MATE ROV COMPETITION

# 2025 COMPETITION MANUAL
# PIONEER CLASS

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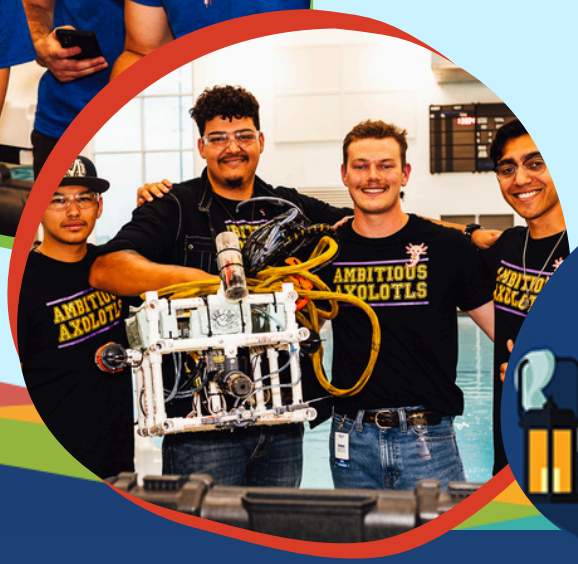



MTS
marine technology society

NSF

# 2025 MATE ROV COMPETITION:

## UN Decade of the Ocean, MATE Year of the Great lakes: Monitoring and Mitigating the Impacts of Climate Change on Our Water World

## PIONEER CLASS COMPETITION MANUAL

For general competition information, including a description of the different competition classes and eligibility requirements, visit Compete.

## Contents

# OVERVIEW

## From Technical Talents to Teamwork, Problem-Solving, Creativity, and Critical Thinking: MATE Develops Skills for Success in the Workforce.

As you prepare to develop and deploy technologies to monitor ocean conditions and understand ecosystems, make sure to find a moment to reflect on the skills that you are developing to allow you to tackle these tasks. These are the skills that you will take with you along your educational journey and pathway into the workplace.

They also happen to be the skills that are in high demand by employers around the globe. Machine learning, data analytics, AI, video marketing, critical thinking, creativity,

collaboration, time management, and leadership – articles published by LinkedIn and Forbes Magazine highlight these technical and employability (aka "Soft") skills as the most "in-demand for the next 10 years" and, likely, beyond.

A number of these skills could be described as "entrepreneurial," part of a skill set that also includes the ability to understand the breadth of business operations (from using data to make informed financial decisions to researching and critiquing potential design solutions and producing content for media outreach); acknowledge your strengths (and weaknesses!); work as an integral part of a team; and apply technical knowledge and skills in new and creative ways. By developing a business acumen, a mindset for innovation and collaboration, and an understanding of how to take environmental, social, and governance (ESG) factors into consideration when making business decisions, you will be well prepared for the global workplace and ready to tackle today's (and tomorrow's!) challenges.

As your read through this manual you will see the following icons:*


These icons correspond to the employability (orange) and ROV-specific (green) knowledge and skills that you gain as you build your ROV and prepare for the competition and which of the various competition requirements – from Product Demonstration to Engineering and Communication – help to develop each of these skills.

**These icons are from* Evaluate-Compete*, which is designed to help give you a competitive edge in preparing for the competition and the workforce! High school and college teams are invited to participate in the projects pilot testing phase. Visit Evaluate-Compete for more information.*

## THINK OF YOURSELVES AS ENTREPRENEURS

The MATE ROV Competition not only encourages you to reflect on the skills that you develop, but, for more than a decade, has also challenged you to think of yourself as an entrepreneur, embrace the skills that being one requires, and transform and organize your team into a start-up company. Use the following questions as a guide to assist you with this process:

- What is your company name?
- Who are its leaders, including the:
    - CEO (chief executive officer – the leader)
    - CFO (chief financial officer who oversees the budget and spending)

- Who manages Government and Regulatory Affairs (i.e. who's in charge of reviewing the competition rules and making sure that they are understood and followed by everyone)?
- Who is responsible for research and development (aka R&D)?
- Who is responsible for system(s) engineering? Design integration? Testing? Operations?
- Who is responsible for fund-raising, marketing, and media outreach?
- Who is the company's ESG research and engagement analyst?
- What other positions might you need? (Depending on your personnel resources, more than one person may fill more than one role.)
- What products and services do you provide?
- Beyond MATE, who are your potential clients?

## 10 CHALLENGES – 10 YEARS – ONE OCEAN

In short, the **MATE ROV Competition's philosophy** is about student learning. It is about the knowledge and skills gained through participating in the competition and how that knowledge and those skills prepare you for your future career in the ocean STEM workforce – and beyond.

As you contemplate your future education and career plans, the challenge presented to you today is how to apply your knowledge and skills to addressing the competition mission tasks so that we can effectively consider and respond to the question "how do we move from the ocean we have to the ocean we want?"

Again this year the MATE ROV Competition is highlighting the United Nations Decade of Ocean Science for Sustainable Development and aligning its mission tasks with the "10 Challenges for Collective Impact". This 2025 MATE ROV Competition also continues to inspire ESG principles in order to do "good for good" for our ocean planet and global community. Again this MATE ROV Competition season the "client" is us – our global community of learners, inspired by the ocean, innovating and collaborating to address societal challenges. You are presented with a request for proposals (RFP), the specifics of which are included below.

# PIONEER CLASS DEMONSTRATION

**All PIONEER class companies are required to submit a video that:**

- Demonstrates the ability of their vehicle to perform specific tasks.
- Shows compliance with MATE's design, build, and safety specifications.

**Video specifications:**

Video specifications: The video MUST show the following ROV features for the specified amount of time. Companies can choose to narrate the video to help explain how their vehicle meets these required specifications. Alternatively, a MATE official may schedule a Teams, Zoom, Skype, Google Hangout, GoToMeeting, Webex or other type of video conferencing

session with the company. During the session, companies must visually show, and answer questions about, the following ROV features.

The video MUST show in this order:
IMPORTANT NOTE!!! PIONEER class companies may power their ROV using either a 48-volt or a 12-volt supply. Additional details on PIONEER power supplies can be found in section 3.3 Electrical.

1. If using 48 volts, 15 seconds (or more) of the 48-volt power supply **(ELEC-002P).**
2. If using 48-volts, 15 seconds (or more) showing a properly sized Littelfuse. The company MUST use a ruler to show that this fuse is within 30 cm of Anderson Powerpole connectors. **(ELEC-008P, ELEC-010P)**.
   If using 12 volts, 15 seconds (or more) showing a properly sized fuse within 30 cm of the main point of connection. The company must use a ruler to show this distance **(ELEC-008P)**.
3. 30 seconds (or more) of the inside of the control box showing the wiring and components.
   If the company uses a control box, 30 seconds showing the inside of the control box including the wiring and components. MATE will be looking for:
   - No exposed wiring **(ELEC-017P)**.
   - That the control box is neatly laid out with attention to workmanship. **(ELEC-022P)**.
   - Separation and identification of 120VAC wiring from DC and control voltages. **(ELEC-023P**). If 120VAC is not used in the control box, you should video a slide stating that AC power is not used in the control box.

   If the company does not use a control box, 15 seconds (or more) showing the entire control system (controller, laptop/computer, etc.).
4. If using 48 volts, 15 seconds (or more) in the control system showing that there is no conversion of the 48V until it reaches the ROV. Power supplies, ESCs, H-Bridges or other voltage conversion devices are not allowed on the surface. **(ELEC-003P & ELEC 004P)**.
5. 30 seconds (or more) showing any hydraulic / pneumatic systems including an on/off valve, a pressure release valve and a regulator in the system **(FLUID-004, FLUID-008),** and that any pressurized cylinder, pressure storage device meets the MATE specifications of **(FLUID-009, FLUID-011). Note for 2025:** 15 seconds (or more) showing the specifications for pneumatic components, including the pressure rating of any tubing used. In addition, the type of fluid should be clearly stated in the video (**FLUID-001, FLUID-005).** If the vehicle does not use fluid power**, you should video a slide stating that Fluid Power is not used on this ROV for 10 seconds.**
6. 15 seconds (or more) showing the top-side strain relief. The video must show the tether and wires, with strain relief, entering the control station or topside controller **(ELEC-024P).**
7. 15 seconds (or more) showing the bottom-side strain relief. The video must show the tether entering the ROV and strain relief for the tether **(ELEC-024P).**
8. 60 seconds (or more) total, 10 seconds (or more) per side of the ROV (4 sides plus top and bottom) showing that all motors are waterproofed, and propellers are shrouded

and protected with guards. There are no sharp edges or elements of the ROV that could cause damage **(MECH-006, ELEC-017P).**

Video demonstrating specific tasks: Following those requirements, the video must demonstrate that the ROV can complete the following product demonstration tasks. The ROV must complete all the tasks within 15 minutes.

