



3rd Annual Greater Philadelphia
SeaGlide Competition

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 that 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 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 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 early spring at Temple University's Pearson Hall, located at 1800 N. Broad Street, 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 and compliance checks, 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, an explanation of the final design, and future design plans. 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 technical sections 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 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 and lack of crew 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 schools and youth organizations in the Pennsylvania, New Jersey, and Delaware tri-state area.

b. Registration and Fees

Team registration opens in early fall until capacity is reached. Only one team per school or organization will be accepted. Teams may register for either Tier 1 or Tier 2. If a team is competing in Tier 2, they may have a separate craft for the Tier 1 Vehicle Performance section only. 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. Each school may have up to two teachers and two students attend a 2-day training session where each person may participate in either SeaGlide building or 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. The AUV may be given 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 a slide presentation. The commercial and slide presentation will be submitted prior to the competition day, but will be presented and judged on the day of the competition. The Vehicle Performance will take place in a pool on the day of the competition. For more information, refer to the Technical Sections.

B) Technical Sections

I. White Paper

a. Overview

The white paper is a 3-to-5-page paper that states the purpose of the SeaGlide, provides background on the problems and solutions, and describes and justifies your current design and future plans. The white paper should include all of the following:

- An explanation of how specific scientific principles apply to your design
- Figures (i.e. photographs, diagrams, graphs) and/or tables
- Updated computer code (if any)

Figures and tables do not count toward the length of the white paper. Updated computer code should be included in the appendix and does not count toward the length of the white paper.

b. General notes

- It is expected that the paper submitted was written only by students and is original and unique for this competition year. Papers with substantial portions copied from previous years' submittals will be penalized or disqualified.
- Limit file size to 3 MB by appropriately compressing pictures.
- Papers should be saved as a PDF (preferred), Word document, or Google Doc with filename "<SCHOOLNAME> SeaGlide White Paper 2020". You *must* send the file- do *not* share access to a file storage website.
- Submit papers to SeaGlideNotebooks@gmail.com, using subject line "Submission: <SCHOOLNAME> SeaGlide White Paper 2020".

c. General Rubric

Section	Points	Details
Cover Page	5	School name, Team name (optional), Advisor name and contact information, School ID#
Introduction	10	Briefly describe the problem and how your SeaGlide design is a solution.
Background	10	Provide detailed historical and/or scientific background on the problem and solutions for it.
Design Process and Solution	35	Describe the process by which you proposed and decided on your design and rejected alternative designs. Include any research, calculations and testing.
Future Plans	20	Describe future plans for your design. Include any research, calculations and testing to support these plans.
Summary	10	Make your case as to why your team deserves a multi-year SeaGlide development contract. Include a cost breakdown (the cost of the basic kit may be listed as one item). Original 3D-printed components are to be valued at \$0.05 per gram.
References	5	References should be cited throughout the document. Use the APA citation style.
Content/Organization	5	The white paper should have a professional appearance: section headings, page numbers, appropriate chart and figure titles with corresponding references in the text, appropriate use of references, and good organization.
Appendix A: SeaGlide Computer Code	0	This section should contain Arduino code that was newly developed for the SeaGlide. It should be clearly commented and indented. Do not include the basic buoyancy engine code unless it was modified, in which case only include the specific sections that were modified.
Total	100	

II. Presentation

a. Commercial

Teams must produce a professional marketing commercial with a duration between 60 and 90 seconds. The commercial must focus on product features, product differentiation, and current and future design solutions. The commercial must encourage the Navy to fund the design, research and manufacture of your SeaGlide. It should also show other

elements that cannot be demonstrated in the slide presentation (motion, development process, testing, teamwork).

