Autonomous Surface Vehicle Competition
2nd Annual

"Double Trouble"

June 18th – June 21st, 2009
Norfolk, 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	Friday	March 20, 2009
Journal Paper, Resume and Website Due	Friday	June 5, 2009
Team Check-in & Orientation	Thursday	June 18, 2009 5PM
Safety Inspections and In-water Practice Time	Friday	June 19, 2009 Morning
Static Judging and In-water Practice Time	Friday	June 19, 2009
Qualifying Runs	Saturday	June 20, 2009
Finals	Sunday	June 21, 2009
Awards Party (evening)	Sunday	June 21, 2009

*subject to change

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1 GENERAL INFORMATION

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.

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 captain". The team captain, and only the team captain, will speak for the team during the competition runs. Only the student component of each team is eligible for the cash awards.

Location and Facilities:

The competition will be held at the Norfolk Base lake from June 19- 21 2009. Check-in and registration will be at the hotel Thursday June 18, 2009 beginning at 5pm EST.

The Norfolk Base lake is a natural pond with an average depth of 5 feet (depth varies with weather). We are still evaluating the solutions for vehicle deployment. Detailed Competition information will be provided once the layout is finalized by AUVSI and the host site.

A tent (10 by 10 foot or equivalent space) will be provided at the location for each team to have a covered work area. It is recommended 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.

Schedule:

Teams will register on Thursday evening 17h00 June 18, 2009 for the mandatory orientation meeting. Practice will occur Friday all day. Static judging will take place on Friday. Qualifying runs will occur on Saturday. Qualifying teams will compete in the Finals on Sunday. The Awards Ceremony and Competition Banquet will take place Sunday evening, June 21. The event will be rain or shine. Times may vary due to schedule delays due to bad weather.

2 MISSION

There has been a shipwreck. And the sinking boat is not a cargo ship, it is a ferryboat! You must quickly prepare for a rescue mission to save the live of the passengers. First, quickly navigate through the open water, and then follow the navigation channel to avoid the reefs, dock with the sinking ship to rescue the passengers still on-board and tow the lifeboat back to the dock. As if the rescue operations were not already enough for you, you just learned that there are two pirate skiffs on their way to the sinking ship. Be ready to fight them off to protect the passengers of the sinking ship!