The UNCUT video must show the vehicle:

1. Launching safely from the side of the pool and maneuvering to tasks.
    a. See specifications **(MECH-004 & MECH-005).**
2. Completing the required tasks. This includes:
    **a. Task 1.1: Shipwrecks – Determine the cargo that the ship carried**
        i. Remove the cover
        ii. Replace the cover
    **b. Task 2.1 Produce Power**
        i. Disconnect the old sacrificial anode from the base
        ii. Connect the new sacrificial anode onto the base
    **c. Task 2.2: Monitoring Environmental Impact**
        i. Place a hydrophone in the designated area
            1. Place the hydrophone in the designated area
            2. Pull the pin to release the hydrophone from the base

NOTE: For this demonstration, actual cargo does not need to be included in the container; companies must remove the cargo cover for at least 10 seconds before replacing it. Companies may use the same anode as both the sacrificial and new anode for this demonstration. Companies are not required to remove the hydrophone from the platform; companies should carry the hydrophone down from the surface.

The camera angle must demonstrate that the ROV is under its own power and not assisted by humans when in the water. The MATE ROV Competition requires that the camera show the complete ROV in the field of view at all times. A video that cuts between camera angles will not pass the demonstration requirement of "uncut" footage. The video is permitted to show a split screen or may incorporate a separate window showing the ROV camera or other footage. However, the video MUST show an uncut view of the vehicle from launch to completion of the tasks. The tasks must be completed within 15 minutes.

Companies may complete the tasks in any order they wish.

See Documentation Submissions Guidelines for submission information. Additional submission information can be found in PART 6: SUBMISSION GUIDELINES AND KEY DEADLINES.

Companies are allowed to make minor changes to their ROV after their video demonstration, but the overall systems must be the same. Minor changes include adding/removing buoyancy, adding tools/sensors that were not used for the demonstration, etc. The frame,

motor configuration, and the control system must be the same for the video demonstration and the World Championship competition. Safety inspectors will refer to images of the ROV and control system taken from the demonstration video. Vehicles with different systems will not pass the safety inspection.

***NOTE for 2025!!!***
PIONEER class companies are encouraged to contact the regional coordinator closet to them about opportunities to showcase their vehicles, volunteer as judges, and/or otherwise participate in regional events.

Regional competitions benefit from the participation of PIONEER class companies by:

- Showcasing PIONEER ROVs to RANGER, NAVIGATOR and SCOUT class companies to help them to learn about advanced systems and get ideas for "next year"
- Inspiring RANGER, NAVIGATOR, and SCOUT students to see what's possible if they continue to progress through the competition classes
- Providing examples of educational pathways and potential post-secondary institutions and programs to continue to pursue STEM learning
- Having access to additional volunteers and judges

Companies benefit from attending the regional by:

- Having access to the product demonstration props and the opportunity to conduct a "wet" run
- Receiving feedback from safety inspectors, including identification of potential safety violations and what can be done to enhance their vehicle from a safety standpoint
- Receiving technical help from engineers and technicians as well as from other companies
- Gaining insight and sharing ideas with other companies
- Earning points for the corporate responsibility portion of the competition
- Recruiting graduating high school students to your college/university and your ROV team

# PART 1: PRODUCT DEMONSTRATION


## OVERVIEW

**PIONEER** class companies will take part in ONE product demonstration that consists of three distinct tasks:

**TASK #1: Shipwrecks, Spotter Buoys, and Flying Fish: Documenting the Impact of Climate Change and Invasive Species on the Great Lakes**
**TASK #2: Marine Renewable Energy: Producing Power from Our Planet While Monitoring Environmental Impact**
**TASK #3: *MATE Floats!***

This product demonstration score will be added to your ENGINEERING & COMMUNICATION and SAFETY scores to determine your total, overall score for the competition.

## SCORING OVERVIEW

The competition consists of product demonstrations, engineering and communication, and safety with the following scoring breakdown:

- **Product demonstrations**
  - 350 points (max), plus a time bonus
  - Weight restrictions
    - 10 points (max)
  - Product demonstration organizational effectiveness
    - 10 points (max)
  - Jobsite Safety & Environmental Analysis
    - 5 points (max)
- **Engineering & Communication**
  - Technical documentation
    - 100 points (max)
  - Engineering presentations
    - 100 points (max)
  - Marketing displays
    - 50 points (max)
  - Company Spec Sheet
    - 20 points (max)
  - Corporate Responsibility
    - 20 points (max)
- **Safety**
  - Initial Safety and Documentation Review
    - 20 points (max)
  - Safety Inspection
    - 30 points (max)
  - Jobsite Safety and Environment Analysis (JSEAs)
    - 10 points (max)

**TOTAL POINTS = 725**

## TIME

Each product demonstration includes:

- 5 minutes to set up at the product demonstration station
- 15 minutes to attempt the tasks

- 5 minutes to break down and exit the product demonstration station

Your company will have 5 minutes to set up your system, 15 minutes to complete the tasks, and 5 minutes to demobilize your equipment and exit the product demonstration station. During the 5-minute set-up, you may reassemble your vehicle after the weigh-in and place it in the water for testing and/or trimming purposes. The 15-minute demonstration period will begin after the full 5 minutes of set up time expires, regardless of whether the company is ready to start the product demonstration. It may begin sooner if your CEO notifies the product demonstration station judges that your company is ready to begin.

At any time during the demonstration, you may pilot your ROV to the surface and remove the vehicle from the water for such things as buoyancy adjustments, payload changes, and troubleshooting, but the 15-minute product demonstration clock will only stop if a judge determines it is necessary for reasons beyond your control. Otherwise, the clock will only stop after all of the tasks are successfully completed and the ROV has been piloted to the surface, side of the pool and is withing the grasp of a company member. Your ROV is not required to return to the surface between tasks.

Your 5-minute demobilization will begin as soon as the 15-minute demonstration time ends, regardless of where your ROV is located (i.e., still at depth, on the surface, etc.).

**TIME BONUS**
Companies will receive a time bonus for each product demonstration if you:
1) successfully complete all the tasks,
2) return your ROV to the surface under its own power so that it touches the side of the pool, and
3) physically touch your vehicle before the demonstration time ends.

Companies will receive 1 point for every minute and 0.01 point for every second under 15 minutes remaining.

## CONTEXT & NEED

As we dive into another MATE ROV Competition season (and our second year as part of the Marine Technology Society!) we continue to highlight scenarios aligned with the United Nations Decade of Ocean Science for Sustainable Development (2021-2030) while adding a new twist – tackling mission tasks in the Great Lakes!

Rising temperatures, extreme weather, damaged ecosystems, and rising sea levels are affecting all parts of our world, and the Great Lakes are no exception. Home to 84% of North America's surface fresh water and 21% of the world's fresh water, the Great Lakes are one of the world's largest surface freshwater ecosystems. They are becoming ever more threatened as our planet's temperatures continue to rise. We know that our ocean is becoming more acidic as it absorbs carbon dioxide that human activity releases into the atmosphere; studies based on computer models suggest that this same phenomenon may also be happening in big, freshwater systems, such as the Great Lakes. Besides disrupting aquatic life and habitat, acidification could deteriorate the thousands of wooden shipwrecks believed to be resting on the bottom, the majority of which have yet to be discovered.

What impact does a warming, freshwater ecosystem have on these cultural resources? That is an important question for Thunder Bay National Marine Sanctuary (TBNMS). One of 16 national marine sanctuaries managed by the U.S. National Oceanic and Atmospheric Administration (NOAA), TBNMS is charged with protecting a significant collection of nearly 100 historic shipwrecks in Lake Huron off the U.S. state of Michigan coast.

The 2025 competition mission tasks challenge you to help answer that question by documenting a shipwreck, installing sensors on a moored buoy for long-term monitoring, and collecting a water sample to measure pH and to detect eDNA to identify the presence (or absence) of an invasive species, which is only compounding the disruptive impacts of climate change on Great Lakes ecosystems. Moving from fresh to saltwater, this year's tasks also require you to maintain offshore wind farms and monitor the impacts of these structures and floating solar panel arrays on organisms that range in size from jellyfish medusa to blue whales. Finally, in 2025, we continue to task you to deploy a vertical profiling float, one that can collect and contribute data to a global repository, enabling us to collectively and collaboratively monitor ocean health.

We launch the 2025 season with continued optimism that together we can inspire, innovate, and create technology solutions to mitigate the impacts of climate change and pave the way to a sustainable future for both our ocean and the Great Lakes. And with the technologies that enable increased and improved monitoring and data collection to support us, we remain optimistic that we can influence mindsets and guide communities to embrace and adapt practices for the good of us all.

If you have competed in the MATE ROV Competition in the last 4 years, it will come as no surprise that once again this (our 23rd!) competition season the "client" is us: our global community of learners, inspired by the ocean, innovating and collaborating to address environmental and societal challenges. Our 2025 scenarios and mission tasks continue to inspire ESG and acknowledge and embrace the UN Sustainable Development Goals and its 10 Challenges for Collective Impact," while also calling attention to the similar climate challenges that are facing freshwater ecosystems.

