SOLAR SPLASH TECHNICAL REPORT 2025

CAL POLY POMONA

Boat #8

Advisor: *Professor Gerald Herder*

Team Members: *Issac Castillo, Talia Dorian, Jeryl Fernandez, Maya Itelman, Caden Nihart, Elijah Tolosa, Matthewes Zemoy, Pablo Diaz, Kailin Lankford, Liam Kaschner, Trevor Matsumoto, Sean Wygant, Eirik Ubeda, Jayvee Bonus, Sarah Boyd, Ivan Guadarrama, Ryan Fong, Helena Mock & Anjana Korisal*

Executive Summary

The 2024-2025 Cal Poly Pomona Solar Boat Team's primary goal was to return the club to a competitive level for the first time in seven years. The team emphasized designing and building a new boat from scratch and creating a sustainable system where future teams can grow from a strong foundation rather than losing the experience and knowledge from teams before, who have graduated and left the team. The project objectives that we chose to spearhead were to design a cost-effective hull for both speed and longevity, and refining the electrical and drivetrain system, utilizing all necessary parameters for maximum performance.

Several key improvements that we have had included the creation of a custom hybrid-planing carbon fiber hull reinforced with Nomex honeycomb, allowing for a light and durable structure for competition. Upgrading with a 16 kW Lynch Motor Company permanent magnet motor paired with a modern AllTrax motor controller, offering an increase in power while keeping other necessities maintained. We have also begun to integrate other powerful tools, including SolidWorks simulation and MATLAB, to optimize our research and development in all ways possible.

In comparison to previous years, our 2024-2025 team has had major improvements. With the utilization of an improved boat design and electrical system, we plan to reach a sprint time of 30 seconds and an endurance distance greater than 60 laps, improving on the previous CPP Solar Boat's performance.

Beyond our technical changes, Solar Boat has been able to dive further into social media, allowing us to have an influx of new members. Overall, there has been a 5 fold increase of members since the beginning of the school year, ranging from students of all majors. The growth of our club has allowed us to have a more notable presence on our campus, and allowed us to divide the work into more categories personalized for each member.

While the club has had major achievements, there have been several challenges that we have had to overcome. Budget restrictions caused us to be highly cautious with our club funds, focusing on maximizing the present materials rather than being careless with our plans for the boat. This led us to focus on designing our own system from scratch and at times having to postpone or scrap potential ideas as it was infeasible to do so with our current budget. However, where CPP Solar Boat really shined was the adaptability to uncover innovative solutions. With the utilization of a strong leadership, project management, and team collaboration we have been able to slowly turn our biggest weaknesses into our greatest strengths. We hope that this strong and unwavering desire to continue pioneering as a club remains in the club and our future Solar Boat members.

Table of Contents

I. Overall Project Objectives

The overall goal of this year's Solar Boat team was to bring the club to competition for the first time in seven years. As a team, we will gain experience that can be passed down to the next generation of CPP Solar Boat. The majority of the boat this year will be entirely new, with supplemental parts sourced from the club's long term storage.

This year's projects will establish a system to iterate and optimize all designs with a solid and reliable platform in future years. The first and foremost project of the year was to build an entirely new hull and panel mounting system. Our race day goals are to perform well in all three races, with the most focus placed on the sprint and endurance. The goal for the sprint race was to have a maximum speed of 20 MPH to be competitive, and a stretch goal of 24 MPH to be competitive with the top teams. Our time goal for each sprint race is 30 seconds or less. The team's goal for the endurance race is an average moving speed of 12 MPH or 60 laps. While the slalom is not a focus of this year's design, a goal of one minute was set.

The last Cal Poly Solar Boat team to participate in Solar Splash was the 2017-2018 team. During the 2018 race, they posted a minimum sprint time of 60.35 seconds; our goal is to cut this in half. The best performance in slalom for that same year was 129 seconds and they completed 43 total laps in the endurance. We will be cutting the time in each event in half and increasing our endurance performance. Based on design calculation we are on track to meet our performance goals this year. As of writing this report we are out performing and farther along in the project than the 2023-2024 team as well.

The boat hull has been designed as a hybrid planning-plowing hull. A single hull vessel has not been used by Cal Poly since 2017. Returning to this type of hull will increase efficiency, speed, and simplify our build process. Computational Fluid Dynamics was performed on the final hull design to optimize for efficiency and minimize drag. The motor in use this year is more powerful than previous motors used, a 16kW LMC DC motor. An AllTrax SR48600 motor controller has been added to the drive circuit. Using this system we can easily tune and control this motor.

All solar panels in use have been tested for open and short circuit performance, as well as load tested to predict how much power can be harvested. New batteries were donated by UPS batteries. These batteries were load tested to find the optimal discharge rate of the battery pack. Using this method the team will be able to track power usage during the endurance and ensure power is used to math the optimal curve.

When the solar panels are in use they can be used as a range extender to increase speed. In the water the MPPT will be used as a data acquisition system. The skipper will relay on board information to members on the shore who will use a custom MatLab program to plot the power usage relative to expected discharge rates.

As much time will be spent practicing for the slalom and testing the system in the water to prepare for race days. To ensure the team can improve next year a new documentation plan has been established that is available to all members. This will ensure future years have access to previous knowledge and can contribute freely.

II. Solar System Design

A. Current Design

Our solar array for this year uses 3 panels. Two are 235W panels and one is a 250W panel, totaling the race limit of 720W of solar power under normal, one-sun conditions. The panels are wired in parallel using a junction box to keep the system voltage under the 48V limit.

B. Analysis of Design Concepts

The off-the-shelf panels we used for our solar array had one major drawback. They used a metal frame around the panels to keep them sturdy and give easy mounting points. This adds a considerable amount of weight to the panels, and in next year's design, we plan to create our own lightweight panels to avoid this issue.

III. Electrical System

A. Current Design

This year, we improved on our electrical design by replacing our old AllTrax motor controller with a modern and more durable version from AllTrax. The new controller is rated for 600 amps and includes a fan for air circulation, which improves on the older model rated for 400 amps. We expected that this newer controller would improve efficiency and reduce heat.

IV. Power Electronics System

A. Current Design

Three 36-volt solar panels are connected in parallel and connected to an MPPT charge controller to create efficient charge conditions. Three 12V, 22AH, deep cycle lead acid batteries (6-DZF-22) are connected in series to create a nominal 36V power system. This is then connected in parallel with another set of 3 batteries, creating a battery pack of 6 total batteries. Each battery weighs 15.6 lbs and has a maximum discharge current of 150A. The total weight of the battery pack is 93.6 lbs, which is under the competition maximum of 100.3 lbs. The battery pack, solar array, and drivetrain are connected together with an AB switch. Power is passed through a solenoid and then to our permanent magnet motor. The solenoid is controlled through the motor controller and a signal line consisting of a throttle, key-switch, and dead-man switch. Various fuses and diodes are used throughout to ensure safety and proper flow of power. A schematic provided by AllTrax[1] was used as the base of our design and is provided in Fig. 1