3 MISSION TASKS

3.1 Thrust generation

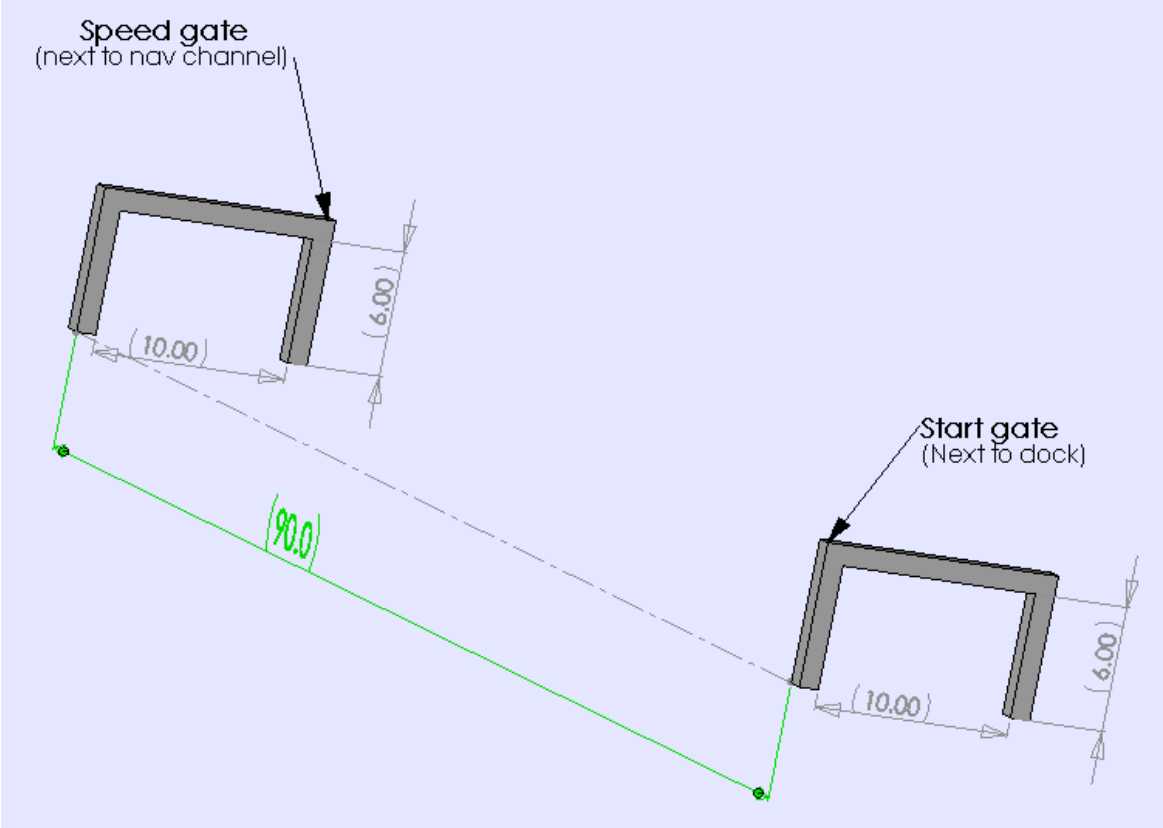
Before leaving the dock to go on the rescue mission, the seaport controller wants to assess that your ship has the thrust needed to successfully accomplish the mission. You will start by demonstrating the thrust your ASV can generate by hooking up your vehicle to a thrust measurement system (your interface will be 2 carabineers that you must attach to your vehicle). Your vehicle will then generate as much thrust as possible in 10 seconds. 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). You will be rewarded with 5 point per pound of thrust generated. See figure 2 in Annex for the suggested harnessing mechanism between the strain gauge and your ASV.

3.2 Speed Gate

Having demonstrated that your vehicle can deliver plenty of thrust you can now speed through the open water between the start gate and speed gate. The vehicle will have to demonstrate the ability to steer a steady course while going as quickly as possible to the speed gate (30-50 yards away from the dock).