Again this year we are tasking our MATE competition community to design and build a remotely operated vehicle and the necessary sensors, tooling, and complementary technologies to combat climate change, provide clean energy, protect ecosystems from invasive invaders, and monitor the health of the salt- and freshwater habitats of our Blue Planet. Equipped with scientific data and technology solutions and with an understanding of the actions that we need to take, we can proactively and confidently move from the aquatic ecosystems we have to the ocean, rivers, lakes, and streams we want.

Albeit we won't be able to make that move without an appropriately educated and skilled workforce, one that is aware of and informed about the challenges we face and prepared to apply knowledge and skills to tackling them.

## REQUEST FOR PROPOSALS (RFP)

### 1. General

a. Mission Task #1: Shipwrecks, Spotter Buoys, and Flying Fish: Documenting the Impact of Climate Change and Invasive Species on the Great Lakes
Ocean Decade Challenges for collective impact:
**#2: Protect and restore ecosystems and biodiversity**
**#7: Expand the Global Ocean Observing System**
**#8: Create a digital representation of the ocean**

In addition to hosting the MATE World Championship, in 2025 Thunder Bay National Marine Sanctuary (TBNMS) will be celebrating its 25th anniversary as the first national marine sanctuary protecting the maritime history of the Great Lakes. Designated in 2000, this 4,300-square-mile area of Lake Huron is now both a national marine sanctuary and a state underwater preserve, one of 13 underwater preserves in the state of Michigan.

TBNMS currently has nearly 100 shipwrecks under its charge, but is well-positioned to add to this stewardship as additional shipwrecks are discovered. And, given the long history of travel and transport on the Great Lakes, there are more to be discovered. From dugout and birchbark canoes to wooden sailing craft and steel freighters, thousands of ships have made millions of voyages across the Great Lakes. Travel over the last 150 years was especially substantial, transforming the Great Lakes into one of the world's busiest waterways.

With growth came adversity, particularly before the advent of accurate weather forecasting, radar, and GPS to assist ships in steering clear of inclement weather, natural obstacles like shoals and shallow water, and each other. Over 200 pioneer steamboats, tall-masted schooners, and bulky freighters have wrecked near Thunder Bay alone. Discovering these known wrecks, identifying and documenting them, sharing their histories, using technology to create ways to explore them (without ever having to get wet!), and ensuring their protection for future generations is core to the mission and role of TBNMS.

*Photomosaic of the wooden two-masted schooner* E.B. Allen. (E.B. Allen | Thunder Bay National Marine Sanctuary (noaa.gov))

Ensuring their protection includes using technologies to monitor and track the impacts of rising temperatures and absorption of carbon dioxide and resulting increases in acidity on these cultural resources. Enter NOAA and Sofar Spotter buoys, moored platforms outfitted with a suite of sensors, both at and below the surface, that collect and transmit data in real time. While NOAA buoys have been operational for more than 10 years, Sofar Spotter buoys

are a new addition to Thunder Bay. Low-cost and easy to deploy, Spotter buoys include thermistors (temperature sensors), pressure sensors, and current meters, sensors that measure the partial pressure of carbon dioxide, and more. Coupled with more traditional technologies (aka researchers in the field) to measure these water quality parameters, these buoys are providing access to additional data that will allow us to better understand and evaluate the health of these freshwater ecosystems.

*A NOAA buoy in Lake Michigan.* (New science with historic data: 15 years of Great Lakes environmental data archived in NOAA data repository | NOAA Great Lakes Environmental Research Laboratory (noaaglerl.blog))

While perhaps not so much a threat to the deterioration of shipwrecks as rising temperatures and acidic conditions, Asian carp are a threat to Great Lakes ecosystems and its $7 billion fishing industry. Growing up to 100 pounds and four feet in length, these invasive species were originally imported into the southern U.S. in the 1970s to help control algal blooms and parasites in aquaculture ponds and wastewater treatment facilities. Escaping into local rivers, streams, and lakes, Asian carp made their way into the Mississippi River basin and headed north, through the Illinois River watershed and into the Great Lakes where they compete with native species for food and space and upset the balance of the lake ecosystem.

*Asian carp* (Eat Asian Carp? Sure, why not? Conservation official says they don't taste as fishy - Missourinet)

Enter another technology – environmental DNA, known as eDNA – that is allowing researchers to monitor and track the carps' progress through river basins, watersheds, and into the Great Lakes. eDNA technology allows for the detection and monitoring of species using DNA fragments shed by organisms in the water column. It involves collecting and processing water samples (and not organisms!) to sequence for DNA, providing a non-invasive, cost-effective, and comprehensive approach to determining the presence (or absence) of species in aquatic ecosystems. Although in the case of invasive species, the hope is NOT to find their DNA in water samples, eDNA is a powerful tool in cataloging aquatic biodiversity. Building and expanding an eDNA catalog of the biodiversity of the Great Lakes and surrounding watersheds will help us to understand – and protect – this ecosystem.

b. Mission Task #2: Marine Renewable Energy: Producing Power from Our Planet While Monitoring Environmental Impact
   Ocean Decade Challenges for collective impact:
   **#2: Protect and restore ecosystems and biodiversity**
   **#4: Develop a sustainable and equitable ocean economy**

Countries around the world are embracing the installation of offshore wind farms as a means of renewable energy production and as a way to mitigate the impacts of climate change. As of June 2024, there were nearly 300 offshore wind farms operating in 20 countries worldwide, with the majority of those in China. Couple that with the creative minds working to leverage the existing infrastructure and install floating solar panel arrays amongst offshore wind farms and we arrive at increased efficiency, amplified impact, and a powerhouse of technologies producing energy for our planet.

With the installation of offshore wind farms and floating solar panel arrays comes the need to service and maintain the subsea infrastructures. Combating the corrosiveness of saltwater is a priority to maintaining the integrity and extending the lifespan of these structures. As any owner of an ocean-going vessel (big or small) knows, zinc, aluminum, and magnesium are "sacrificial anodes" – that is, metals that are more easily corroded than steel, which is what

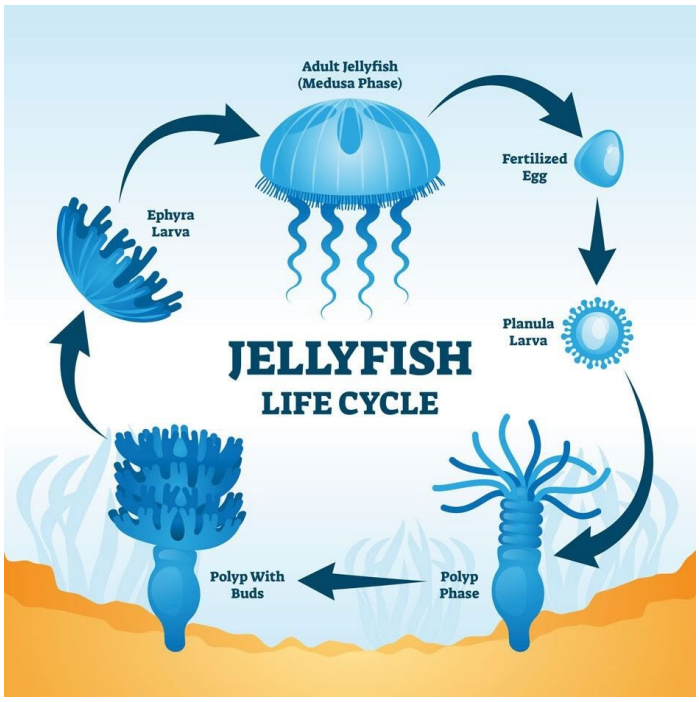
offshore wind structures are typically made of.  Attaching a block of zinc to submerged offshore wind infrastructure is a common practice, as is replacing the block with a new one once it's been significantly "eaten" away. Periodically replacing sacrificial anodes adds life to any structure by reducing and slowing down ongoing corrosion.

*Sacrificial anodes attached to a ship's hull* (Sacrificial anodes - Cathwell)

Even with sacrificial anodes, corrosion can and does happen.  Painting offshore structures with a marine epoxy is a technique used to isolate and combat corrosion.  As with sacrificial anodes, this epoxy helps to maintain the integrity and extend the time that these structures would need to be replaced.

Like offshore oil rigs, offshore wind farms and floating solar panel arrays provide "reef" habitats where diverse groups of marine organisms congregate – from fish to invertebrates. Invertebrates in particular thrive; in an otherwise open water environment, these offshore structures offer a hard substrate to attach to, which is vital for many invertebrates.  The organisms growing on these reef habitats are a key to a diverse ecosystem, and a cornerstone of the marine food web.

Researchers at the Florida Institute of Oceanography are particularly interested in studying jellies, including the impact that offshore structures may have on the life cycles of these organisms. One challenge has been to develop the tooling to effectively – and without causing damage – collect the various life cycle stages, from larvae to polyp to adult medusa. The collection of these soft-bodied organisms, in all of their life-cycle stages, is important for understanding the species.