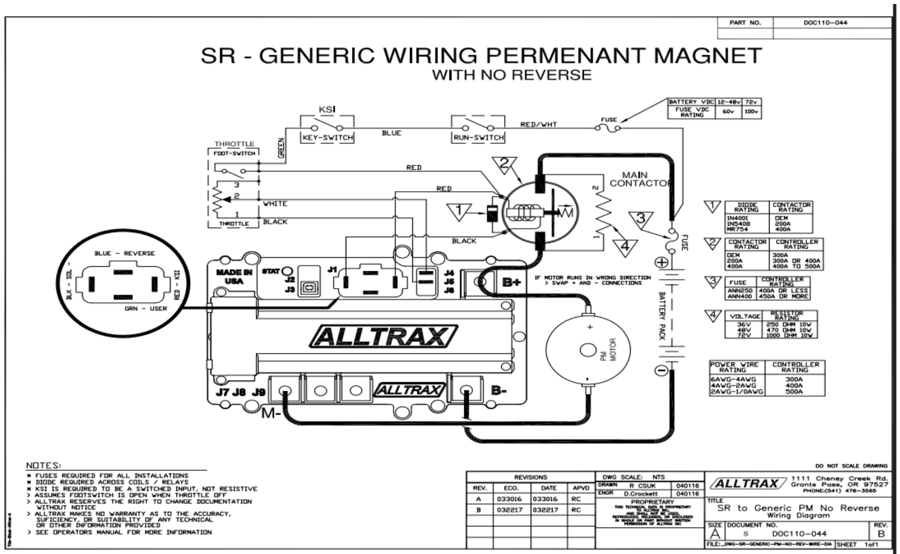


Fig. 1: Circuit diagram of the power electronics configuration, not including the solar array

V. Hull Design

Initial plans for this year's competition were to use a hull donated to the club two years ago. After attending the competition as volunteers in 2024, the team decided the hull was not suitable for this competition. The boat donated was a planing hull design. While it would be fast, it would not hold the weight of solar panels or perform well in the endurance race. The team decided a new hull was needed that would perform well in all portions of the competition.

A. Current Design

The final design used is a hybrid planing-displacement hull. Overall length is 15' 7.5" with a width of 3' and height of 18". A CAD model of the final design can be seen in *Fig. 2.* The body of the vessel is made of carbon fiber and epoxy. The core of the hull is 2" thick Nomex honeycomb used for low-density structural support. The Nomex core allows for lightweight construction that is more than capable of maintaining the structural integrity. To create the carbon fiber body, we placed blocks of polystyrene foam between each of the wooden profiles of the hull and cut the foam following this shape, which created a mold now resembling the body. These profiles are slices of the SolidWorks file of our hull, slices we took every 6 inches to get a good shape of the hull. The mold was then sanded down to maintain an even and smooth shape, coated in 5 layers of latex paint for protection, and then a coat of Bondo body filler to create a solid surface. We will then lay carbon fiber on top of the entire foam mold, coat it in epoxy resin, and then cure it via vacuum bagging. Once fully cured, we remove the carbon fiber from the mold, and the product is our hull. The solar panels will be attached to extruded aluminum that will be bolted down to the lip on the sides of the hull, creating a canopy above the skipper.

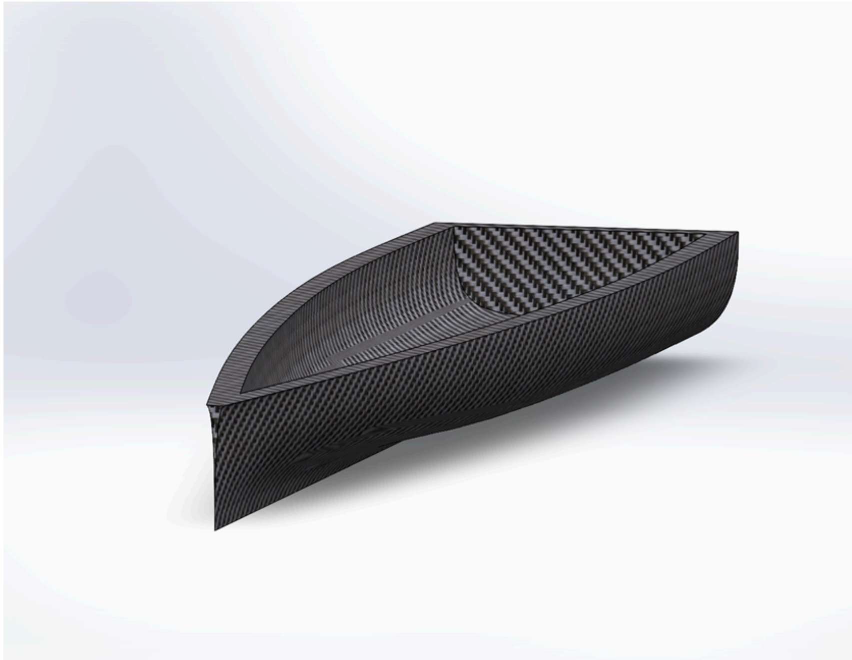


Fig 2: CAD model of Final Hull Design

We ran into a few problems during the R&D and manufacturing processes of the hull. A problem we ran into was the type of carbon fiber we had in our possession. We would have preferred using pre-preg carbon fiber, carbon fiber pre-impregnated with resin and ready to be laid into a mold. This would provide a cleaner and more accurate finish, but we did not have the funding to acquire pre-preg carbon fiber as it is a considerable price increase. To our convenience, we already had a stockpile of carbon fiber rolls and vacuum pumps left behind by previous clubs, so we decided to purchase resin and the proper vacuum bagging equipment and hand lay the carbon fiber ourselves. Funding was an issue in more places than with the carbon fiber, it was a major issue across the entire process. On many occasions, club members had to finance parts of the build themselves; for the vacuum bagging materials, the club officers split the cost 5 ways. The club eventually set up a GoFundMe, which provided a good amount of funding, but this is still not a steady or reliable source of income. Some of our problems were caused by human error as well. The original plan was to lay the carbon fiber on the negatives of the cut foam and use that foam for passive flotation. There was also a miscommunication with the foam supplier and we did not receive enough foam.

Due to time and material constraints, future hull improvements will have to be made for next year's boat. A critical improvement to be made is using pre-preg carbon fiber, freeing club members of the complex task of laying the carbon fiber and resin ourselves. There is a freezer in the club’s shop to store pre-preg; it’s just a means of affording it.

