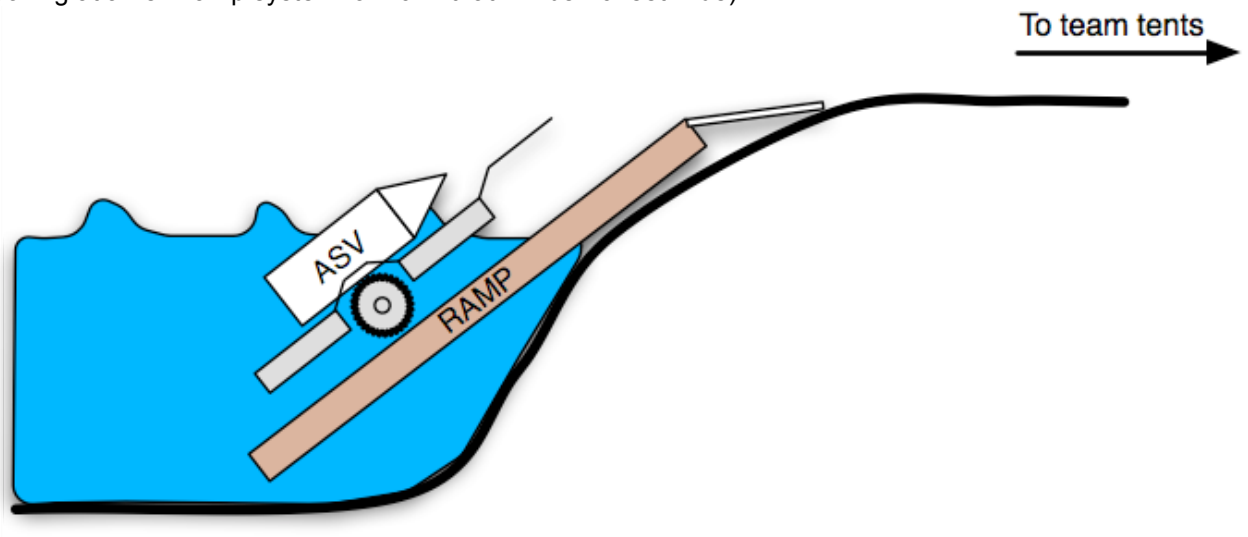
During the competition, the vehicles are required to be used in solely autonomous mode (all command, control, decision and computation systems are fully and strictly onboard the vehicle). No bi-directional wireless (or wired) communication will be allowed. The only authorized bi-directional communication of the vehicle during a run is for the Air Challenge Station reporting tasks. The only authorized incoming communication to the vehicle is the E-Stop and the remote control (both of which stops the run as soon as they are enabled). No human interaction is allowed with the vehicle once the run begins. Remote data monitoring or remote data logging is not permitted during a run. Data recorded or logged on the vehicle may be analyzed between runs. All laptops connected to the vehicle must be left with the lid closed on the competitor table. Exclusively during practice runs and during start up procedures, remote control, remote data monitoring/visualization and wired/wireless connections are allowed. Each team during check-in must register all wireless signals (802.11, wireless serial, Bluetooth, RC remotes, wireless transmitters, etc) with the judges to prevent accidental interference with other teams during practice.

7.2.9 Competition Arena

No team member is allowed to enter the arena at any time (this includes wading, swimming, and diving as well as on a float, boat, etc.). Competition officials will be responsible for recovering lost vehicles. Officials will make all reasonable efforts to recover a lost vehicle but cannot guarantee that they will be able to do so. All teams recognize that by entering the competition, they risk damage to or the loss of their vehicle. The judges, officials, hosts, and sponsors can take no responsibility for such damage or loss. No materials (other than water from the water gun) may be released into the waters of the arena. Vehicles that interfere with competition elements may be disqualified at the judges' discretion

7.2.10 Putting your vehicle in the Competition Arena

The competition officials are making all reasonable efforts to acquire a ramp to launch the vehicles from. All team will be required to provide their own trailer (Suggestions: garden cart, golf cart, dump cart, etc). Trailers will be moved by hand on site (no motor vehicle allowed). A handle system that is connected to the trailer by a solid link (no rope/chain as it cannot be use to back up nor to align the trailer) that exceeds the length of the ASV by 2-4 feet is required in order to move the trailer on the ramp. All trailers must be negatively buoyant (sink when put in the water). The ramp will be minimally 3 feet wide (although we are looking at a new ramp system for 2011 that will be ~6 feet wide)



7.2.11 Safety Requirements

The officials will suspend the operation of a vehicle at any time they deem that it is required for safety or security considerations. All vehicles, regardless of weight, must have clearly marked safe zones to pull to lift the vehicle. Each team will be responsible for manually moving the vehicle (on trailer or similar device) to / from the launch area and the team's designated work area. Vehicles must have readily identified tow points and tow harness on at all time when the vehicle is in the water (for emergency towing). It is the team responsibility to provide a thrust measurement/tow harness. The vehicle must be capable of being towed by a boat using a single line at speeds up to 5 knots when un-powered.

7.3 Safety Inspection

Prior to each time slot, each vehicle will be inspected for safety. The safety inspection will requires every team to identify all underwater moving parts or actuators (propellers, water gun, etc) and their associated protection mechanism (shrouds, etc) in addition to demonstrating the functionality of both the physical emergency stop and the wireless E-Stop. Passing this safety inspection is a hard requirement for being allowed to get in the water. If after successfully passing a safety inspection a change or modification is made to a moving part, actuator or its protection mechanism, a new safety inspection will be required before being allowed in the water. Please be proactive about requesting a safety inspection as it may prevent your time from getting in the water and you may loose your time slot if you do not pass it.

7.4 Qualification Inspections

In addition to the safety inspection, the competition judges will evaluate each competing ASV during static judging. Judges will inspect for exposed electronics, fluid leaks, stability, potential cutting hazards, physical E-Stop placement and function, wireless E-Stop operation and towing ability. Judges have the discretionary right to impose penalties (i.e.: loss of points) going up to the disqualification of a team for safety violations.

8 ONSITE EXPECTATIONS

The organizers have made every attempt to provide the competitors with maximum resources at the Competition site, including electrical power, test pools, Internet access, and practice time in the main arena. This event is not only open to the public, but there is a distinct possibility that a potential future employer or sponsor may also be observing the event. It is expected that **ALL** teams will be present during **ALL** days of the competition (practice, qualification and final days alike). If your team does not make it into the finals, it is expected that your team will display your vehicle and be present in the team tent during this time.

9 AWARDS

Cash prizes (and serious bragging rights) of up to $20,000 will be awarded at the discretion of the judges.

10 RESUMES

One goal of the competition is to foster links between young engineers and the companies, universities, and government agencies involved in ASV development. To advance that goal, each team should provide resumes of team members with class year and expected graduation date. These resumes will be available to sponsors and employers with opportunities for employment, internships and co-op programs. Electronic versions of team member resumes can be submitted along with the journal paper. Students are also encouraged to use AUVSI's Online Career Center at http://careers.auvsi.org

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