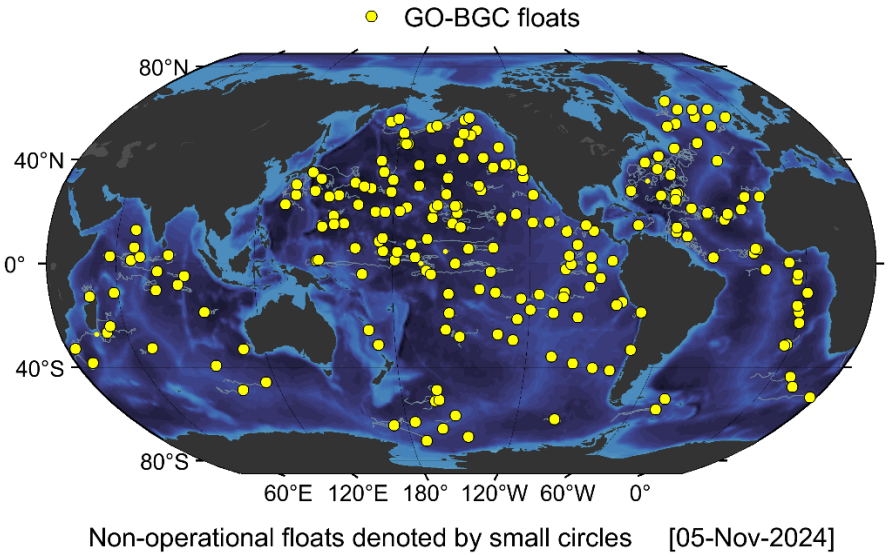



([Jellyfish - Great Barrier Reef Foundation - Great Barrier Reef Foundation])

While the subsea infrastructures of offshore wind farms and floating solar panel arrays are assets for some marine species, they can be obstacles for others. Not only the structures themselves, but the intensity and noise produced during pre-construction surveys, installation, operation, and, when the time comes, decommission of these installations and its impact on marine mammals is of particular interest. One way to monitor both the noise production from and the presence of marine mammals around these structures is by deploying a series of hydrophones on the seafloor. By understanding the prevalence of noise as well as marine mammals, steps can be taken to mitigate any detrimental impacts of these offshore marine renewable energy producers, allowing us to save both magnificent species and our beautiful blue ocean planet.

c. Mission Task #3: *MATE Floats!*
   Ocean Decade Challenges for collective impact:
   **#5: Unlock ocean-based solutions to climate change**
   **#7: Expand the Global Ocean Observing System**
   **#8: Create a digital representation of the ocean**

The goal of the National Science Foundation (NSF)-funded GO-BGC Project is to build a global network of chemical and biological sensors that will monitor ocean health. Scientists, engineers, and technicians from multiple organizations are using NSF grant funds to build and deploy 500 robotic ocean-monitoring floats around the globe. The temperature, depth, and bio-geochemical information that these floats collect will add significantly to the repository of data needed to better understand ocean processes and predict the consequences of climate change. As of November 2024, more than 200 GO-BGC floats have been deployed throughout the global ocean.




*GO-BGC Float locations as of November 5, 2024 (*Array Status | GO-BGC).

These GO-BGC floats have joined a larger network of vertical profiling floats that have been circulating the world ocean for more than 20 years. Named after the ship made famous by Jason of Greek mythology, the Argo float program is an international effort of 30+ countries that since 1990 has deployed nearly 4,000 floats to collect temperature and salinity data and make this data accessible to the global community of researchers, revolutionizing the way we learn and share information about the ocean. GO-BGC floats are essentially the next generation of Argo floats, representing a technological evolution in sensor technologies with the development and addition of bio-geochemical sensors – and, most importantly, making the data that these sensors collect part of the repository available to the broader science community.

The MATE ROV Competition's primary focus is on engineering ROVs. However, the GO-BGC project provides an opportunity to present competitors with the challenge of designing and building another type of underwater technology, one that contributes to ocean observations and research that is critical to understanding the impact of climate change.


*Readying a GO-BGC float for deployment (GO-BGC | Global Ocean Biogeochemistry Array)*

## 2. Mission Scope and Purpose

This and the following sections contain the technical specifications and requirements for ROV services needed to support the **UN Decade of the Ocean, MATE Year of the Great Lakes: Monitoring and Mitigating the Impacts of Climate Change on Our Water World**. In 2025, ROV services include:

1. Task 1. Shipwrecks, Spotter Buoys, and Flying Fish: Documenting the Impact of Climate Change and Invasive Species on the Great Lakes
    - Use visual clues to determine the identity of an unknown shipwreck using type of ship, length of ship, and cargo carried
    - Create a 360° photosphere image of the shipwreck environment
    - Replace a damaged thermistor on a subsurface Spotter buoy
    - Install a pC02 sensor to the subsurface Spotter buoy
    - Collect a water sample
    - Measure the pH and dissolved C02 levels of the water sample
    - Use eDNA to determine if the unknown sequences include invasive carp
    - Model invasive carp moving into the Illinois River watershed over time
2. Task 2. Marine Renewable Energy: Producing Power from Our Planet While Monitoring Environmental Impact
    - Connect a floating solar panel array to the grid
    - Replace a sacrificial anode on the base of an offshore wind farm
    - Apply a patch to a corroded area on the base of an offshore wind farm

- Collect polyp stage jellies from underneath the solar panel array
- Collect a medusa stage jelly from mid-water
- Collect fish species from underneath the solar panel array
- Place a hydrophone in the designated location

3. Task 3. *MATE Floats!*
   - Prior to the competition, design and construct an operational vertical profiling float
   - Float communicates data with the mission station
   - Float completes vertical profiles
   - Data verifies that the float maintains a depth of 2.5 meters
   - Profile graphed as depth over time

## 3. Specifications

See the specific tasks described below as well as the **VEHICLE DESIGN & BUILDING SPECIFICATIONS** and **COMPETITION RULES** sections.

## 4. Maintenance and Technical Support

The company shall warrant the ROV and associated systems and equipment for at least the duration of the product demonstrations. Repair or replacement shall be at the company's expense, including the cost of shipping the ROV to and from the competition facility.

During regional events, the company shall provide at least one day of technical support to resolve hardware, software, and operational issues. They shall provide at least three days of the same for the World Championship event.

## 5. Shipping and Storage

Refer to Shipping Information for specifics on shipping to the MATE World Championship site.

Delivery of the ROV and associated systems and equipment shall be no later than the date of the geographically closest regional contest or by the first day of the MATE World Championship (June 17, 2025).

## 6. Evaluation Criteria

a. Technical documentation
b. Engineering presentation
c. Marketing display
d. Company spec sheet
e. Product demonstration
f. Safety

## 7. References

a. General

- United Nations Decade of Ocean Science for Sustainable Development
- 17 UN Sustainable Development Goals
- 10 Challenges - Ocean Decade
- A Hotter Future Is Certain, Climate Panel Warns. But How Hot Is Up to Us

- ESG (environmental, social and governance)
- Here's What Climate Change Is Doing to the Great Lakes
- Great Lakes Facts and Figures
- Scientists: Atmospheric carbon might turn lakes more acidic

b. Task 1: Shipwrecks, Spotter Buoys, and Flying Fish: Documenting the Impact of Climate Change and Invasive Species on the Great Lakes
   - Frozen in Time: National Marine Sanctuary Researchers Discover Lost Shipwreck Ironton
   - Thunder Bay National Marine Sanctuary (noaa.gov)
   - Shipwrecks | Thunder Bay National Marine Sanctuary
   - 3DShipwrecks.org
   - What are 360° photospheres? And what are panoramas?
   - Spotter Platform - Subsurface
   - Great-Lakes Region Acidification Research
   - Freshwater Acidification Research in Thunder Bay Great Lakes Fishery Commission - Invasive Carps
   - What are Invasive Carp?
   - New Study Finds Asian Carp Threat to Lake Michigan Is Greater Than Previously Thought
   - Environmental DNA Technology Committee
   - Exploration Tools: Environmental DNA: NOAA Office of Ocean Exploration and Research
   - Deep Trouble: In hunt for Asian carp, scientists find DNA, controversy
   - How eDNA technology is changing the game for protecting ocean species Location of the Illinois River basin

c. Task 2: Marine Renewable Energy: Producing Power from Our Planet While Monitoring Environmental Impact
   - Top 10 Things You Didn't Know About Offshore Wind Energy
   - What are the advantages and disadvantages of offshore wind farms?
   - Offshore wind farms by key country 2024
   - A metaheuristic optimization model for the inter-array layout planning of floating offshore wind farms
   - Wind turbine design – Corrosion control challenges
   - Singapore unveils one of the world's biggest floating solar panel farms
   - Where the Sun Meets the Sea: Offshore Floating-PV Powers Singapore's Journey Toward Carbon Neutrality
   - RWE And SolarDuck To Explore And Develop Offshore Floating Solar Parks Globally
   - Jellyfish and Comb Jellies
   - Wind Turbine – Discovery of Sound in the Sea
   - Recent Advances in Autonomous Environmental Monitoring Technologies to Support Offshore Wind Energy

d. Task 3: *MATE Floats!*
   - GO-BGC | Global Ocean Biogeochemistry Array

- Expanding Fleet of Autonomous Floating Robots Targets Deeper Understanding of Global Ocean Dynamics
- 2021 MATE Floats! | MATE ROV Competition Website
- Adopt-a-Float Newsletters | GO-BGC

## WEIGHT RESTRICTIONS

In light of some of the environments in which the ROVs will be operating, an ROV weight requirement has been included in the request for proposals (RFP). Lighter vehicles will be given special consideration and vehicles above a certain weight will not be considered. Size of the ROV will be limited by a 1-meter square opening that companies must launch and recover their vehicle through.