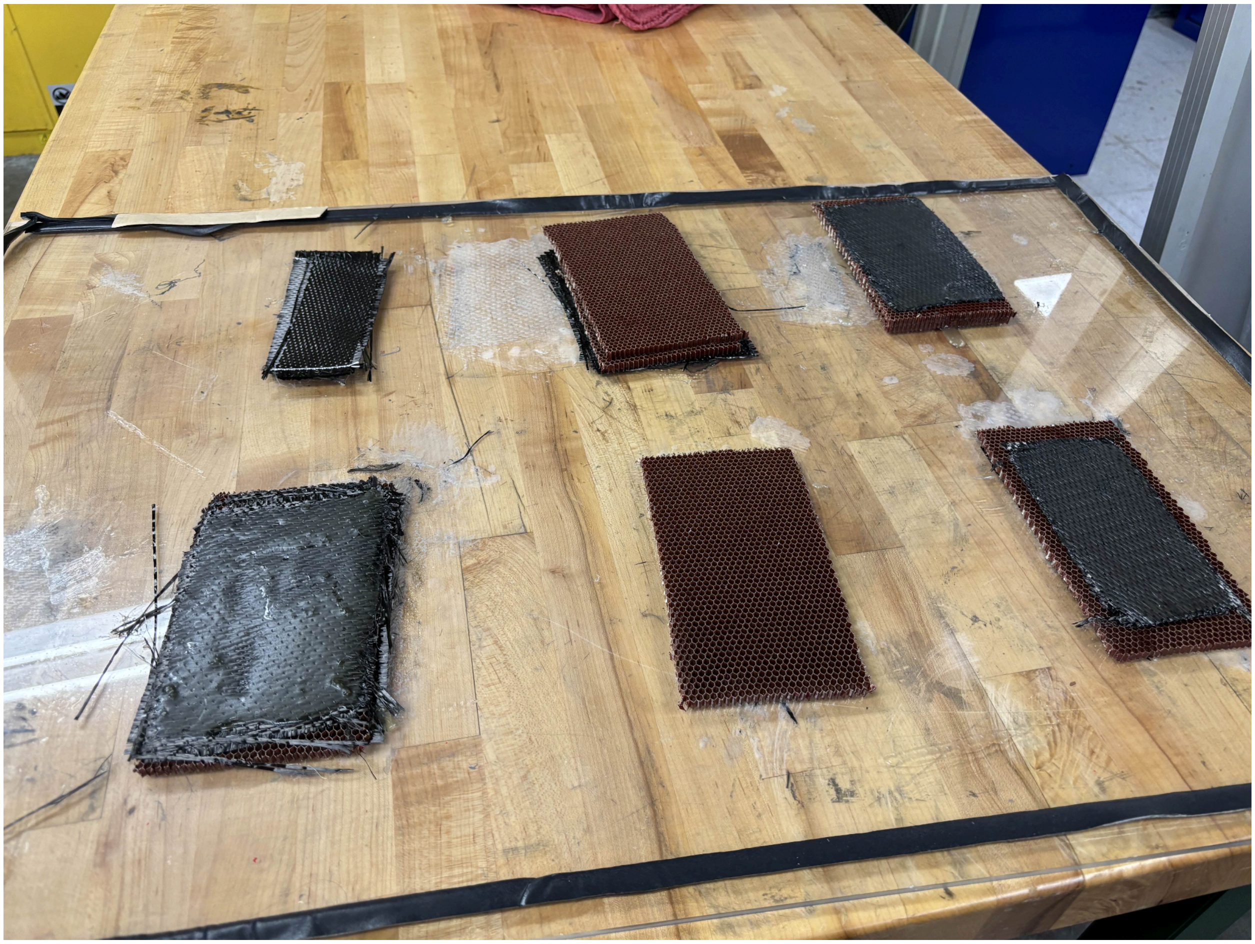


Fig. 3: Test Coupons of Carbon Fiber and Nomex Composite.

B. Hull design analysis

In this study, the hydrodynamic performance of a custom-designed planing hull was evaluated through Computational Fluid Dynamics (CFD) simulation. The primary goal was to determine the drag coefficient and assess fluid behavior around the hull body to simulate operating conditions. SolidWorks Flow Simulation was used to model and analyze the steady-state water flow around the hull surface at a velocity of 12 mph (5.364 m/s).

The planing hull was chosen for its efficiency at higher speeds, where lift reduces the wetted surface area, minimizing drag. Due to the complexity of planing calculations, the tests were run with the assumption of displacement rather than planing.

To characterize the resistance experienced by the hull, simulations were run with water properties at standard conditions ($\rho = 999\ kg/m^3$). The projected wetted area was specified as 36 ft^3 (3.3445 m^3), matching the design parameters. From the simulation output, the steady-state drag force acting on the hull was recorded as 205 lbf (911.9 N).

Using the classical drag force equation, the drag coefficient was calculated [2]. Substituting the measured values yielded a final drag of 0.019. This low drag indicates a streamlined hull shape with minimized flow separation.

Flow visualization showed attached flow along the majority of the hull surface with minor separation zones near the aft section, as seen in *Fig. 4*.

The hull has a weight capacity of 680.16 lbs, and once the boat is fully loaded, it will have a max weight capacity of 739.44 lbs. The hull has a volume of 10.85 ft^3 and once loaded with everything on board, a final volume of 11.85 ft^3.

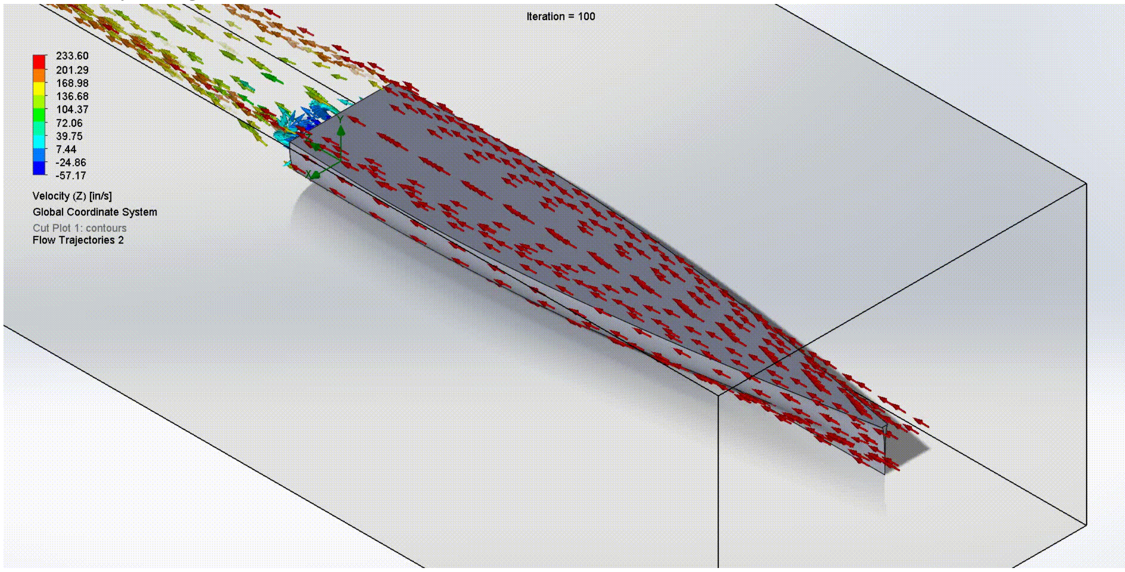


Fig. 4: SolidWorks Flow Analysis of Final Hull Design

C. Design Testing and evaluation

As of writing this technical report, the boat is not complete and we are unable to conduct testing or analysis of the hull. Once the hull is complete, we plan on conducting time trials in the water where we will see how the hull's design and weight affect speed and drag. A test that can be conducted without needing the hull finished is a 3-point bend test of coupons, see *Fig. 3*. 4"x2" coupons made of the same layup as the boat can be made and tested on the 3-point bend test machines that are in the materials lab on campus. These tests can provide valuable information about the hull, such as its modulus of elasticity, stress-strain behavior, fatigue properties, and failure point.

IV. Drivetrain and Steering

This year's drivetrain and steering system is derived from the system design in 2023. A shortened 25-horsepower Mercury outboard. A new 16 kW Lynch Motor Company DC permanent magnet motor is adapted to the outboard, seen in *Fig. 5*. The outboard and motor are connected with an adapter designed by the club and mounted to the transom of the boat. Steel cables connected to the outboard are used to tilt the outboard left and right by rotating a steering wheel. The old system has been updated to work with a new motor and hull, and revisions were made to ensure component reliability.

A. Current Design

Two 8 kW LMC D126 motors are mechanically coupled in series for a total of 16 kW of power. The motor output shaft is connected to the input shaft of the outboard via a Jaw coupling. A motor adapter was designed by the club and machined by a local machinist. The outboard is a shortened 25-horsepower Mercury outboard that was donated to the club. The Mercury outboard includes a clamp that is fastened to the hull's transom. A mounting loop on the outboard is connected to a steel cable, which pulls the free portion of the outboard left and right.

Fig. 5: Drivetrain Fitment Test Example

The boat's steering system is based on a custom-built cable and drum mechanism guided by a rigid conduit frame structure. This design provides a lightweight, durable, and easily serviceable steering solution that connects the skipper's steering input directly to the outboard motor.

The system starts with a steering wheel mounted at the skipper's position, mechanically linked to a drum assembly. As the wheel turns, the drum winds and unwinds a braided cable. The frame layout minimizes excessive cable flexing and keeps the cable properly aligned, reducing wear and steering friction.

The conduit frame extends from the steering station to the transom area, providing direct, supported pathways for the cables. Cross-bracing is used where necessary to maintain frame rigidity and prevent unwanted deflection during steering input. The cable wraps around pulleys at harsh angles to ensure smooth directional changes without creating sharp bends that could weaken or restrict the cable in any way. At the rear, the cables terminate at an eye round screw, ensuring control over motor angle and direction. The geometry of the frame also ensures symmetrical pull and return paths for better responsiveness and minimizing backlash or play in the system.