Final rules

Final rules



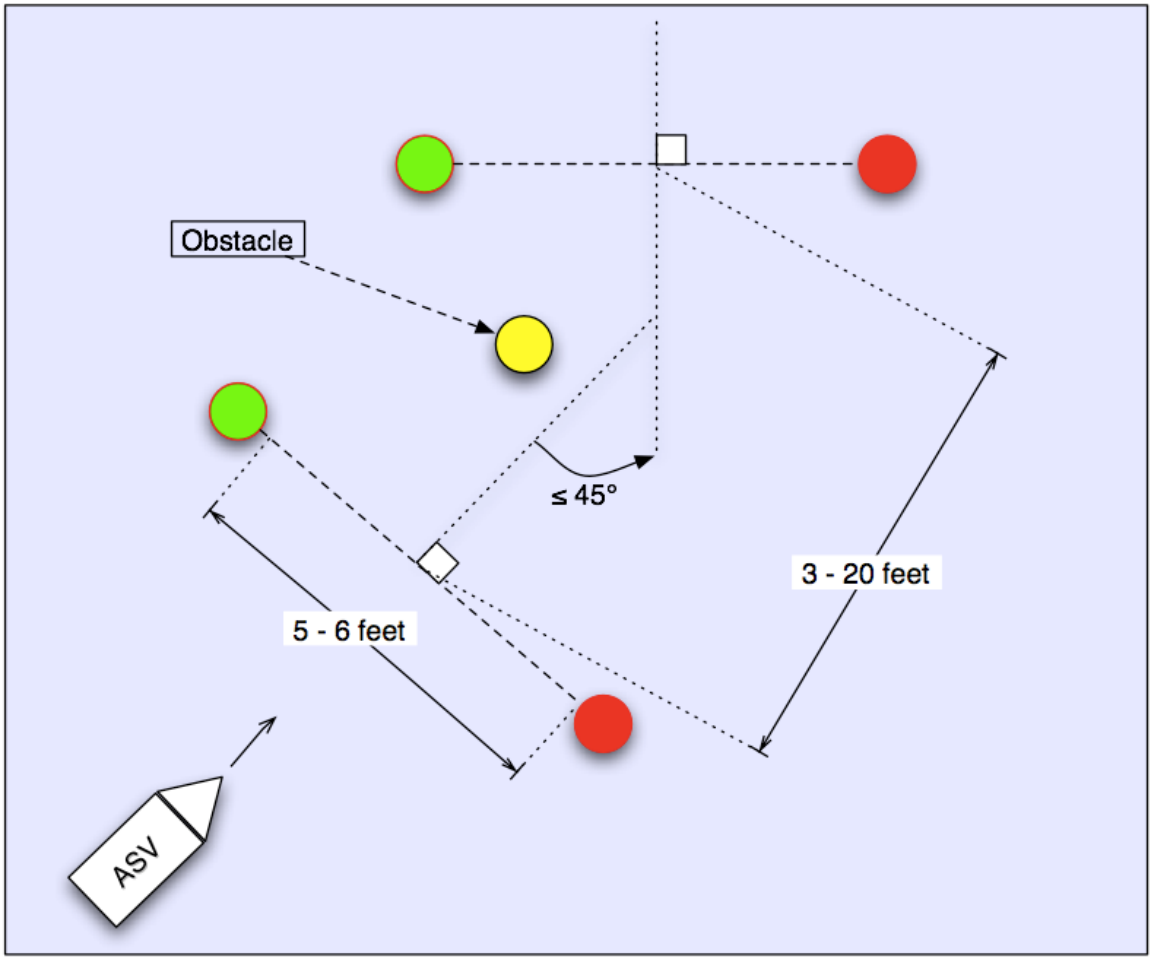
Note: the units on the diagram above are in feet. The distance between the gates may vary.

The opening in the gate will be 10 feet wide and 6 feet high. The gate will be **BLACK** with **YELLOW** stripes. Your vehicle will be timed how long it takes to transit through the starting gate. Points for this task will be calculated by starting with 500 points and subtracting the run time in seconds. Passing the Speed gate is a requirement to move on to the next tasks.