b. Commercial General Rubric

Section	Points	Details
5-second Splash Screen	1	School name, Team name (optional), School/Team logo, School ID#
Introduction	2	Briefly introduce your SeaGlide.
Product Features	5	Describe your SeaGlide's design features.
Design Process	5	Describe your team's design process.
Future Plans	5	Describe future plans for your design.
Summary	2	Make your case as to why your team deserves a multi-year SeaGlide development contract.
Graphics/Animation/Video	5	Demonstrate proper use of the video medium.
Content/Organization/Quality	5	The commercial should make good use of its time, be well-organized, and be clearly shot.
Total	30	

c. Slide Presentation

Teams must produce a slide presentation which they will present to judges. This slide presentation will contain more details than the commercial and last between six and eight minutes. Any number of teammates may act as presenters. The slide presentation should discuss the design process and obstacles the team overcame. It should also 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 observe, but may not contribute.

d. Slide Presentation General Rubric

Section	Points	Details
Cover slide	5	School name, Team name (optional), School/Team logo, School ID#, Names of presenters
Introduction	5	Briefly describe the problem and how your SeaGlide design is a solution.
Design Process	20	Discuss your design process, including obstacles overcome and alternative designs that were considered.
Design Modifications	15	Discuss specific design modifications.
Data and/or Calculations	10	Present any data or calculations that were part of the design process.
Closing Remarks	5	Make your case as to why your team deserves a multi-year SeaGlide development contract.
Content/Organization/Quality	5	The slide presentation should make good use of its time and be well-organized. Graphics and photographs should be clear and properly sized.
Question & Answer	5	The presenters clearly answer all of the judges' questions.
Total	70	

III. Vehicle Performance

a. Tier 1

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. Original 3D-printed components are to be valued at \$0.05 per gram. This must be presented to the judge at Vehicle Compliance. The performance requirement is to glide a straight distance of 20 feet in 15 minutes. There will be checkpoints at 10 and 15 feet. SeaGlides must be tethered with fishing line, which must remain slack at all times. At any time, teams may use the tether to pull their SeaGlide back to the starting line and re-release it. Teams must pull their SeaGlide back if the body crosses into another lane or if a judge deems that a wing is in danger of touching a SeaGlide in an adjacent lane. Re-releasing a SeaGlide does not reset the elapsed time. Points are based on two parts: 1) the elapsed time it takes to reach each checkpoint and the finish line, and 2) how close the SeaGlide is to the center of the finish line.

b. Tier 1 Rubric

(T = elapsed time, B = best elapsed time for that distance)

Section	Points
Checkpoint 1	15(B÷T)
Checkpoint 2	25(B÷T)
Finish Line (time)	35(B÷T)
Finish Line (best target)	Green: +25, Yellow: +15

c. Tier 2

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. Original 3D-printed components are to be valued at \$0.05 per gram. This must be presented to the judge at Vehicle Compliance. The performance requirement is to navigate a simulated canyon consisting of two turns in 15 minutes. The simulated canyon is 5 feet wide, and the center path is as follows: 7.5 feet straight, 90 degree turn left, 4 feet straight, 90 degree turn right, 10.5 feet straight. SeaGlides must be tethered with fishing line which must remain slack at all times. At any time, teams may use the tether to pull their SeaGlide back to the starting line and re-release it. Teams must pull their SeaGlide back if the body crosses into another lane or if a judge deems that a wing is in danger of touching a SeaGlide in an adjacent lane. Re-releasing a SeaGlide does not reset the elapsed time. Points are based on three parts: 1) the elapsed time to reach the end of each straightaway or the finish line, 2) demonstration of autonomous turning, and 3) how close the SeaGlide is to the center of the finish line.

d. Tier 2 Rubric

(T = elapsed time, B = best elapsed time for that distance)

Section	Points
End of Straightaway 1	10(B÷T)
Autonomous Left Turn	10
End of Straightaway 2	15(B÷T)
Autonomous Right Turn	15
Finish Line (time)	25(B÷T)
Finish Line (best target)	Green: +25, Yellow: +15

Note: A SeaGlide may not score points for any section without completing the section preceding it. For example, a SeaGlide may not score points for reaching the end of Straightaway 2 if it never performed an autonomous right turn.

C) Competition Day

I. Check-In

Check-in begins at 8:00 am. Please plan to arrive between 7:30 and 8:00 am. Advisors should report directly to check-in.