***Note for 2025!!!***

All weight measurements will include the vehicle and all tools and components. The weight measurement will NOT include the tether. The following will NOT be included in the weight measurement:

- The topside control system and the tether
- The vertical profiling float
- Any independent sensors if removable from the ROV

Vehicles will be weighed in the on-deck circle 15 to 20 minutes prior to the company's product demonstration run. Note that the vehicle will be weighed before EACH product demonstration run. The weight bonus, if any, will be added to each product demonstration score.

Weight measurements will be conducted using a digital scale. In addition, companies must be able to personally transport the vehicle and associated equipment to the product demonstration station and to the engineering presentation room. ROV systems must be capable of being safely hand launched.

Competition officials will use the following chart to award points for weight:

| **Weight (in air)** | |
|---|---|
| **< 18 kg** | **+10 points** |
| **18.01 kg to 25 kg** | **+5 points** |
| **25.01 kg to 35 kg** | **+0 points** |

Vehicles greater than 35 kg in weight will not be allowed to compete in the product demonstration.

**Weight Protocol**

Only the six designated product demonstration company members will be allowed into the on-deck circle during and after the weigh-in. Once a company's vehicle has been weighed, it must remain there until the company moves to its product demonstration station. Companies that detach equipment from the vehicle may not re-install that equipment until the 5-minute set up period. At that time, companies may replace any items that were detached for the measurement, but no new equipment (i.e., equipment that was not included in the weight measurements) may be added to the vehicle. If it is discovered that a

company added equipment that was not included in the measurements, the company will not be permitted to compete in that product demonstration run.

A video showing a simulated weight measurement is posted here.

# PRODUCT DEMONSTRATION

**IMPORTANT *NOTE*: Questions about the competition, production demonstrations, and design and building specifications should be posted to the MATE ROV Competition Forum Board. Questions will be answered by MATE ROV Competition officials so that all companies can see the questions and answers. This will also help to avoid duplicate questions. That said, please make sure that your question(s) has not already been asked – and answered – before posting. It is up to you and your company to read, comprehend, and comply with ALL rulings posted on the site. All pertinent rulings will be posted to the 2025 Official Rulings thread, which will be pinned to the top of the forum board.**

## ORGANIZATIONAL AND OPERATIONAL EFFECTIVENESS

Companies will receive up to 10 points for Organizational and Operational Effectiveness. This includes points for teamwork, collaboration and communication, project management, problem solving and the ability to deal with obstacles, and system design and control.

**Organizational and operational effectiveness is included on the product demonstration rubric posted here. This rubric will be posted by March 1, 2025. In the meantime, companies may refer to the previous year's rubrics for a general idea of the categories and points.**

***NOTE FOR 2025!!!***
Companies must launch through a 1-meter square area on the surface, side of the pool. This square will simulate a ship's moon pool/internal launch bay. All items launched and recovered MUST go through this 1-meter square.

## TASK 1: Shipwrecks, Spotter Buoys, and Flying Fish: Documenting the Impact of Climate Change and Invasive Species on the Great Lakes

**This task involves the following steps:**

**Task 1.1 Shipwrecks**

- **Use visual clues to determine the identity of an unknown shipwreck**
  - **Determine type of ship – 5 points**
  - **Determine length of ship**
    - **Within 5 cm – 10 points**
    - **Between 5.01 cm and 10 cm – 5 points**
    - **Not within 10 cm – 0 points**
  - **Determine the cargo that the ship carried**
    - **Remove the cover and determine the type of cargo – 5 points**

        - **Replace the cover – 5 points**
    - **Identify the shipwreck – 10 points**
- **Create a 360° photosphere image of the shipwreck environment**
    - **Create an image**
        - **Create a 360° photosphere image showing all 7 targets – 25 points**
        - **Create a 360° photosphere image showing 5 to 6 targets – 15 points**
        - **Create a 360° photosphere image showing 3 to 4 targets – 10 points**

          **or**
        - **Display still images of all 7 targets – 10 points**

**Task 1.2 Spotter Buoys**

- **Replace a damaged thermistor on the subsurface Spotter buoy**
    - **Remove the damaged thermistor**
        - **Release the top end connection point – 5 points**
        - **Release the bottom end connection point – 5 points**
    - **Install a new thermistor**
        - **Attach the top end connection point – 10 points**
        - **Attach the bottom end connection point – 10 points**
- **Install a pC02 sensor to the subsurface Spotter buoy**
    - **Place pC02 sensor in designated area – 5 points**
    - **Connect pC02 sensor to subsurface Spotter buoy – 10 points**

**Task 1.3 Lake Acidification and Invasive Carp**

- **Collect a water sample – 10 points**
    - **Lake acidification**
        - **Determine the pH of the water sample**
            - **In situ - 10 points**
            - **On surface - 5 points**
        - **Measure the dissolved C02 levels of the water sample – 5 points**
    - **eDNA of invasive carp**
        - **Determine if the unknown sequences include invasive carp – 10 points**
        - **Model invasive carp moving into the Illinois River watershed over time**
            - **Computer model – 20 points**
            - **Manually – 10 points**

**Total points = 160 points**

**Product Demonstration Notes:**

**Task 1.1 Shipwrecks**

An unknown shipwreck will be located on the bottom of the pool. The shipwreck will be constructed from ½-inch PVC pipe. Depending on the type of ship, the shipwreck may also be constructed from rope, plastic sheeting, and/or other materials. Companies must use visual clues to determine the identity of the unknown shipwreck. A shipwreck handbook (see PRODUCT DEMONSTRATION RESOURCES) will be available at the product demonstration station. The shipwreck handbook will include 9 unknown shipwrecks; the shipwreck located on the bottom of the pool will match one of these shipwrecks. Each of the 9 shipwrecks in the handbook will have unique factors to set it apart from other shipwrecks.

Companies must determine the type of ship. The shipwreck will either be a sailing schooner, a steam-driven paddlewheel ship, or a propeller-driven bulk freighter. Sailing schooners will be identified by a mast. Masts will be constructed from ½-inch PVC pipe and painted brown. Steam driven paddlewheel ships will be identified by an octagonal paddlewheel. Paddlewheels will be constructed from ½-inch PVC pipe. Propeller driven bulk freighters will be identified by a propeller. Propellers will be constructed from ½-inch PVC pipe with corrugated plastic attached to it. Companies will receive 5 points for successfully determining the type of ship. Successfully determining the type of ship is showing the station judge the shipwreck's mast, paddlewheel, or propeller on a video display and verbally communicating the type of ship to the judge.

Companies must measure the length of the shipwreck from bow to stern. Both the bow and the stern of the shipwreck will rise approximately 20 cm above the bottom of the pool. The measurement must be taken from the very front of the ½-inch PVC rising at the bow of the shipwreck to the very back of the ½-inch PVC rising at the stern of the shipwreck. Companies should verbally communicate their length measurement to the station judge. If companies are calculating the total length from a given distance, that should also be verbally communicated to the station judge. Companies will receive 10 points if their measurement is within 5 cm of the true length of the shipwreck. Companies will receive 5 points if their measurement is between 5.01 and 10 cm of the true length of the wreck. Companies will receive 0 points if their measurement is greater than 10 cm from the true length. Companies will only have one chance to correctly measure the length of shipwreck.

Shipwrecks in the Great Lakes are historical sites and must be preserved. Therefore, companies will be penalized 5 points each time their ROV comes in contact with the shipwreck, up to penalty of 25 points total. This includes the ROV tether and other components, but does not include the profiling float, which acts independently once released. If any part of the ROV comes in contact with the shipwreck, the station judge will inform the company, and the company will be penalized 5 points.

Companies must determine the type of cargo carried by the ship. The cargo container will be constructed from a Sterlite 6 qt plastic container with a lid that will act as a cover. The container will be painted brown so the contents cannot be seen from the outside. A ½-inch PVC handle will act as a carrying mechanism for the cover. Companies must first remove the cover from the cargo container. The cover will not be secured to the container; the cover will be weighted and resting on top of the cargo container. The cargo will be constructed from ½-inch PVC tees and 90° elbows painted a certain color. Yellow tees and elbows represent wheat. Red tees and elbows represent bricks. Black tees and elbows represent coal. White tees and elbows represent furnace sand. Note: the cargo container and cover are not considered part of the shipwreck and may be contacted by the ROV without penalty.