3.3 Navigate the channel

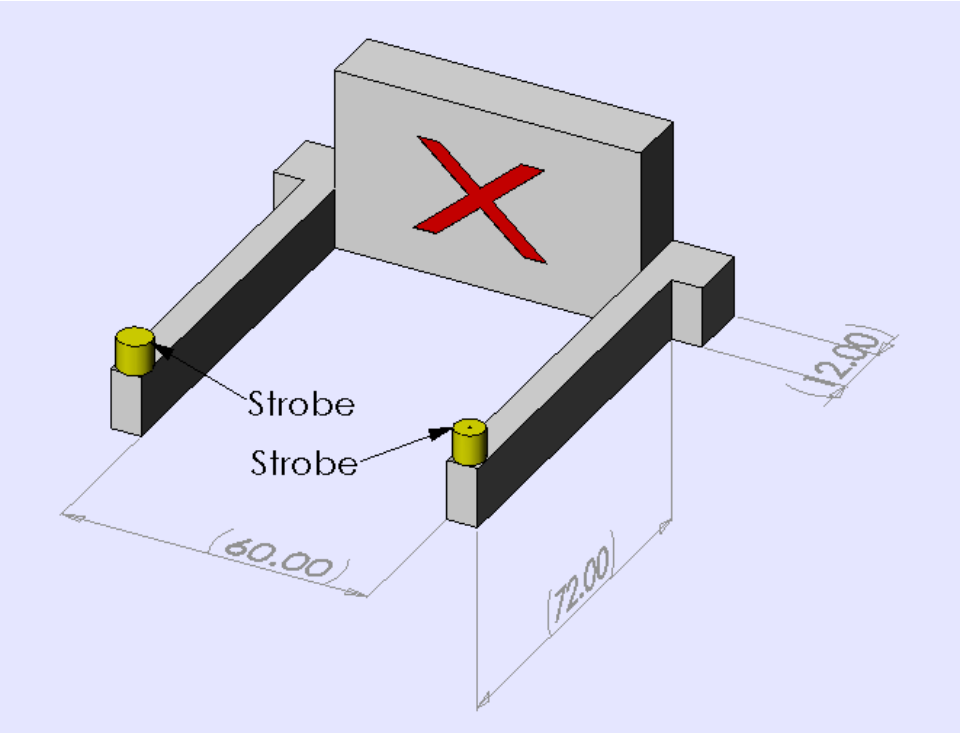
To get to the sinking ship, you must navigate through a reef. Safe passage through the reef is marked with buoys. To avoid crashing, the vehicle should navigate through pairs of **RED** and **GREEN** buoys. The **GREEN** buoy will always been on the port (left) side of the vehicle while the **RED** one will be on the starboard (right) side. Each pair of buoys your vehicle navigates through is worth 50 points. Moreover, up to 3 flotsams from the shipwreck will b in the channel. A **YELLOW** buoy will identify them. There is no penalty for hitting a flotsam (but be careful not to get entangled in it). Each flotsam avoided is worth 100 points.

GPS position of the buoys will not be given and the buoys may be moved at anytime during the event. Buoys will be moved between the competition phases (tests, qualification, finals) but will not be moved during a phase.



3.4 Find and dock with sinking transport ship

The vehicle should enter a U-shaped portion of the sinking transport ship marked on either side by flashing strobe lights and in huge **RED** 'X' indicating where to dock with the sinking ship. The center of the 'X' will be between 1 feet and 3 feet from the water level. The extremities of the U-shaped sinking ship will be marked with **AMBER** strobes. GPS coordinates for the sinking ship will be provided. The dock will be made of PVC tubes and corrugated plastic. The dock will tethered to anchors. Docking with the sinking ship to rescue passengers is worth 500 points. A successful docking happens when the ASV enter the U-shaped sinking ship and make contact with the area where the X for at least 5 seconds.