Aside from the steel braided cable and conduit tubing, all materials used for the steering setup were sourced from existing club inventory. This approach reduced project costs while also supporting sustainability and reusing available resources.

B. Design analysis

The motor adapter was designed by a previous club president. The adapter was designed to be 3D printed for final production. Upon test fitment, the body of the adapter blocked fasteners and could not be used. The adapter was slimmed down to create clearance for fasteners. Another test fit made it evident that the body of the adapter made contact with the motor's heat sink. To avoid melting the adapter, a local machinist was contacted to produce the adapter out of aluminum.

The steering system was designed to be easily maintained and simple to construct. Utilizing a steering wheel and drum already in our possession meant the majority of the cost for steering could be spent on reliable cables. One-eighth-inch steel cable was wrapped around the drum and down the length of the boat on port and starboard. 10 lbs springs were used to tension the cable and ensure the steering system always returned to center in the event of an emergency. Eye hooks were used to guide the cables along the boat. To reduce friction and increase reliability, the cable is greased.

C. Design Testing and Evaluation

We will be testing this drivetrain in the days before the competition, both in and out of water, to ensure that everything works as intended and can provide enough thrust to achieve the speeds we wish to travel. Once everything is completed, we will be running tests and comparing actual output speed to the theoretical speeds given by computational fluid dynamics software.

For our steering systems, we were deciding between multiple different methods, such as a push-pull system with a steering wheel, a drum and cable system, or a pulley system. After consulting with our skippers about their preferred method of steering, it was determined that the pulley system would be the easiest to learn and maneuver, as most of our skippers are freshmen and have never driven a boat before joining our team. The number of days between when we complete our boat and when we have to travel to Springfield is exceptionally few, meaning the quickest method to maneuver the boat is preferred.

V. Data Acquisition and Communications

A. Current Design

This year's design will use a Victron Energy Smart Shunt Battery Monitor to relay important battery information to the skipper. This monitor supports the display of state of charge, voltage, current, power, consumed Ah, and time remaining. The monitor uses bluetooth and the skipper will be able to see its display through a phone. The skipper will report this information through their radio to the rest of the team on land

B. Analysis of Design Concepts

Our choice to use an off the shelf product was made to save on time. While it provides a base for our data acquisition, next year we hope to create a custom solution. One alternative is to implement sensors across various subsystems of the boat (solar, motor, battery) and transmit that over a CAN bus to a built-in dashboard display on the boat[3]; an example can be seen in *Fig 6*. This will allow for us to have more detailed and custom information transmitted to the skipper; additionally, the creation of a dash with a display allows for a larger screen that is easier for the skipper to see. This system would also allow us to use a wireless communication protocol other than bluetooth that might have great enough range to directly transmit information to shore, rather than relying on the skipper to relay. Overall though, our current system is satisfactory for our goals this year of getting a product that works and is reliable.

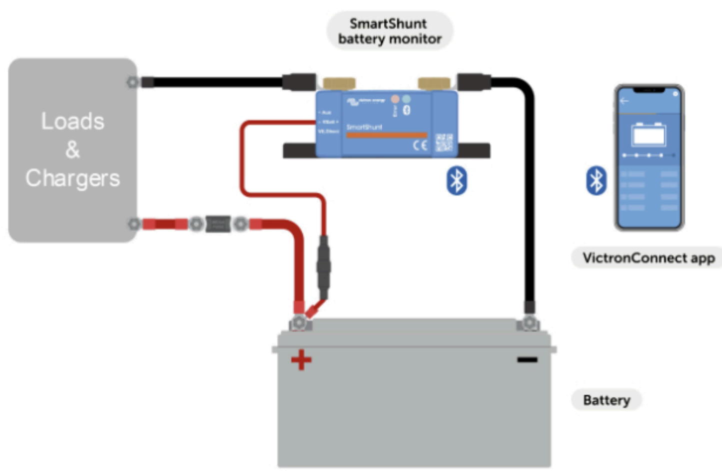


Fig. 6: Circuit diagram of SmartShunt battery monitor

VI. Project Management

A. Team Structure and Roles

The CPP Solar Boat Team is split into two sub-teams, Electrical Team and Mechanical Team. Within each team members are split into project groups. Team names are used to allow members to understand who they can ask for help and how their current role fits into the club. Each group is assigned a project to complete in accordance with the requirements of Solar Splash Regulations. The Mechanical and Electrical Team leads, manages and advise members on each project while working with members on specific projects. The President, Vice Presidents, Treasurer, and Scheduler work on the administrative side of the club and participate in the Electrical or Mechanical Team. Finances and fundraising is managed by the Treasurer with help from the Scheduler to select dates and ensure lab, project, and meeting spaces are available. Communication between the school, other clubs, and the club advisor is done by the President and Vice Presidents. The President and Vice Presidents also manage and advise all projects when needed, and may take more time on specific projects that require their skills and attention.

The Electrical Team designed, built, and tested several systems. Electrical systems included were drive circuit, charging circuit, solar panel optimization and battery pack optimization. The Mechanical Team was responsible for designing, building, and testing the hull, drive line, steering system, and mounting systems. All members of the team helped in building the hull and writing the technical report.

B. Project Timeline and Scheduling

The 2024-2025 Solar Boat Team began work in August of 2024. At this stage a plan was set to complete the entire system by April 1st of 2025. This would allow us to have a completed boat and test the entire vessel in time for both Solar Splash and the SMUD Solar Regatta. The drive and charging circuits were to be completed by December of 2024. Final Design of the boat hull was to be completed by December 18th 2024. Mounting systems and steering design was due by February 2025. Testing was to take place in April and May of 2025.

As seen in the following figure, the first milestone made was a final design for the hull, this was done in early December of 2025. The Drive circuit was delayed after the loss of a motor controller, and completed in December of 2025. The charging system experienced several revisions throughout the school years as solar panel availability changed. The final solar system was completed in March of 2025. Building of the model for the hull began in February of 2025 and the hull was completed May 20th of 2025. The vessel was completed May 24th 2025 and testing performed May 27th of 2025.

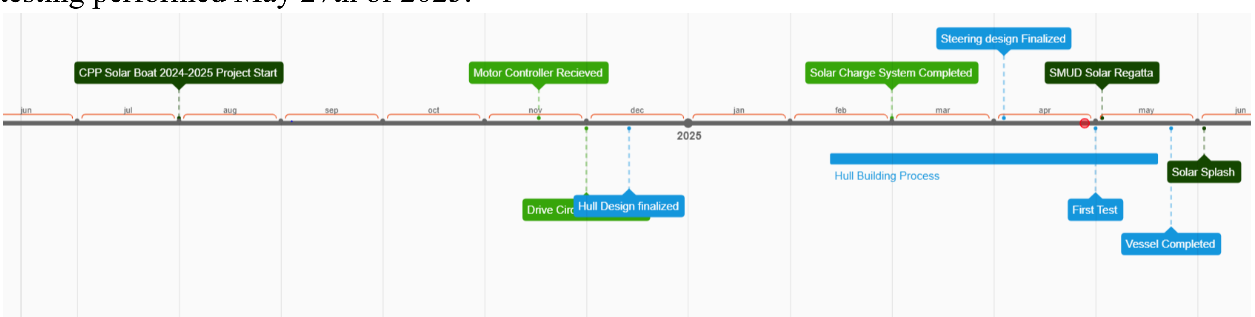


Figure 7: 2024-2025 CPP Solar Boat Projects Timeline

C. Budget and Fundraising

Our budget for the year was 5754.56 dollars that we received from the school. This was less than expected with the cost of lodging for competitions being 4000 dollars, the travel fee being 2000, and the creation of the boat being 5000 dollars. We were short by about 5000, and redistributed our funds to be 2754.56 dollars for the creation of the boat. 2000 dollars were used to pay for old expenses that had been incurred by previous years. The rest of the funding was used for registration and buying miscellaneous items such as gloves, wires, and tools to facilitate the building of the boat. We also went through the process of requesting additional funds to cover the cost of travel and lodging that were not covered in the original amount we received. We received an additional 6000 dollars which we broke down into: 3000 for lodging, 2000 for travel, and 1000 for food and other expenses incurred such as toll roads used when transporting the boat.