Companies will receive 5 points for successfully removing the cover and determining the type of cargo. Successfully removing the cover is defined as the cover no longer in contact with any portion of the cargo container. Successfully determining the type of cargo is showing the station judge the exposed cargo and verbally communicating to the station judge the type of cargo: wheat, bricks, coal, or furnace sand. Companies must have successfully removed the cover in order to identify the cargo.

The lid will weigh less than 5 Newtons in water.

Once the cover has been removed and the cargo identified, companies must replace the cover, leaving the shipwreck as they discovered it. Companies will receive 5 points for successfully replacing the cover on the cargo container. Successfully replacing the cover is defined as the cover no longer in contact with the ROV, resting on top of the cargo container, and no part of the cover in contact with the bottom of the pool. The cover does not have to fully conceal the cargo inside. Companies must show the station judge the cover on the cargo container in a video display. The cover must stay on the cargo for the entire product demonstration run. If the cover is knocked off at any time during the product demonstration run, companies will lose their points for replacing the cover. If these points are lost, companies may attempt to replace the cover again to regain these points.

Companies then must identify the shipwreck. Companies must have determined the type of ship, the length of the ship (even if incorrectly measured), and the cargo of the ship to identify the shipwreck. (Note: The cover does not have to be replaced over the cargo to identify the shipwreck.) When all three factors have been determined, companies may consult the shipwreck handbook located at the station to identify the ship.

Companies will receive 10 points for successfully identifying the shipwreck. Successfully identifying the shipwreck is defined as verbally communicating to the station judge the name of the shipwreck and confirming that the three factors visually match with that shipwreck information. For example, if the company determines the ship is a paddlewheel ship, the length is 1.56 meters, and the cargo was wheat, they could consult the shipwreck handbook and identify the ship as the Albany.

Companies must create a 360° photosphere of the shipwreck area. A 1-meter square constructed from ½-inch PVC pipe, painted red, will be on the bottom within 1 meter of the shipwreck. This square will be the center location of the 360° photosphere. Companies should land within this square to take their photos/images/videos to create the 360° photosphere. Alternatively, companies could use a device, operating as an independent sensor, and place it within the square to create the 360° photosphere (see 3.3.2 Independent Sensors for additional information). The device is permitted to contain cameras. Seven 15 cm x 15 cm colored squares made from corrugated plastic will be located on other product demonstration props throughout the mission area. One square will be on the bottom of the pool inside the 1-meter square, four more will be on mission props situated on the bottom of the pool, and two more will be positioned on mission props floating on the surface of the pool. All seven targets will be visible from within the 1-meter square.

Companies must use images taken from within the 1-meter square to create a 360° photosphere of the shipwreck area. Companies will receive 25 points for creating a 360° photosphere showing all 7 targets. Companies will receive 15 points for showing a 360° photosphere with 5 or 6 targets. Companies will receive 10 points for creating a 360° photosphere showing 3 to 4 targets. The photosphere must be shown to the station judge on a display at the mission station before the end of the product demonstration time. The photosphere must be a single image; companies cannot scroll through multiple images to show the station judge the various targets. Companies are allowed to rotate their view of their single 360° photosphere to show the judge the various targets. The company should point out all seven targets (or as many as there are in the photosphere) on their image to the

station judge. The color of the targets will be the same at each mission station, but colors of targets will differ between the mission stations.

Companies are not limited on how they create their 360° photosphere. Companies may use a commercial product or develop their own method for creating the image.

To receive the full 25 points, companies must create a "true" 360° photosphere, meaning that the image shown to the judge must be able to be rotated to any viewing position and must not have any edges (i.e., the image should be able to rotate in any direction indefinitely). Companies that take only a panorama (with edges) or stitch multiple photos together into a photomosaic (with edges) are limited to 15 points, even if their panorama or photomosaic shows all seven colored targets. Examples of 360° photospheres of shipwrecks can be found here: Shipwrecks | Thunder Bay National Marine Sanctuary.

If desired, companies may also export their 360° photosphere to a MATE ROV Competition Form: Photosphere Upload Form. This may be done during or after the 15-minute product demonstration run, or any time prior to the end of the World Championships on June 22, 2025. Companies are not required to submit their photospheres, nor will any points be awarded, but companies that do so will have their photospheres shared on the World Championship web page and then in the 2025 Archives page. Before uploading, save the image using the naming conventions outlined in 6.1 DOCUMENTATION, including your school affiliation and company name. Regional competitions may or may not provide the ability to upload 360° photosphere images. Contact your regional coordinator or visit your regional contest's website to determine if this will be available at your regional.

Alternatively, companies may choose not to create a true 360° photosphere, but instead take and display individual photos of all seven targets. Companies will receive 10 points when they successfully display all seven individual targets as still images. Successfully displaying all seven targets as still images is defined as showing the station judge seven different images, each one containing a different target. Companies may not combine multiple targets into one still image; seven different images must be displayed.

**Task 1.2 Spotter Buoys**

A Spotter buoy will be located in the pool at the start of the product demonstration. The Spotter buoy will consist of a float at the surface constructed from a 2-inch tee and foam, a mid-water thermistor constructed from 1 ½-inch, 1-inch and ½-inch PVC pipe, and a base, on the bottom, constructed from 1 ½-inch and ½-inch PVC pipe. A #310 U-bolt will act as a carrying mechanism for the thermistor. A rope will connect the surface, mid-water, and bottom base of the Spotter buoy. A new thermistor, constructed identically to the one located on the Spotter Buoy in mid-water, will be on the surface, side of the pool.

Companies must replace the damaged mid-water thermistor on the Spotter buoy. The thermistor will be connected by Velcro to two 1 ½-inch end caps, one of which will hang down below the surface Spotter buoy, the other which will have flotation attached and rise up from the base of the Spotter buoy. Companies must release the damaged thermistor by pulling down to release it from the top end cap, and by pulling up to release it from the bottom end cap.

Companies will receive 5 points for successfully releasing the top end Velcro connection and 5 points for successfully releasing the bottom end connection point. Successfully releasing from the top connection point is defined as no part of the damaged thermistor touching the top end cap. Successfully releasing from the bottom connection is defined as no part of the damaged thermistor touching the bottom end cap. Companies may release either end of the damaged thermistor first; the two releases may be done in any order. The damaged thermistor is considered debris; companies must return the damaged thermistor to the surface or it must be under control of their ROV at the end of the product demonstration run.

Once the damaged thermistor has been removed from both connection points, companies may install the new thermistor by attaching it to both the top and bottom end connection points. The new thermistor will be located on the surface, side of the pool at the start of the product demonstration run. Companies will receive 10 points for successfully attaching the new thermistor to the top end connection point. Successfully attaching the new thermistor to the top end connection point is defined as a Velcro to Velcro stick from the Velcro loops at one end of the thermistor to the Velcro hooks on the inside of the 1 ½-inch end cap. Companies will receive an additional 10 points for successfully attaching the new thermistor to the bottom end connection point. Successfully attaching the new thermistor to the bottom end connection point is defined as a Velcro to Velcro stick from the Velcro loops at one end of the thermistor to the Velcro hooks on the inside of the 1 ½-inch end cap. Companies may connect to either the top end or bottom end first; the two connections may be done in any order. Once installed, the thermistor must remain installed for the entire product demonstration run. If the thermistor becomes disconnected from the top and/or the bottom connection point, companies will lose their points for attaching to that connection point. Companies may attempt to reattach to the connection point to regain their points.

Companies must also install a pC02 sensor to the base of the Spotter buoy. A pC02 sensor will be available at the surface, side of the pool at the start of the product demonstration run. The pC02 sensor will be constructed from ½-inch, 1-inch, and 2-inch PVC pipe. A connector will be constructed from ½-inch pipe and be inserted into the 1-inch pipe on deployment. Companies must place the pC02 sensor in the designated area. The designated area will be a 50 cm square of ½-inch PVC pipe painted orange. Companies will receive 5 points when they successfully place the pC02 sensor in the designated area. Successfully placing the pC02 sensor in the designated area is defined as the sensor completely within the PVC of the designated area and standing upright. The pCO2 sensor must remain upright and in the designated area for the entire product demonstration run. If the pCO2 sensor comes out of the designated area or is knocked over at any time during the run, companies will lose points for placing it in the designated area. If it does move out of the designated area or is knocked over, companies may place it again to regain their points.

After placing the pC02 sensor in the designated area, companies must connect the sensor to the Spotter buoy base. The Spotter buoy base will have a port, constructed from 1 ½-inch PVC pipe. Companies will receive 10 points for successfully connecting the pC02 sensor to the base of the Spotter buoy. Successfully connecting the pC02 sensor to the base is defined as the pC02 connector no longer in contact with the vehicle and both ½-inch PVC pipe connections inside the 1 ½-inch PVC ports on the base of the Spotter buoy. The pC02 sensor must stay installed for the entire product demonstration run. If the connector is pulled out or becomes disconnected at any time during the run, companies will lose points for connecting

the pC02 sensor to the Spotter buoy. If it does become disconnected, companies may reconnect the sensor to regain their points.