Note: 'inches' is the unit used in the diagram above

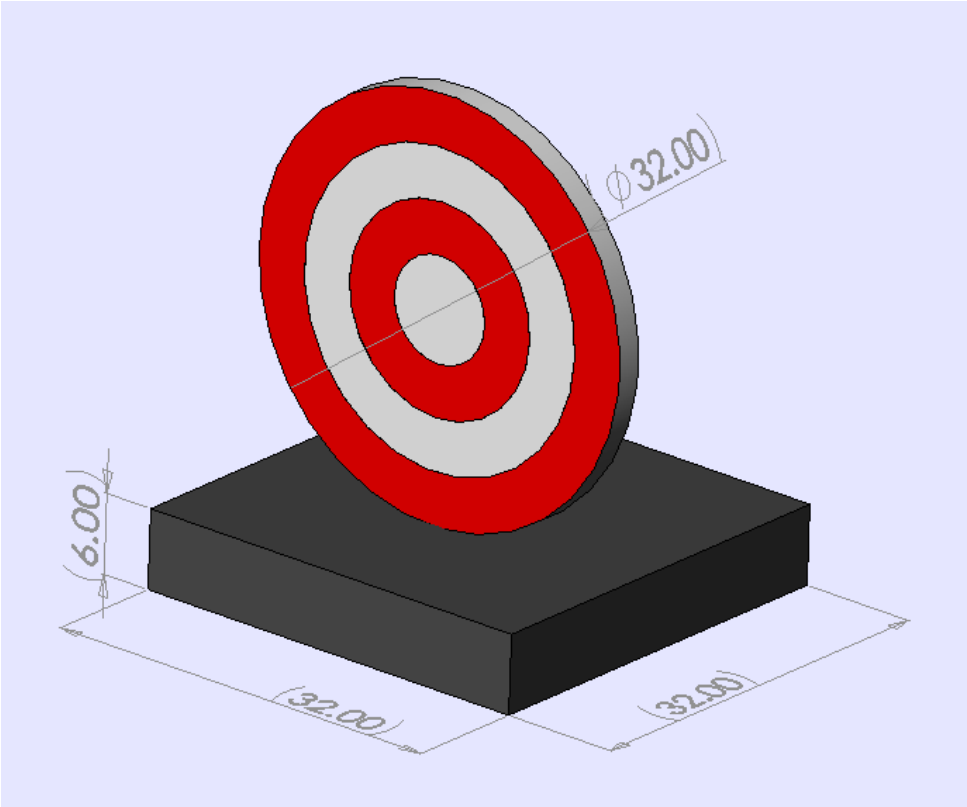
3.5 Pickup stranded lifeboat

The vehicle will need to locate the lifeboat located near the transport ship and pick it up. The GPS coordinates of the lifeboat will be provided to you before the 250 points will be awarded for docking with the lifeboat and displacing it toward the dock. 500 additional points will be awarded if the payload is brought back to the afloat base (dock). The payload will be a 24" (diameter) **ORANGE** type IV life ring buoy with 10lbs of weight attached to it (the weight will be equally distributed under the buoy). See below for a picture of such a similar buoy.

The buoy will be tethered to an anchor. 10 pounds will be needed to severe the link between the anchor and the tether. Velcro will be used to attach the tether to the anchor.

3.6 Fight the pirates!

Luckily for the passengers, you managed to rescue all the ferry passengers and tow the lifeboat before the pirates gets there. But you are facing the pirates and they still want money and hostages! Make the pirates change their mind about looting by firing at them. Each pirate skiff you hit is worth 250 points. The pirate skiff will be identified by floating targets. The diagrams below describe what the targets will look like. The target will be 32 inches wide and will have concentric 4" wide white and red circles painted on them. The center of the target is a hole. If you shoot through the hole, it gives you 500 points instead of 250.The target will rest on a black ~6 inches high floating base.



Note: 'inches' is the unit used in the diagram above

3.7 Return to dock

Now that you have rescued all the passengers, are towing the safety boat and fought the pirates, it is time to return all the passengers back to the dock. Your vehicle will go back to the dock on its own (tip: you can use the GPS coordinates you acquired before leaving the dock). If you return to the dock after completing the speed gate task, the navigation challenge, the sinking transport ship, the lifeboat rescue and fighting the pirates in one run, points will be awarded for time remaining on the clock at the rate of 100 points per minute. Docking is considered as completed once your vehicle immobilizes itself less than 3 feet away from any side of the starting dock.

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.

During the competition, the vehicle must operate autonomously, with no control, guidance, or communication from a person or any off-board computer.

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 may be no more than 10 pages long (including all figures, references, and appendices). 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. Teams that do not meet the deadline may be disqualified from the competition.

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 visit each team. 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 the static display period (not just during the judges' scheduled visit). 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 run is 35 minutes long and divided in preparation and performance period. The first 5 minutes constitute the preparation period. During this time, the vehicle may not be deployed in the water. The 30-minute-long performance period immediately follows. **These times are subject to change depending on the number of contestants.**

Preparation period: The vehicle may remain on the crane, or be placed in the dock. A team may waive any portion of the 5-minute-long preparation period and start the 30-minute-long performance period. Once the performance period starts, the team loses any unused time in the preparation period.