Our project has been generously supported through funding from GoFundMe, individual donations, and in-school events such as the Engineering Carnival Fundraiser. In addition to this, we have also been sponsored by AllTrax, who provided the motor controller, UPS who supplied the batteries, and SMUD, who contributed the solar panel

D. Sustainability and Team Continuity

Continuing forward as a club, we have decided to store any and all documents that are vital for future members on Google Drive including reports, sponsorship/fundraising ideas, receipts, project data, etc. In addition, we also have a club member discord, where we share ideas pertaining to the club, schedule workshops, and remain in contact with any alumni who are willing to share any important information or maintain our community. As the club has begun to reach a competitive level, we have had an influx of new members as previously the club had been a majority of upperclassmen. Our new members have been taught the required processes and knowledge for our goals by our Electrical and Mechanical Leads. In the future, we plan on hosting and participating in engineering workshops (soldering, solidworks, etc.) to teach new members skills that could be important to both the club and any future classes they may take.

E. Discussion and Self-Evaluation

A big setback we faced was financial support. The 2023-2024 leadership thought we had 12,000 dollars in our account so they only requested 234 dollars from our student government. We in fact only had 5754.56 dollars in the account and after reimbursements from this year's cabinet travelling to Solar Splash in June of 2024 for reconnaissance, we were left with 2754.56 in the account to pull from. A solution for this problem was to start crowd-funding from relatives and friends of our members. We were able to raise about 1800 through this method. Another solution was to fill out additional budget requests to our student government and once approved, we received another 6,000 dollars.

Our school has a new financial initiative known as "The Green Initiative Fund" where they would be able to allocate 15,000 dollars to sustainability projects. We would have loved to apply for this fund but were told that our project didn't qualify for this financial initiative since the fund was only applicable to on-campus sustainability efforts. When we had presented to our student government about the additional funding request, other leadership positions in the school government cabinet asked the treasurer if we qualified to use "The Green Initiative Fund". After some discussion, it was established that we most likely would have qualified if the board of directors held a special meeting. Unfortunately, we were told that we could qualify, with less than a month before the school year ended, and therefore, financial meetings for the school year had ended. While this wasn't able to help the team this year, knowing what can be done to help our financial struggles can benefit our team in future years.

Given that we built our hull from scratch, many of the processes were delayed until the hull was built. This includes the steering system, and testing of the motor and outboard compatibility, since both of these required the hull to implement the systems. For future years, we hope to have both the Electrical Team and Mechanical Team work on their portions concurrently so that once the hull is finished, both teams can implement their systems and test as a whole.

Another setback we had at the beginning of our process was that since we have not competed since 2018, we only had one 250 Watt panel that was measuring about 70% efficiency, and some student made panels that were measuring about 35% efficient. We didn't have the funds to travel up to Oregon to claim the free panels that were offered by Grape Solar, so we found other pathways to obtain panels for free. An in-state municipal company, Sacramento Municipal Utility District, hosts a similar solar boat race to Solar Splash, with the only caveat being we must use their panels. Competitors can use the panels they lease for as long as they continue in the competition. This being said, not only did we get free panels, but also were able to experience a solar boat race before Solar Splash and can tweak anything that needs improvement before this competition.

During the hull design portion, some disagreements arose when deciding between design iterations made by different members. After doing Computational Fluid Dynamic analysis, one design was performing better than the other with less drag and eddy currents so that was the final design chosen.

IV. Conclusions and Recommendations

A. Strengths and Weaknesses

A key strength of our boat is its lightweight nature. The use of carbon fiber and Nomex saves weight in the hull, an important advantage when the weight of the solar panels and outboard is a factor we don't have much control over. The simplicity of our cable and drum steering system provides a cluster-free steering system that has fewer points of failure. An area we can improve is making a better mold for the carbon fiber. If not enough latex is applied the bondo can eat through the foam and create a surface full of impurities. This leads to more time repairing the mold before we can begin the layup, a time and energy-consuming process.

B. Completion of Objectives

Most team objectives were completed or are currently on track to be completed before the competition. One critique is that our objectives often fell behind the intended completion date. Many factors, such as a lack of funding, difficulty acquiring materials, and miscommunications in the next step of the manufacturing process set us back week at a time.

C. Reflection on the Design Process

Our project timeline was a short one. Previous teams before us took 2 years to design and build a new hull, whereas we are attempting the same goal in 1 year with no Solar Splash experience and little knowledge left behind by previous teams. The team was under-equipped for some shop days. Occasionally, there was no peel ply for making carbon fiber coupons, no wood to cut profiles, and we were always short on supplies. This was largely due to funding issues and not team negligence. An important factor we learned was to always make room for mistakes, it's not if it's when something goes wrong. When something starts going wrong, it is better to take a step back and take the time to reevaluate instead of forcing through. Having the time to reevaluate gives one this privilege.

D. Future Recommendations

Three areas of improvement have been identified for future development: electrical systems, mechanical systems, and administrative techniques. To improve the electrical system of the boat, new panels should be made. Existing panels work well but are extremely heavy. In past years the club has utilized custom panels made in house. This strategy should be used to decrease weight and maximize available surface area for solar cells while minimizing panel overhang. Further efficiency increases can be found by implementing more robust data acquisition systems. On-board control systems can also be implemented to allow the motor controller to be tuned in real time.

Mechanical efficiency can be improved by building a new outboard. The current outboard in use is optimized for a gas engine operating near 5200 RPM[4]. The motor in use reaches max power at 3600 RPM. A custom out board can be geared to a higher RPM and paired with custom propellers specialized for each race. Solar Panel mountings can be changed to a canopy, or swapped to a quick release system. Future hull builds should spend more time in the design phase. For higher quality vessels pre-preg carbon fiber can be used. More time should be spent testing and practicing before competition. All data recorded should be easily accessible in a centralized location.

For our team in the future, we also want them to explore other funding options such as all avenues of allocations the school can give, and to reach out to more potential sponsors such as hardware stores and metal providers. It may be helpful to implement strict deadlines to ensure projects are completed on time. More roles in the club can be created to focus on administrative tasks such as external club communications and media presence.

E. Lessons Learned

The team learned to always give ourselves more time than we think on tasks. If something goes wrong, we now have the time to fix our mistakes and continue. Better scheduling is also needed, as we never set any hard deadlines for objectives to be completed by. A more relaxed team environment was beneficial to team chemistry, but when priority tasks need to be completed, a hard deadline is needed.

V. References

[1]“Operators Manual SR,” *http://www.alltraxinc.com/*, 2016. https://alltraxinc.com/wp-content/uploads/2022/02/DOC113-014-E_OP-SR-MANUAL-new.pdf (accessed Apr. 28, 2025).

[2]S. Balasubramaniam and M. N. Musa, “Hydrodynamic Analysis of a Model Patrol Boat Hull,” Universiti Teknologi Malaysia, Johor, Malaysia, Dec. 2019.

[3]“SmartShunt 300 A / 500 A / 1000 A / 2000 A,” *Victron Energy*. https://www.victronenergy.com/upload/documents/Datasheet-SmartShunt-EN.pdf (accessed Apr. 27, 2025).