**Task 1.3 Lake Acidification and Invasive Carp**

Companies must first collect a water sample from inside a container. A 1-liter soft water bottle will be suspended inside a 2-gallon bucket. A ¾-inch male adapter will be glued to the mouth of the water bottle and penetrate through a hole in a 2-gallon bucket lid. A ¾-inch coupling will be screwed onto the adapter to secure it to the bucket lid and into the 2-gallon bucket. The soft water bottle will be filled with hypersaline water colored red with food coloring. Plastic cling wrap will cover the top of the coupling to prevent the salty water from mixing with the pool water. Companies must penetrate through this plastic wrap and collect 50 milliliters of water from inside the soft water bottle.

Companies will receive 10 points for successfully collecting a water sample. Successfully collecting a water sample is defined as 50 milliliters of salty water being returned to the surface, side of the pool. Companies may pump the water inside the soft water bottle all the way to the surface and collect it there, or companies may pump the water inside the soft water bottle into a container on their vehicle and return that container to the surface, side of the pool. The station judge will verify the salinity of the water obtained with a hydrometer.

Companies must measure the pH of the water sample. Companies can do this in situ, using a pH meter and testing the water inside the 1-liter soft water bottle, or companies may measure the pH using a MATE-supplied litmus strip after they have returned the water sample to the surface. Companies measuring pH in situ must do so before retrieving a water sample.

For companies attempting to measure the pH in situ, the pH sensor may either be incorporated into and powered by the ROV or an independent sensor. Companies must insert their sensor through the ¾-inch coupling and into the liquid within the 1-liter soft water bottle. Companies will receive 10 points for successfully determining the pH of the water sample in situ. Successfully determining the pH in situ is defined as showing the station judge the sensor's pH reading and verbally communicating to the judge whether the sample is acidic or alkaline. An acidic reading is defined as a reading from 0.1 to 7.0. An alkaline reading is defined as a reading from 7.01 to 14.0.

Alternatively, companies may return the water sample to the surface and use a MATE supplied litmus strip pH test to test the pH of the water sample. Companies may choose to bring and use their own surface pH sensor as well. Companies will receive 5 points when they successfully test the pH of the water sample on the surface. Successfully testing the pH on the surface is defined as showing the mission station judge the reading and verbally communicating to the judge whether the sample is acidic or alkaline. An acidic reading is defined as a reading from 0.1 to 7.0. An alkaline reading is defined as a reading from 7.01 to 14.

Companies must also measure the dissolved C02 levels of the water sample. When the water sample is returned to the surface, companies will use a commercial carbon dioxide test kit to determine the dissolved C02 levels of the water sample. The test kit will include all the components needed to complete the testing, including a test tube, reagents, and titrator. The process for testing is detailed in the dissolved C02 Test Procedure, which can be found in

the PRODUCT DEMONSTRATION RESOURCES. This procedure includes a video. Companies will receive 5 points when they successfully measure the dissolved C02 levels of the water sample. Successfully measuring the dissolved C02 levels is defined as showing the station judge that the sample has turned pink and verbally communicating the amount of reagent (C02 B) used to turn the sample pink. The sample must maintain color for 10 seconds after mixing.

Once the water sample has been successfully collected, companies will receive laminated sheets with ten eDNA code sequences representing unknown organisms. Companies must compare the unknown DNA sequences to those of the invasive carp species. The Invasive Carp Species Handbook will be available at the product demonstration and will include four DNA sequences of the four invasive carp species. See the PRODUCT DEMONSTRATION RESOURCES to access the handbook. Companies must compare the ten unknown DNA sequences to the invasive carp species sequences.

Companies will receive 10 points for successfully determining if the unknown sequences include invasive carp. Successfully determining if the unknown sequences include invasive carp is defined as verbally communicating to the station judge whether or not any unknown samples match that of the invasive carp. The ten unknown samples may have no invasive carp species, one, two, three or all four invasive carp species. Companies must verbally communicate to the station judge which, if any, unknown DNA sequences match to the four DNA sequences of the invasive carp species.

At the start of the product demonstration run, companies will receive a data set showing invasive carp species in five regions throughout the Illinois river watershed. Companies must create a model showing the movement of invasive carp through the Illinois River watershed.


*Location of the Illinois River basin* | Download Scientific Diagram (researchgate.net)
This map may be downloaded here: Illinois River Basin Map Hubspot

The data will divide the watershed into five regions presented in the map below. The regions are as follows:


*Illinois River basin map divided into 5 regions*

The data also will show if and where carp were found in each section of the watershed from every year from 2016 to 2025, ten data points for each location. The data will say Y (yes) if invasive carp are present or N (No) if invasive carp are not present.

| | Region 1 | Region 2 | Region 3 | Region 4 | Region 5 |
|---|---|---|---|---|---|
| **2016** | **N** | **N** | **N** | **N** | **N** |
| **2017** | **Y** | **N** | **N** | **N** | **N** |
| **2018** | **Y** | **N** | **N** | **N** | **N** |
| **2019** | **Y** | **N** | **N** | **N** | **N** |
| **2020** | **Y** | **Y** | **Y** | **N** | **N** |
| **2021** | **Y** | **Y** | **Y** | **N** | **N** |
| **2022** | **Y** | **Y** | **Y** | **N** | **N** |
| **2023** | **Y** | **Y** | **Y** | **Y** | **N** |
| **2024** | **Y** | **Y** | **Y** | **Y** | **N** |
| **2025** | **Y** | **Y** | **Y** | **Y** | **N** |

*An example data set of invasive carp in the Illinois River watershed*

Companies must use the data provided at the product demonstration station to construct a model of carp movement through the Illinois River watershed. Companies may create a computer-animated model showing this movement of invasive carp, or companies may manually create a model of invasive carp moving through the Illinois watershed.

Companies will receive 20 points for successfully creating a computer-animated model of invasive carp moving through the Illinois River watershed. Successfully creating a computer-animated model is defined as the model showing the entire watershed map and highlighting the years in which invasive species were found and in what regions of the watershed. Companies may use any program, simulation, or method to create their model; companies are not restricted in any way for the creation of their computer-animated model. The company must show the judge their completed model on a display at the product demonstration station. The model shown to the station judge must be shown before the 15-minute time product demonstration time period ends.

Two examples of computer-animated models using the example data found in the Product Demonstration Resources section: Model 1 Model 2

- Companies may create any type of model; the model does not need to follow either of the examples.
- Companies do not need to display the data before or after the model. Data was shown on the models as an example.
- Companies may come with a model or images already prepared and modify them to fit the data provided at the mission station.

Alternatively, companies may choose to manually create a model of invasive carp moving through the Illinois River watershed. Companies will receive 10 points for successfully creating a model of invasive carp moving through the Illinois River watershed manually. Successfully creating a model manually is defined as printing a paper copy of the watershed map, highlighting each region of the watershed in a different color, and writing on the map what year invasive carp first appeared in that section. Companies choosing to manually create the model must bring their own printed version of the map; the MATE ROV Competition will not provide printed copies of the maps to teams.

An example of a manually created model using the example data found in the Product Demonstration Resources section: Manual Model

## TASK 2: Marine Renewable Energy: Producing Power from Our Planet While Monitoring Environmental Impact

**This task involves the following steps:**

**Task 2.1 Produce Power**

- **Connect a floating solar panel array to the grid**
    - **Retrieve the power connector – 5 points**
    - **Install the power connector into the hub**
        - **Remove the cover from the connection port – 5 points**

        - **Install the connector – 10 points**
- **Protect an offshore wind farm from corrosion**
    - **Replace a sacrificial anode onto the base of an offshore wind farm**
        - **Disconnect the old sacrificial anode from the base – 10 points**
        - **Connect the new sacrificial anode onto the base – 15 points**
    - **Mitigate corrosion**
        - **Conduct a visual inspection of the base structure – 5 points**
        - **Apply an underwater epoxy patch to the corroded area – 10 points**

**Task 2.2 Monitor Environmental Impact**

- **Collect life stages of jellyfish**
    - **Collect polyp stage jellies attached to the solar panel array**
        - **Collect 4 or more polyps – 10 points**
        - **Collect 1 to 3 polyps – 5 points**
    - **Collect a medusa stage jelly from mid-water**
        - **Visually determine medusa jelly is in open water – 5 points**
        - **Collect the medusa jelly – 15 points**
- **Collect fish species aggregated underneath the solar panel array**
        - **Collect 4 or more fish species – 10 points**
        - **Collect 1 to 3 fish species – 5 points**
- **Place a hydrophone in the designated location**
    - **Remove the hydrophone from the platform – 5 points**
    - **Place the hydrophone in the designated location – 10 points**
    - **Pull the pin to release the hydrophone from its base – 5 points**

**Total points = 120 points**

**Product Demonstration Notes:**

**Task 2.1 Produce Power**

Companies must connect a floating solar panel array to the grid. The floating solar array panel will be on the surface adjacent to an offshore wind turbine. A rope will connect the surface components to a base unit on the bottom. The floating solar panel array, the wind turbine, and the base structure will be constructed from ½-inch PVC pipe and corrugated plastic sheeting.