Performance period: When the officials signal the start of the performance period, the team may ask to have the vehicle deployed into the water and released to perform the mission. Only tournament officials may deploy and recover the vehicle. The time required to deploy and/or recover does not count against the 30-minute limit. This is to prevent unsafe actions in an attempt to speed the deployment and recovery processes.

At any time while a vehicle is running, the team captain can signal the end of the run and request the

retrieval of the vehicle. Only officials may retrieve a vehicle and return it to the dock. The countdown clock for the performance period stops when the official touches the vehicle to recover it. The clock continues its countdown once the team establishes communication with the vehicle, or the vehicle is safely back at the dock, whichever is first (i.e. if a team has wireless communication with the ASV, the countdown clock continues while the support boat is returning the ASV to the start). Once a team has the officials stop and re-deploy their vehicle, all points earned in previous runs are lost.

If a vehicle experiences a significant interference from a piece of equipment, line, buoy, or barricade, the team captain may ask, at that time, to have the clock stopped, 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 captain 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 gate, light, or target object does not qualify for this option, and a vehicle interfering with those items may be disqualified at the judges' discretion.

The mission ends when any of the following occur:

- The 30-minute (or the time limit set by the number of contestants) performance period ends.
- The judges order the end of the mission.
- The team captain requests the end of the mission.
- The ASV leaves the marked competition zone

4 SCORING

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

Performance Measures	Max. Points
Weight	See Table 1
Generate F pounds of thrust (thrust measurement lbs)	F x 5
Navigate Through the Starting Speed Gate (500 pts minus time in seconds)	500
Navigate through X buoy set in the channel	X x 50
Avoid N obstacles in the navigation channel	N x 100
Dock with Transport Ship	500
Pickup Payload	250
Shoot down targets (250 or 500 (center hole) pts each)	250 / 500 / 750 / 1000
Return to dock	500
Bring Payload back to dock	500
Finish All Tasks with T minutes Left on Clock (whole + fractional)	T x 100

Performance Points are scored by completing tasks in any order during a run within the performance period time limit.

5 Sequence of events during the competition

5.1 Static display period

Each team will receive a visit from the judges during this period for the static judging. 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 have a series of visits from the judges during scheduled time periods. The judges may work together in small groups.

5.2 Practice runs

Practice time slots will be scheduled on an ad hoc basis by the technical director or the designee 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 be approved by the technical director or the designee before it will be allowed into the arena.

5.3 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, the website and the journal paper. The team that is in first place will have first choice, etc. Ties will be broken by a coin toss or random draw.

5.4 Qualifying round of the competitions

Each qualifying team will be assigned a time slot to perform the mission. Twenty minutes before the beginning of their time slot, the team may enter the staging area near the launch site. At the beginning of their time slot, the team may move to the launching site on the dock. The first 5 minutes are for preparation. During this period, the vehicle may not be deployed in the water. When the 5-minute limit has expired (or the team has waived the balance of the preparation time), the judges will begin the competition time clock. These competition minutes are for the vehicle to perform the mission. Once this period has begun, the team may ask to have their vehicle placed in the water to begin its mission. Vehicles will be put into and taken out of the water by tournament officials. The time required to do so will not count against the competition time limit. If a vehicle is in the water, the team may request that it be lifted onto the dock. Tournament officials will move the vehicle onto the dock and (when requested) redeploy the ASV into the water. Again, the time required to move the vehicle into and out of the water will not count against the competition time limit. However, time spent by the team on the dock does count against the competition time limit. The exception is when the vehicle is performing an autonomous survey and the clock will continue to run while retrieving and moving the vehicle. The mission will continue until the competition time limit has expired, or the team captain requests the end of the mission, or the judges order the termination of the mission. 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' decisions on the termination of the run are final. Each team will be given 1 (one) try at the thrust measurement. 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. Physical buttons will be operated by competition officials). As soon as the thrust measurement is completed, the vehicle must be returned to autonomous mode. Thrust measurement can only be done before attempting any other tasks. The time required to install or remove the harness on the vehicle for the thrust measurement will not count against the competition time limit. The time used during the actual thrust measurement will count toward the time limit.