[4]“Mercury 25 HP Tiller Outboard Motor - 2025,” *Defender.com*, 2025. https://defender.com/en_us/mercury-25-hp-tiller-outboard-motor (accessed Apr. 29, 2025).

VI. Appendix

Appendix A: Battery Documentation

6 UPS Battery Center 12 V 6-DZF-22 batteries

Product Specifications

Dimensions
Terminal Type: M5 - Insert Terminals (screws included)
Length (mm/inch): 181mm / 7.13"
Width (mm/inch): 77mm / 3.07"
Height (mm/inch): 172mm / 6.77"
Total Height (mm/inch): 172mm / 6.77"
Approx. Weight (kg/lbs): 7.1kg / 15.6kg

Nominal Voltage (V): 12V

Open Circuit Voltage (V/Block): 13.1V - 13.45V

Number of Cells (Per Block): 6 Cells

Rated Capacity (Ah, 25°C):
2h rate (to 1.75V/Cell): 22.2Ah
3h rate (to 1.75V/Cell): 24Ah
5h rate (to 1.80V/Cell): 26Ah
10h rate (to 1.80V/Cell): 28Ah
20h rate (to 1.85V/Cell): 30Ah

Container Material: Enhanced ABS

Charge Voltage:
Float (V/Block): 13.50V - 13.80V
Cycle (V/Block): 14.60V - 14.80V

Maximum Discharge Current (A): 150A (5s)

Maximum Charge Current (A): 2.9A

Working Temperature(°C):
Operation (maximum): -20°C to 50°C
Operation (recommended): 20°C to 30°C
Storage Temperature(°C): -20°C to 50°C

	Item	48V Battery Bank	60V Battery Bank	72V Battery Bank
Charger Parameters	Max. Charge Voltage (V)	58.6V-59V	73.3V-73.7V	88.0V-88.4V
	Float Charge Voltage (V)	54.8V-55.2V	68.6V-69.0V	82.3V-82.7V
	Max. Charge Current (A)	2.7A-2.9A	2.7A-2.9A	2.7A-2.9A
	Shifting Current (A)	0.55A-0.6A	0.55A-0.6A	0.55A-0.6A
	Temperature Compensation Coefficient (mV/℃/Cell)	2.5~4.0 mV/℃/Cell	2.5~4.0mV/℃/Cell	2.5~4.0mV/℃/Cell
Controller Parameters	Low-voltage Protection (V)	42V±0.5V	52.5V±0.5V	63V±0.5V
	Limited Current (A)	≤25A	≤25A	≤25A
	Turn-on Lock Current (A)	≤0.15A	≤0.15A	≤0.15A
Electric Motor Setting	Average Current (A)	≤10A	≤10A	≤10A
	Electric Motor Power (W)	≤450W	≤600W	≤650W

SAFETY DATA SHEET

Section 1 – Identification

Product Identifier: Non-Spillable Batteries Technical Name(s): Sealed Lead-Acid Batteries (SLA), Valve Regulated Lead-Acid Batteries (VRLA), Absorbed Glass Mat Batteries (AGM), Sealed Lead Calcium Batteries, Sealed Maintenance Free Lead-Acid Batteries
Manufacturer: UPS Battery Center Ltd., 147 Limestone Cr., Toronto ON M3J 2R1Canada
Company phone number: 1-416-848-7755 **Emergency telephone (24hr) - INFOTRAC - 1-800-535-5053 (Domestic), 1-352-323-3500 (International)**
Product Use: Electric Storage Battery
Prepared by: UPS Battery Center Ltd. (416 848-7755)
Prepared date: April 9, 2024
Trademarks: UPS BATTERY CENTER.COM This SDS applies only to products bearing these trademarks.

Section 2 – Hazards Identification

2.1 Overview

This product is a battery with the GHS Label: Valve Regulated Lead Acid Battery, Non-Spillable.

Under normal conditions, this product is sealed and does not leak or vent gasses or hazardous substances. There is no contact with the internal components of the battery or the chemical hazards under normal product use and handling. In the absence of an accident or incident, the classifications below are not likely to apply. Nevertheless, this Safety Data Sheet (SDS) contains valuable information critical to the safe handling and proper use of this product. This SDS should be retained and made available to employees and other users of this product.

The information in the classifications below in Section 2.2 and Section 2.3 apply to contact with discharged sulfuric battery electrolyte, which could occur during an accident or incident. This could occur under severe over- charge conditions where there may be venting of sulfuric acid gas and could also occur when hazards are presented during reclamation (recycling).

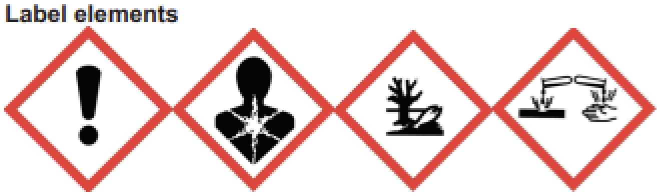
2.2 Classification of substance

Hazard	Category	Hazard Statements
Health Hazards		
Acute Toxicity – Oral	Category 4	H302 Harmful if swallowed

Acute Toxicity - Inhalation	Category 4	H332 Harmful if inhaled
Skin Corrosion / Irritation	Category 1A	H314 Causes severe skin burns and eye damage
Reproductive Toxicity	Category 1A	H360Df May damage the unborn child. Suspected of damaging fertility
Specific Target Organ Toxicity (Repeated Exposure)	Category 1	H372 Causes damage to organs (respiratory system) through prolonged or repeated exposure
Specific Target Organ Toxicity (Repeated Exposure)	Category 2	H373 May cause damage to organs through prolonged or repeated exposure
Serious Eye Damage / Eye Irritation	Category 1	H318 Causes serious eye damage
Specific Target Organ Toxicity (Single Exposure)	Category 3	H335 May cause respiratory irritation
Specific Target Organ Toxicity (Single Exposure)	Category 1	H370 Causes damage to organs (respiratory system)
Environmental Hazards		
Hazardous to the Aquatic Environment - Acute	Category 1	H400 Very toxic to aquatic life
Hazardous to the Aquatic Environment - Chronic	Category 1	H401 Very toxic to aquatic life with long lasting effects
Physical Hazards – not classified		

<u>Signal Word:</u> DANGER

Label elements



Placards are only required for transportation of spent or damaged batteries destined for reclamation (recycling).

2.3 Canada

Classification of substance

D1A	Class D - Poisonous and Infectious Material, Division 1: Materials causing immediate and serious toxic effects, Subdivision A: Very toxic material
D2A	Class D- Poisonous and Infectious Material, Division 2: Materials causing other toxic effects, Subdivision A: Very toxic material
E	Class E – Corrosive Material

Label elements

Signal Word: **DANGER**

Other hazards

In Canada, sealed lead-acid batteries are considered as hazardous according to the Workplace Hazardous Materials Information System (WHMIS).

2.4 Precautionary Statements

Prevention	Do not handle until all safety precautions have been read and understood
	Obtain special instructions before use
	Use personal protective equipment as required
	Wash face, hands and any exposed skin thoroughly after handling
	Do not breathe dust/fume/gas/mist/vapors/spray
	Use only outdoors or in a properly ventilated area
	Do not eat, drink or smoke when using this product
	Avoid release into the environment
	Keep out of reach of children

	Do not attempt to remove cover
	Avoid heat, sparks and open flame while charging batteries
	Avoid contact with internal acid
	Always be aware of the risk of fire, explosion or burns
	Do not solder a battery directly
	Keep away from fire or open flame
	Do not disassemble or modify the battery
	Do not short circuit the positive and negative terminals with any other metals
Response	Immediately call a poison center or doctor/physician
	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center or doctor/physician
	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower. Wash contaminated clothing before reuse
	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a poison center or doctor/physician if you feel unwell
	IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell. Rinse mouth. Do not induce vomiting
Storage	Store locked up
Disposal	Dispose of contents/container to an approved waste disposal plant in accordance with applicable regulations

2.5 OSHA Regulatory Status

This product is considered hazardous by the OSHA HCS (Hazard Communication Standard), WHMIS (Work-place Hazardous Materials Information System), IOSH (Institution of Occupational Safety and Health), ISO (International Organization for Standardization) and by EU Directive (67/548/EEC) and a SDS is required for this product considering that when used as recommended or intended, or under ordinary conditions, it may present a health and safety exposure or other hazard.

