



2nd Annual Greater Philadelphia SeaGlide Competition 2019

Executive Summary

The SeaGlide Competition is an Autonomous Underwater Vehicle (AUV) Science, Technology, Engineering, Art, and Mathematics (STEAM) educational program and competition. A SeaGlide is a miniature underwater glider which moves by changing its buoyancy, taking in or expelling water, and shifting its center of gravity so it may dive or rise in the water. As the glider completes its dive and rise cycles, its wings generate lift, propelling the glider forward. Full scale underwater gliders require very little energy and can be fully or partially autonomous, allowing them to deploy for months at a time to collect valuable data about the world's oceans. SeaGlide offers this type of technology on a smaller scale and instructions for design modifications to incorporate sensor readings, increased maneuverability, and more are available on the SeaGlide forum (<https://robonationforum.vbulletin.net/forum/seaglide>). SeaGlide consists of an educational tool kit that centers on a curriculum-designed program that teaches students about the basics of naval architecture, marine engineering, computer programming and electrical circuits. The program is designed to provide high school students with the materials and knowledge to construct an AUV. The students are then encouraged to build upon that basic knowledge to innovate and create unique AUV designs to meet specific mission scenarios.

The Greater Philadelphia SeaGlide Competition (GPSGC) is held in the early spring at Temple University's Pearson Hall, located at 1800 N. Broad St, Philadelphia, PA 19122, in conjunction with the SeaPerch competition. The SeaGlide competition takes place on a Saturday, alongside the high school portion of the SeaPerch competition. The competition begins with team check-in, followed by an opening ceremony, competition rounds, and the presentation of awards.

The GPSGC is the culminating competition that consists of three technical sections where the students are able to showcase their final designs. The three technical sections are the White Paper, Presentation, and Vehicle Performance. The White Paper is submitted on a predetermined deadline for judging in advance of the competition date. The White Paper emphasizes the documentation of the design approaches, engineering processes used, and an explanation of the final design. The Presentation section is the opportunity for the teams to compete against other teams for a fictional Navy contract. The Presentation consists of both a commercial and a slide presentation, in which students discuss their designs and obstacles they overcame during the engineering process. Students should be prepared to answer questions afterwards. The Vehicle Performance section takes place in the pool, where student will compete in challenges determined by the tier level they have entered. The Tier 1 challenge is a straight speed run and the Tier 2 challenge is the navigation of a simulated underwater canyon.

Specifications for the events are outlined in the document below and can be found on phillynavalstem.com along with other resources to aid teams with building, practice, and test setups prior to competition.

The Competition Scenario

The United States Navy is interested in acquiring a fleet of underwater gliders with a variety of capabilities. The Navy recognizes that the autonomous nature and low energy usage of underwater gliders may provide cost savings to the US taxpayer. Furthermore, their small size makes them ideal for clandestine operations. The Navy is seeking to fund companies to design and produce underwater gliders that will be ready for deployment within the next few years. Your school is competing as a company seeking this funding. Companies are not expected to produce a working prototype that meets all of the

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Navy's requirements, but they are expected to present a functional underwater glider, as well as research and plans that indicate the company will be capable of meeting the Navy's requirements.

The capabilities of the gliders that the Navy eventually wishes to deploy can be divided into two types. First, the US Navy wants to locate, deactivate, and recover unexploded warheads on the ocean floor. It believes that underwater gliders could be used to locate them, and that the gliders' small size make them ideal for use in contested waters. The gliders should be capable of object avoidance, object recognition, detecting energy signatures, and communicating via satellite. Second, the US Navy, in conjunction with the National Oceanic and Atmospheric Administration, wishes to continuously gather data on the world's oceans. The gliders should be capable of object avoidance, measuring a variety of properties of the ocean water, and communicating via satellite.

Tier 1: The Navy is primarily interested that the company can build a simple functioning and autonomous underwater glider capable of traveling in a straight line. Additional capabilities, such as maneuverability, sensor data recording, and communication are greatly encouraged. The Navy expects the company to provide a White Paper that explains their design process and testing, but also includes detailed future plans for how they will meet at least some of the Navy's other requirements.

Tier 2: The Navy is primarily interested that the company can build a simple functioning and autonomous underwater glider capable of navigating through a simulated canyon of known dimensions. Additional capabilities, such as sensor data recording and communication are greatly encouraged. The Navy expects the company to provide a White Paper that explains their design process and testing, but also includes detailed future plans for how they will meet at least some of the Navy's other requirements.