5.5 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 (excluding static judging, weight and thrust measurement points). 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.

6 AWARDS

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

7 ASV Requirements

Each team may enter only one vehicle into the competition. The competition judges will physically inspect each vehicle. The judges may disqualify any vehicle that they deem to pose an unreasonable safety hazard. 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 disqualification of a vehicle.

7.1 Weight and Size Constraints

For the International ASV Competition, each entry 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). Table 1 shows the bonuses and penalties associated with a vehicle's weight in air.

Table 1. Size and weight constraints on ASVs entered into the 2008 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 Vehicle Requirements

General Requirements

The operating (mechanical, electrical, and software) systems of the ASV must be constructed by the students. 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.

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.

Propulsion Requirements

The entire propulsion and energy system must be self-contained on the vehicle. Gasoline powered vehicles are not allowed due to the environmental damage fuel spills could cause. All vehicles must be battery powered. All batteries must be sealed to reduce the hazard from acidic or caustic electrolytes and 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 the sake of safety, please check with judges if there is any potential for danger. For all propeller based propulsion system, a propeller shroud is required. A 1-pager document will explain in greater details the needs and requirements for propeller shrouds. If a team has any questions or concerns, they are encouraged to contact the organizing committee.

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.

Camera payload Requirements

The vehicle must be able to support a payload in a watertight case, up to size 12 x 12 x 12 inches and weighing up to 10 lbs, which may be supplied by the competition committee during the competition. For 2009, the payload will be built in 2 parts. It will be composed of a smaller (approx 3”x3”x6”) camera assembly (wireless camera & battery) and a bigger dummy bloc of foam & lead. The camera assembly will be covered in Velcro (male) and the bigger dummy bloc will have a hole corresponding to the size of the camera assembly. The hole in the bloc of foam and lead will be covered in female Velcro to mount the camera assembly. The teams will offered the option to use either only the smaller camera assembly (with exact size and weight to be specified in the ASV forum) or the bigger 12”x12”x12”, 10 lbs payload (the bloc of foam and lead with the camera assembly inserted in the bloc). 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. Loss of the payload at any time will immediately end the run. Specific information regarding the content, center of gravity, and tie-down/latch points will be supplied by the organizing committee. 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.

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). Once the 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.

Autonomous Control Requirements

During the competition, there will be no wireless communication or external control of the vehicle, or computation done on an external base-station, except for wireless E-Stop. All control must be done onboard the vehicle. No human interaction is allowed with the vehicle once the run begins. Remote data monitoring or remote data logging is not permitted during the competition. Data recorded or logged on the vehicle may be analyzed between runs. During the practice runs and during start up procedures, remote control and 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.

Competition Area

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 may be released by the vehicle into the waters of the arena.

Safety

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 be lift-able on a harness or sling of some type. 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 onboard for emergency towing. 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 their first run, each vehicle will be inspected for safety. The safety inspection will requires every team to identify all underwater moving parts (propellers,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.

7.4 Qualification Inspections

In addition to the safety inspection, each competing ASV will be evaluated by the competition judges 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.

5 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. 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.