Section 3 – Composition / Information on Ingredients

Under normal use and handling there is no contact with internal components of battery. Under normal use and handling batteries do not emit regulated or hazardous substances. After contact with terminals, wash hands before eating, drinking, smoking, applying cosmetics or handling contact lenses. If battery is damaged all listed precautions should be taken to prevent exposure.

Components	Chemical Abstract Service (CAS) Number	Enzyme Commission Number (ECN)	% Weight	OSHA Regulatory Status
Lead (Pb)	7439-92-1	231-100-4	about 50%	Hazardous
Lead Dioxide (PbO2)	1309-60-0	215-174-5	about 10%	Hazardous
Lead Sulfate (PbSO4)	7446-14-2	231-198-9	about 10%	Hazardous
Calcium (Ca)	7440-70-2	231-179-5	about 0.05%	Hazardous
Sulfuric Acid (H2SO4)	7664-93-9	231-639-5	about 20%	Hazardous
Fiberglass Separator	65997-17-3	266-046-0	about 5%	Hazardous
Acrylonitrile Butadiene Styrene Case	9003-56-9	618-371-8	about 5%	Non- Hazardous
Tin (Sn)	7440-31-5	231-141-8	0 - 0.25%	Non- Hazardous
Arsenic (As)	7440-38-2	231-148-6	about 0.2%	Hazardous

Ingredients reflect components of a finished product

Section 4 – First Aid Measures

Non-spillable batteries are sealed and do not leak or vent gasses under normal conditions. Venting of sulfuric acid gas and hydrogen can occur under severe overcharge conditions. During lead reclaim operations, or if battery is ruptured or damaged, exposure to sulfuric acid electrolyte and lead can occur.

Eye Contact: Sulfuric acid electrolyte. Immediately flush with water for 20 minutes, lifting the upper and lower lids. Get immediate medical attention.

Skin Contact: Sulfuric acid electrolyte. Immediately flush with water for 20 minutes. Remove contaminated clothing and launder before reuse. Get medical attention if irritation persists, if area is large or if blisters form.

Inhalation: Sulfuric acid fumes. If irritation develops, remove victim to fresh air and get medical attention. Give CPR (Cardiopulmonary Resuscitation) if breathing has stopped.

Ingestion: Sulfuric acid electrolyte. Do not induce vomiting. Do not give anything by mouth to an unconscious or convulsing person. Flush out mouth with water. Give water or milk to drink followed by milk of magnesia or vegetable oil. Get immediate medical attention.

Lead (Pb): The toxic effects of Lead are accumulative and slow to appear. If symptoms appear see your physician.

After any contact with internal components of the battery, wash hands before eating, drinking, smoking, applying cosmetics or handling contact lenses.

Section 5 – Fire Fighting Measures

5.1 Flammable Properties

Sealed batteries can emit Hydrogen, vaporized sulfuric acid or highly toxic arsine gas in a fire.
Sealed batteries can emit Hydrogen while being over-charged. (Float Voltage in excess of 2.40 Volts Per Cell at 25º C / 77º F).

5.2 Extinguishing Media

Provided that batteries are not part of an electrical circuit, use any media appropriate for surrounding fire (including water, dry chemical, foam, CO2, Halon).

If batteries are part of an electrical circuit, isolate them from power source at the circuit breaker before using water to extinguish fire. If this cannot be done immediately, then water must not be used as an extinguishing media.

5.3 Protection of Firefighters

Ventilate the area well. National Institute for Occupational Safety & Health (NIOSH) approved Self-Contained Breathing Apparatus (SCBA) and full fire-fighting turn out gear is recommended.

Unusual Fire and Explosion Hazards: Keep lighted cigarettes, sparks and flames away. Explosion can result from improper charging and ignition of resulting gases. Explosion can result if charged in gas tight container. Hydrogen can burn with almost an invisible flame of low thermal radia. People have unknowingly walked into hydrogen flames. Hydrogen is easily ignited.

Section 6 – Accidental Release Measures

Steps to be taken if battery vents hydrogen or sulfuric acid gas: Sealed batteries can emit Hydrogen while being over-charged. (Float Voltage in excess of 2.40 Volts Per Cell at 25º C / 77º F). Keep well ventilated and away from flame, spark or heat. If concentrations of sulfuric acid mist are known to exceed Permissible Exposure Limit (PEL), use NIOSH or Mine Safety and Health Administration (MSHA) approved respiratoryprotection.

Steps to be taken if battery is broken: Avoid contact with sulfuric acid electrolyte. Each non-spillable battery contains only enough sulfuric acid to saturate fiberglass separators, so a large spill is not likely to occur. If leak occurs, dilute with water, neutralize with sodium bicarbonate (baking soda), sodium carbon (soda ash) or calcium oxide (lime) until fizzing stops. Hydrogen gas may be given off during neutralization, provide adequate ventilation. The pH should be neutral at 6-8. When neutralized the spill is non-hazardous and can be flushed down the sewer. Do not allow un-neutralized acid to enter the sewage system. Broken battery contains lead and should be treated as hazardous waste. Place broken battery in a heavy gauge plastic bag or other non-metallic container and follow disposal procedure as per Section 13 below.

Section 7 – Handling and Storage

Store indoors in a cool, dry, well-ventilated area away from combustibles and activities that may create flame, spark or heat. Do not store in sealed, unventilated areas. Do not use organic solvents on the batteries. Do not allow metallic tools to short across terminals, as spark may occur. Do not wear metallic jewelry when working on small batteries as dangerous short circuit and severe burns may occur. There is risk of electric shock from strings of series-connected batteries even when not hooked up to charger. Sealed batteries can emit Hydrogen while being over-charged. Do not allow float voltage to exceed 2.40 Volts Per Cell at 25º C / 77º F. Do not remove vent covers.

Section 8 – Exposure Controls & Personal Protection

8.1 Engineering Controls

Charge in areas with adequate ventilation. General dilution ventilation is acceptable.

8.2 Personal protective equipment (PPE)

a) Under normal conditions no protection is required.
b) If battery is ruptured follow precautions in Section 6 and use the following protective equipment:

8.2.1 Eye/face Protection:

Safety glasses or goggles recommended to handle battery if case is damaged.

8.2.2 Skin Protection:

Use acid-resistant gloves to handle battery if case is damaged. An acid-resistant apron is also recommended for large clean-up operations.

8.2.3 Respiratory Protection:

When concentrations of sulfuric acid mist are known to exceed PEL, use NIOSH or MSHA approved respiratory protection.

8.2.4 General Hygiene Conditions:

After any contact with internal components of the battery, wash hands before eating, drinking, smoking, applying cosmetics or handling contact lenses. Discard lead contaminated clothing in a manner that limits further exposure. After contact with terminals, wash hands before eating, drinking, smoking, applying cosmetics or handling contact lenses.

8.3 Exposure Guidelines & Limits

Under normal conditions there is no risk of exposure other than to lead (Pb) through contact with the terminals. If case is damaged, or during reclaim operations, the following table should be observed.