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A. Program Structure and Format

I. Eligibility and Registration

a. *Eligible Participants*

The GPSGC is open to high schools and youth organizations in the Pennsylvania, New Jersey, and Delaware tristate state area.

b. *Registration and Fees*

Team registration opens in early fall until capacity is reached. Only one high school level team (9th- 12th grade) per school or organization will be accepted. Teams may register for both tiers of the competition. If a team is competing in both tiers, it must have a separate craft for each tier. There is no fee to register for the SeaGlide competition.

II. Timeline

a. *Phase I – Program Kickoff*

The program kickoff includes team registration, the delivery of the challenge mission, rules, and deliverables, and new advisor training. Teachers will attend a 2-day training session for building SeaGlide and Arduino coding.

b. *Phase II – Design, Build, and Test*

This is the time between the program kickoff and the competition to learn, experiment, design, build, test, and practice. Depending on the tier the team is entered in, the AUV may have none, one, or multiple modifications to the original structure of the basic SeaGlide kit.

c. *Phase III – Competition*

There are three sections to the competition: White Paper, Presentation, and Vehicle Performance. The White Paper will be submitted prior to the competition day. The Presentation consists of two deliverables: a commercial and an oral presentation. The Vehicle Performance will take place in a pool on the day of the competition. The commercial and slide presentation to accompany the oral presentation will be submitted prior to the competition day, but will be presented and judged on the day of the competition. For more information, see the Challenge Categories and Deliverables section.

B. Challenge Categories and Deliverables

I. White Paper

The white paper is a 3 – 5-page paper that describes how your design approaches and solves the performance challenge. The white paper shall contain an explanation of how your SeaGlide meets the mission requirements, an explanation of how specific scientific principles apply to your design, an analysis of alternative designs, and updated computer code (if any). The computer code is not included in the 3 – 5-page requirement. A more detailed rubric is available at phillynavalstem.com.

II. Presentation

a. Commercial

Teams must produce a professional marketing commercial that lasts one to one and a half minutes. The commercial must focus on product differentiation, product features, product benefits, pricing, and current and future design solutions. The commercial must encourage the government to fund the design and manufacture of your SeaGlide and show other elements that cannot be demonstrated in an oral presentation (motion, development process, testing, teamwork). A more detailed rubric of the commercial can be found on phillynavalstem.com.

b. Oral Presentation

Teams must produce a slide presentation for their oral presentation. This slide presentation will contain more details than the commercial and last about six to eight minutes. Any number of teammates may act as presenters. The oral presentation should discuss the design process and obstacles the team overcame and show elements that could not be demonstrated in the commercial (close-up photos, tables of data, lists of parts). Each team should discuss alternative designs that your team considered, the pros and cons of each, and ultimately why you chose your final design. Each presenter should have a speaking role during the presentation. Following the oral presentation will be a Q&A by the judges. Be prepared to answer questions regarding both your commercial and presentation.

*During the presentation and Q&A, the teacher/advisor and non-presenting teammates may not speak. They may remain in the back of the room and watch.

III. Vehicle Performance

a. *Tier 1 – Introductory Level*

Tier 1 is the introductory level SeaGlide competition in which teams will compete with a basic SeaGlide kit and have a maximum budget of \$50.00. The performance requirements are to glide across a 50-foot pool and to navigate as straight a line across the pool as possible. Teams are scored based on their time and accuracy.

b. *Tier 2 – Intermediate Level*

Tier 2 is the intermediate level SeaGlide competition in which teams will compete by modifying a SeaGlide kit and have a maximum budget of \$100.00. The performance requirements are to navigate a simulated canyon consisting of two turns. Teams will be evaluated on their ability to navigate the simulated canyon, finish the course at a target location, and the time of navigation.

*The SeaGlide AUV relies heavily on the initial launch direction to perform well, especially in the Tier 1 competition. While it is not required, we highly recommend that each team build a launching platform for their vehicle. If you choose to do so, recommendations and requirements on the platform can be found at phillynavalstem.com.

C. Competition Day

I. Competition Day Structure

- a. Team Registration and compliance
- b. Presentation of Colors
- c. Opening Remarks
- d. Performance Rounds and Oral Presentations
- e. Awards Ceremony

II. Arrival and Check-In

Registration begins at 8:00 am. Please plan to arrive between 7:30 and 8:00 am. Advisors should report directly to registration. Each team will be handed a step-by-step checklist that must be completed and certified (initialed) by the Lead Judge at each location before the team is eligible to compete. Once the checklist has been completed, it should be handed to the Lead Compliance Officer.

D. Awards and Competition Advancement

Each section of awards is divided into the two tiers of competition. Awards are given for White Paper, Presentation, Vehicle Performance, and an Overall Winner. For the Overall Winner category, scores from each category will be combined to determine the overall GPSGC champion from each tier.