II. Vehicle Compliance

Each team will be handed a step-by-step compliance checklist that must be completed and certified by a judge before the team is eligible to compete. Compliance will be verified at the pool. Once the compliance checklist has been completed, it should be handed to the Lead Compliance Officer. The items on the compliance checklist can be found at the end of this document.

III. Presentation of Colors and Opening Remarks

IV. Vehicle Performance and Slide Presentations

Each team will be provided locations and time slots.

V. Awards Ceremony

D) Awards and Scoring

I. Awards

Winners for each of the individual sections will receive certificates. The tiers will compete separately in the Vehicle Performance section. The tiers will *not* compete separately in the White Paper and Presentation sections. The overall winner from each tier will receive a trophy.

II. Scoring

The White Paper and Presentation sections will be scored in accordance with more detailed rubrics than the general rubrics provided in Section B. The Vehicle Performance section will be scored in accordance with the rubric provided in Section B. The scores from each section will be combined to determine the overall GPSGC champion for each tier.

III. Breaking Ties

Scoring ties will only be broken where it is required to determine award places. White Paper ties will be broken by additional judging. Presentation ties will be broken by discussion between judges. Pool performance ties will be broken by the farthest checkpoint reached, followed by the least final elapsed time.

E) General Rules

I. Triage

- The vehicle may be worked on by the teams during the competition at the triage station.
- The triage station is equipped with select spare parts and hand tools.
- Triage engineers are not there to build your AUV's replacement parts.
- Triage is to be utilized for repairs and not for building your AUV.
- Triage engineers are there to ensure the safety of students and assist with minor repairs.
- 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:

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

b. General Pool Performance

- Nothing other than the SeaGlide vehicle and launching platform shall be put into the pool during competition.
- 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

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.

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.

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.

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 competition. Once a mentor is

assigned, an email is sent to the mentor and the team advisor containing email and telephone number contact information. It is up to the advisor and/or mentor to establish and maintain connection after the first introductory e-mail is sent.

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.

G) Compliance Checklist

COMPLIANCE (SeaGlide Tier 1 & Tier 2)

Construction

No loose parts that will potentially fall off during competition or handling.	Pass	Fail
All joints are tight. All tie wraps are trimmed and flush as much as possible. In the event exterior wiring is used, it must be fastened securely to the structure	Pass	Fail

Safety

No exposed live wires	Pass	Fail
No metallic sharp edges	Pass	Fail
All electrical contacts are protected	Pass	Fail
No chemicals, CO2 Cartridges or loose materials shall be introduced into the pool, NO GLASS	Pass	Fail

Functional Tests

Team demonstrates function of internal syringe plunger operates properly	Pass	Fail	
If SeaGlide utilizes any controllable appendage(s), the team must demonstrate proper functionality	Pass	Fail	N/A
If SeaGlide utilizes any sensors, team must demonstrate proper functionality	Pass	Fail	N/A

Design Compliance

No more secondary means of propulsion are installed	Pass	Fail	N/A
Glider conforms to allowable budget of \$50.00 or less for Tier 1 . Proof provided.	Pass	Fail	N/A
Glider conforms to allowable budget of \$100.00 or less for Tier 2 . Proof provided.	Pass	Fail	N/A
SeaGlide Launcher (<i>Optional Component</i>)			
1. Must attach to the side of the pool at designated starting point/lane.	Pass	Fail	N/A
2. Must be easily deployed and removed from the side of the pool.	Pass	Fail	N/A
3. Must NOT require any team member to enter the pool deploy or adjust.	Pass	Fail	N/A
4. Must NOT extend greater than 2 feet into the pool lane.	Pass	Fail	N/A
5. End/back of the SeaGlide (i.e. rudder) being within 6" of side of the pool	Pass	Fail	N/A
6. Must NOT impart any force on the SeaGlide at launch.	Pass	Fail	N/A
7. Depth of the launcher Tier must not exceed 2.5 feet.	Pass	Fail	N/A
8. Width of the launcher Tier must not exceed 2 feet.	Pass	Fail	N/A
9. Teams able to activate their SeaGlide without reaching into the pool.	Pass	Fail	N/A

COMPLIANCE (*Circle one*)

PASS

FAIL