Components	CAS Number	ACGIH* TLV	OSHA PEL	NIOSH REL	NIOSH IDLH	Quebec PEV	Ontario OEL
Lead (Pb)	7439-92-1	0.05 mg/m^3	0.05 mg/m^3	0.05 mg/m^3	100 mg/m^3	0.05 mg/m^3	0.05 mg/m^3
Lead Dioxide (PbO2)	1309-60-0	0.05 mg/m^3	0.05 mg/m^3	0.1 mg/m^3	100 mg/m^3	0.05 mg/m^3	0.05 mg/m^3
Lead Sulfate (PBSO4)	7446-14-2	0.05 mg/m^3	0.05 mg/m^3	0.1 mg/m^3	100 mg/m^3	0.05 mg/m^3	0.05 mg/m^3
Calcium Ca)	7440-70-2	None Listed	None Listed	None Listed	None Listed	None Listed	None Listed
Sulfuric Acid (H2SO4)	7664-93-9	0.2 mg/m^3	1 mg/m^3	1 mg/m^3	15 mg/m^3	1 mg/m^3	0.2 mg/m^3
Fiberglass Separator	Not Listed	None Listed	15 mg/m^3	5 mg/m^3	None Listed	None Listed	None Listed
Acrylonitrile Butadiene Styrene	9003-56-9	Not Applicable	Not Applica-ble	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Tin (Sn)	7440-31-5	2 mg/m^3	2 mg/m^3	2 mg/m^3	100 mg/m^3	2 mg/m^3	2 mg/m^3
Arsenic (As)	7440-38-2	0.01 mg/m^3	0.01 mg/m^3	5 mg/m^3	3 ppm	0.1 mg/m^3	0.01 mg/m^3

** Association Advancing Occupational and Environmental Health*

Section 9 – Physical & Chemical Properties

Flammable Properties

Battery (Finished Product)

Flash Point: Not Applicable		Autoignition Temperature: Not Applicable
Flammable Limits:	LFL: Not Applicable	Flammability Classification:
	UFL: Not Applicable	Non-Flammable Solid (Per 29 CFR 1910.1200)

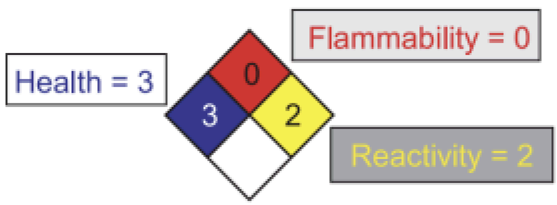
Hydrogen (Emission)

Flash Point: Gas @ normal temperature		Autoignition Temperature: 500º C (932º F)
Flammable Limits:	LFL: 4.1%	Flammability Classification:
	UFL: 74.2%	Flammable Gas (Per 29 CFR 1910.1200)

Hazard Ratings

NFPA Hazard Rating

(for Sulfuric Acid)



Hazard Rating Key
0 = minimal
1 = slight
2 = moderate
3 = serious
4 = severe

Flammability (Red) = 0
Health (Blue) = 3
Reactivity (Yellow) = 2

Appendix B: Flotation Calculations

Hull Volume: $V = 10.85\ ft^3$

Weights:

Item	Weight (lbs)
Panels	134
Motor	70
Outboard	50
Hull	32.7
Batteries	93.6
AllTrax	6
Skipper	180
Outback	11.65
Wiring	10
Solar Mounting	10
Total	597.95

Maximum Carrying capacity: $W_m = (62.4\ lbs/ft^3)(10.85 ft^3) = 680.16\ lbs$

Required Volume for 1.2 factor of safety: $V = (597.95)(1.2)/(62.4\ lbs/ft^3) = 11.499\ ft^3$

Additional volume required: $0.69\ ft^3$ of additional flotation required. Foam from the build process will be attached to the boat to act as additional flotation.

$V_{final} = 11.85\ ft^3,\ W_{capacity\ final} = (62.4 lbs/ft^3)(11.85 ft^3) = 739.44\ lbs$

Factor of safety =1.24

Appendix C: Proof of Insurance

ACORD®

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY): 2/6/2025

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must have ADDITIONAL INSURED provisions or be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER
Alliant Insurance Services, Inc.
560 Mission Street, 6th Floor
San Francisco CA 94105

CONTACT NAME: Van Rin
PHONE (A/C, No, Ext): 415-403-1400 FAX (A/C, No): 415-874-4810
E-MAIL ADDRESS: vrin@alliant.com

INSURER(S) AFFORDING COVERAGE	NAIC #
INSURER A : Lloyds of London	15792
INSURER B :	
INSURER C :	
INSURER D :	
INSURER E :	
INSURER F :	

INSURED CALISTA-14
California State Polytechnic University Pomona
3801 W Temple Ave
Pomona CA 91768

COVERAGES **CERTIFICATE NUMBER:** 1823763017 **REVISION NUMBER:**

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
	COMMERCIAL GENERAL LIABILITY						EACH OCCURRENCE	$
	CLAIMS-MADE / OCCUR						DAMAGE TO RENTED PREMISES (Ea occurrence)	$
							MED EXP (Any one person)	$
							PERSONAL & ADV INJURY	$
	GEN'L AGGREGATE LIMIT APPLIES PER:						GENERAL AGGREGATE	$
	POLICY / PRO-JECT / LOC						PRODUCTS - COMP/OP AGG	$
	OTHER:							$
	AUTOMOBILE LIABILITY						COMBINED SINGLE LIMIT (Ea accident)	$
	ANY AUTO						BODILY INJURY (Per person)	$
	OWNED AUTOS ONLY / SCHEDULED AUTOS						BODILY INJURY (Per accident)	$
	HIRED AUTOS ONLY / NON-OWNED AUTOS ONLY						PROPERTY DAMAGE (Per accident)	$
								$
	UMBRELLA LIAB / OCCUR						EACH OCCURRENCE	$
	EXCESS LIAB / CLAIMS-MADE						AGGREGATE	$
	DED / RETENTION $							$
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY	Y / N					PER STATUTE / OTH-ER	
	ANYPROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED?	N / A					E.L. EACH ACCIDENT	$
	(Mandatory in NH)						E.L. DISEASE - EA EMPLOYEE	$
	If yes, describe under DESCRIPTION OF OPERATIONS below						E.L. DISEASE - POLICY LIMIT	$
A	Club Liability Insurance Program (CLIP)			B1820WLS24A039	7/1/2024	7/1/2025	Each Claim	$1,000,000
							Prop Damage of Others	$25,000
							Aggregate Limit	$5,000,000

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)
Sacramento Municipal Utility District, its officers, directors, employees, and servants are named as additional insured as respects the Equipment Loan Agreement for Two (2) solar modules (JKM250P-60 250 Watt) for use at the Northern California Solar Regatta event, located at Rancho Seco, California during the policy period.

CERTIFICATE HOLDER
Sacramento Municipal Utility District
c/o Talia Dorian
6301 S Street
Sacramento CA 95817

CANCELLATION
SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE
Daniel J Howell

ACORD 25 (2016/03)

Appendix D: Team Roster

Last Name	First Name	Role	Degree/Program
Herder	Gerald	Advisor	EMET
Castillo	Issac	President	Mechanical Engineering
Dorian	Talia	Vice President	Mechanical Engineering
Nihart	Caden	Vice President/Electrical Lead	Computer Engineering
Tolosa	Elijah	Treasurer	Electrical Engineering
Zemoy	Matthewes	Scheduler	Mechanical Engineering
Fernandez	Jeryl	Mechanical Lead	Mechanical Engineering
Matsumoto	Trevor	Mechanical Team Member	Manufacturing Engineering
Kashner	Liam	Mechanical Team Member	Manufacturing Engineering
Diaz	Pablo	Electrical Team Member	Mechanical Engineering
Boyd	Sarah	Electrical Team Member	Electrical Engineering
Wygant	Sean	Electrical Team Member	Electrical Engineering
Korisal	Anjana	Electrical Team Member	Electrical Engineering