E. General Rules

I. Triage

The vehicle may be worked on by the teams during the competition at the triage station.

- i. The triage station is equipped with select spare parts and hand tools.
- ii. Triage engineers are not there to build your AUV's replacement parts.
- iii. Triage is to be utilized for repairs and not for building your AUV.
- iv. Triage engineers are there to ensure the safety of students and assist with minor repairs.
- v. There will be a laptop at triage if a team needs to reset their code or make slight changes.

II. Pool Access and General Pool Performance Rules

a. *Pool Access*

To manage the amount of activity on the pool deck and maximize safety, the following rules are in place:

- i. A limit of two team members can be on the pool deck in the competition area during an event.
- ii. Advisors are not permitted on the pool deck during competition events.
- iii. All team members must wear shoes with rubber soles on the pool deck.
- iv. Absolutely NO glass, chemicals, or loose materials are permitted in the pool or on the pool deck.

b. *General Pool Performance*

- i. Nothing other than the SeaGlide vehicle and launching platform shall be put into the pool during competition.
- ii. In the event that a vehicle is inadvertently interfered with during a competition, or a malfunction of a vehicle's parts (i.e. the motor) occurs that is not the result of the design or construction, the Lead Pool Judge will have the sole authority to provide the team time to fix their vehicle and to allow them to compete at a later time.

III. Redress, Challenges, and Disputes

- a. Sportsmanship is expected at all times. Should a protest or dispute occur during the competition it is the intent to resolve the grievance at the time it occurs, and the ruling by the Lead Judge shall be final.
- b. A team that wishes to have an issue considered shall send the student team captain and one additional student member to the Lead Judge with the inquiry or question. The Lead Judge will make the decision on the issue, and this decision is final. The same issue may not be brought to the judge a second time by any member of the team. Adults may not approach the Lead Judge on the pool deck regarding any perceived issues.

- c. Unsportsmanlike conduct is grounds for the disqualification of a team. Team members and advisors are responsible for the conduct of all members and adults accompanying the team.
 - d.
- IV. Scoring
- a. *Individual Scoring*
Each event will be scored in accordance with its published rubric. Teams will then be ranked by their score. The rubrics can be found on phillynavalstem.com.
 - b. *Combined Scores*
Each team receives a score from each of the three categories: White Paper, Presentation, and Vehicle Performance. Scores from all categories will be combined to determine the overall GPSGC champion from each tier. The overall winner from each tier will receive a trophy.
 - c. *Breaking Ties*
Scoring ties will only be broken where it is required to determine trophy places (i.e. ties will not be broken when ties do not affect the top three results in any event or class overall). Pool performance ties to the 100th of a second will be broken by the faster time.

F. SeaGlide Mentor Program

- I. What is the Mentor Program?
- The mentor program is an important part of the GPSGC. Bringing engineers and students together in a classroom environment is increasing student interest in math, science, and engineering. It increases awareness of Naval Engineering and Naval Architecture as career fields. Benefits of the mentor program include:
- Helping students prepare for college level work
 - Provides students with the opportunities to:
 - work in a collaborative environment
 - experience a major university campus
 - participate in a realistic business and technical scenario
 - interface with industry, academia, and government engineers
- Working with a mentor enhances a team's experience and provides the teacher/advisor with a greater chance of success.
- II. How is the mentor relationship established?
- SeaGlide teams register online and it is at that time they can request partnership with a mentor. Once the request is received for a mentor one may be assigned to you. Every effort is made to find the best fit between the school and the mentor. A returning team may specifically request a mentor they have had in a previous challenge. Once a mentor is assigned, an email is sent to the mentor and the first team advisors. Mentors are given the

first and second advisors name, email address and telephone numbers. The advisor is contacted by the mentor via email or telephone.

III. Meeting with the Mentor

The mentor meets with their SeaGlide team at least four times throughout the Design and Build phase. The first meeting is a great introductory opportunity for the mentor to discuss their career, the fields of science and math and share the fun aspects of math and science. The mentor can provide examples of how they use science and engineering every day. Subsequent meeting times are established where the students engage in the design of the SeaGlide and then on to the building phase.

IV. The Benefits of Working with a Mentor

- The mentor program is increasing student interest in math, science, and engineering.
- Increase awareness of Naval Engineering and Naval Architecture as career fields
- Provides students with the opportunities to:
 - work in a collaborative environment
 - participate in a realistic business and technical scenario
 - interface with industry, academia, and government engineers

Working with a mentor will provide your team with a greater chance of success.

Additional resources for the SeaGlide competition can be found at phillynavalstem.com.