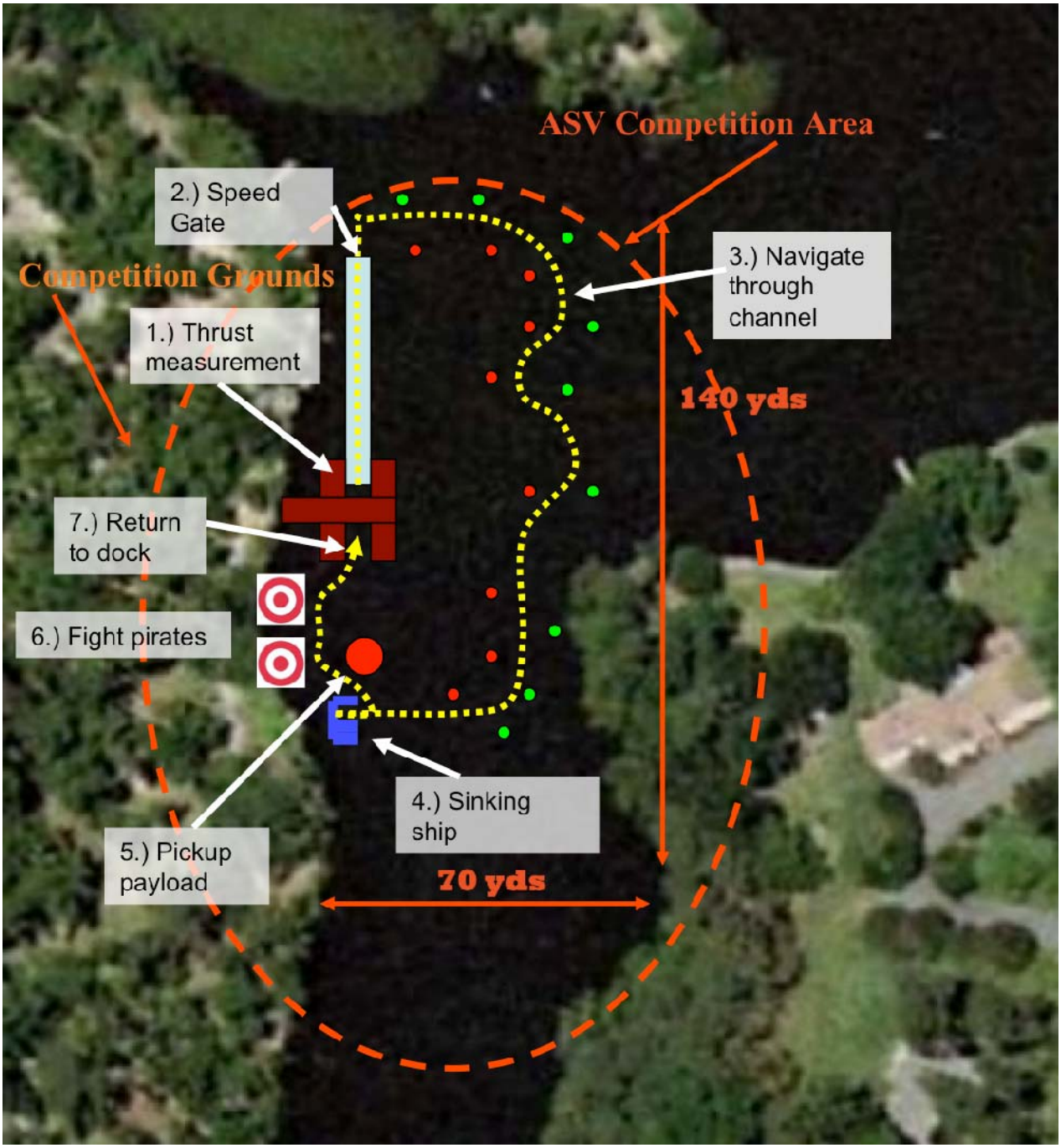
6 RESUMES

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 appended to the journal paper. Students are also encouraged to use AUVSI's Online Career Center at http://careers.auvsi.org

8 Appendix

8.1 Figure 1

Competition layout in the Norfolk base lake



8.2 Figure 2

Suggested way to harness your vehicle with the strain gauge