To connect the floating solar panel array to the grid, companies must retrieve the power connector, remove the cover from the connection hub, and install the connector into the power port. Companies must retrieve the power connector from a platform on the bottom. The platform will be constructed from ½-inch PVC pipe and corrugated plastic sheeting. The power connector will be constructed from 1-inch PVC. A #6 screw hook will act as a carrying mechanism for the power connector. Wire will connect the power connector to the base of the platform. Companies will receive 5 points for successfully retrieving the power connector from the platform. Successfully retrieving the power connector is defined as the power connector under control of the ROV and no longer touching the platform or the bottom of the pool.

Companies must also remove the cover from the connection port. Companies may remove the cover from the construction port before or after they pick up the power connector. The connection port will be constructed from 2-inch PVC pipe. The cover of the connection port

will be constructed from a 3-inch PVC end cap. A #310 U-bolt will act as a carrying mechanism for the cover. Companies will receive 5 points when they successfully remove the connection cover from the connection port. Successfully removing the connection cover is defined as the cover under control of the ROV and no longer in contact with connection port. The connection cover is considered debris; companies must return the cover to the surface or it must be under control of their ROV at the end of the product demonstration run.

Once the power connector has been retrieved and the cover has been removed from the connection port, companies must install the power connector into the connection port. The end of the connector will be covered by Velcro hooks. The inside of the port will covered by Velcro loops. Companies will receive 10 points when the connector is successfully installed into the port. Successfully installing the connector is defined as the connector no longer in contact with the ROV, the connector inserted into the 2-inch port, and the connector making a Velcro-to-Velcro stick. Once installed, the power connector must remain installed for the entire product demonstration run. If the connector becomes disconnected, companies will lose their points for installing the connector. Companies may attempt to reinstall the power connector to regain their points.

The offshore wind farm subsurface structure must be protected against corrosion by replacing a sacrificial anode and applying an epoxy patch to a corroded area. The subsurface structure of the offshore wind turbine will be constructed from ½-inch, 1 ½-inch PVC pipe, and corrugated plastic sheeting. The subsurface structure will be connected to the surface structure by a rope.

Companies must replace a sacrificial anode on the subsurface base structure of the offshore wind farm. Both the old and the new sacrificial anode will be constructed from a 2-inch and ½-inch PVC pipe. Both anodes will be painted silver. To replace the sacrificial anode, companies must first disconnect and remove the old sacrificial anode. Once removed, companies must connect the new sacrificial anode and secure it in place. Two sections of ½-inch PVC pipe will be inserted through a slot cut in the corrugated plastic sheeting. At the start of the product demonstration, both sections of ½-inch PVC pipe will be located underneath the slot in the plastic sheeting. Disconnecting and removing the sacrificial anode requires turning the anode so the ½-inch PVC pipe is parallel to the slot in the plastic sheeting and can be removed through the slot. Companies may rotate the anode in either direction to disconnect and remove it.

Companies will receive 10 points for successfully disconnecting and removing the old sacrificial anode from the base structure of the offshore wind farm. Successfully disconnecting and removing the sacrificial anode is defined as the old sacrificial anode under control of the ROV and no part of it touching the base structure of the offshore wind farm. The old sacrificial anode is considered debris and must be returned to the surface or under control of the ROV when the product demonstration time ends.

Once the old sacrificial anode is removed, companies must connect the new sacrificial anode and secure it into place. The new sacrificial anode will be available at the surface, side of the pool during the 5-minute set up period. Companies must insert both sections of ½-inch PVC pipe through the slot in the corrugated plastic sheeting. Companies will receive 15 points for successfully connecting the new sacrificial anode onto the base structure of the wind farm. Successfully connecting and securing the new sacrificial anode is defined as the anode no

longer in contact with the ROV and both sections of the new anode inserted through, and located below, the slot in the corrugated plastic sheeting. Once connected, the new anode must remain connected for the entire product demonstration run. If the anode becomes disconnected, companies will lose their points for connecting the anode to the base structure. Companies may attempt to reconnect the anode to regain these points.

Both the old and new sacrificial anode will weigh less than 10 Newtons in water.

Companies must also mitigate corrosion on the base structure of the offshore wind farm. This involves conducting a visual inspection to locate an area of corrosion on the base structure and applying an underwater epoxy patch to the corroded area. Companies must first inspect the four "legs" of the base structure for corrosion. Corrosion will be simulated by a spot of orange paint, at least 1.5 cm in diameter. There will only be one area of corrosion on the base structure, and the corrosion area will not be on the underside of any of the "legs". Companies will receive 5 points when they successfully conduct a visual inspection and identify the corrosion spot. Successfully identifying the corrosion spot is defined as showing the station judge the orange painted spot on a video display.

Once the corrosion has been identified, companies must apply an underwater epoxy patch to the corroded area. The epoxy patch will be available at the surface, side of the pool during the 5-minute set up period. The epoxy patch will be simulated by a cloth dish towel with Velcro loops attached at each end. Each of the "legs" of the offshore wind farm base structure will have Velcro hooks. Companies will simulate applying an underwater patch over the corroded area by connecting the Velcro loops on the patch to the Velcro hooks on the "legs" of the base structure. The patch must cover the corrosion spot. Companies will receive 10 points when they successfully apply an underwater patch to the corroded area. Successfully applying an underwater patch is defined as the Velcro loops of both ends of the dish towel attached to the Velcro hooks above and below the corrosion spot. The towel must completely cover the spot of corrosion.

**Task 2.2 Monitoring Environmental Impact**

Companies must collect life stages of a jellyfish, collect fish species, and place a hydrophone to monitor the environmental impact of offshore energy structures. Companies must collect polyp stage jellies attached to the bottom of a solar panel array. The polyp stage jellies will be constructed from black chenille pipe cleaners. The chenille pipe cleaners will be twisted together into a loop with one end inserted into 3/16-inch holes in the ½-inch PVC pipe that is used to construct the offshore solar panel array. Companies must collect the polyp stage jellies and return them to the surface, side of the pool. Companies that successfully collect four or more polyps will receive 10 points. Companies that successfully collect 1 to 3 polyps will receive 5 points. Successfully collecting a polyp stage jelly is defined as the polyp being removed from the PVC framework under control of the ROV and placed on the surface, side of the pool.

Companies must also collect a medusa stage jelly from mid-water. The medusa stage jelly will be simulated by a water wiggler. A 1.5 cm to 2 cm section of ½-inch PVC pipe will be inserted into the water wiggler to make it slightly positively buoyant. At the start of the product demonstration run, the medusa stage jelly will be enclosed within a holder constructed from 3-inch pipe. Companies must pull a ½-inch PVC pin to remove the top cover of the holder, which will release the jelly into the water. When the cover is removed, the

jelly will begin to float to the surface. Companies must first visually determine that the medusa jelly is floating in open water. Floating in open water is defined as the medusa stage jelly no longer in contact with the holder or PVC framework. Companies will receive 5 points when they visually determine the medusa jelly is floating in open water and no longer in contact with the holder. Companies may not attempt to collect the medusa stage jelly prior to visually determining the medusa is floating in open water.

Once it is in open water, companies must collect the medusa stage. Companies may not apply any direct pressure to the body of the jelly when collecting it; companies should collect the jelly as well as water surrounding the jelly The jelly may touch the sides of the container, but no additional pressure should be applied to the body of the jelly. Companies may not grab the jelly in a manipulator or squeeze the body of the jelly in any manner.

Companies will receive 15 points for successfully collecting the medusa stage jelly. Successfully collecting the medusa stage jelly is defined as returning the jelly to the surface, side of the pool surrounded by water, without applying any direct pressure to the jelly. Companies should return their entire collection mechanism to the surface, side of the pool. At no time during the product demonstration run should the jelly be removed from the collection mechanism. Companies should either design their collection mechanism to be removed from the vehicle after successfully collecting the jelly or the product demonstration time should end with the ROV and collection mechanism with the jelly surrounded by water on the surface, side of the pool.

Companies must collect fish species aggregated underneath the solar panel array. Fish species will be simulated by ping pong balls. The ping pong balls will be floating inside a square constructed from ½-inch PVC pipe that represents the floating solar panel array. Companies must collect the fish species and return them to the surface, side of the pool. Companies that successfully collect four or more fish will receive 10 points. Companies that successfully collect 1 to 3 fish will receive 5 points. Successfully collecting a fish is defined as the ping pong ball being removed from PVC square by the ROV and placed on the surface, side of the pool.

Companies must place a hydrophone into a designated location. The hydrophone will be located on a platform on the bottom of the pool at the start of the product demonstration. Companies must first remove the hydrophone from the platform. The hydrophone will be constructed from ½-inch, 2-inch and 3-inch PVC pipe. The platform will be constructed from ½-inch PVC pipe and corrugated plastic sheeting. Companies will receive 5 points for successfully removing the hydrophone from the platform. Successfully removing the hydrophone from the platform is defined as the hydrophone under control of the ROV and no longer in contact with the platform or the bottom of the pool.

Companies must place a hydrophone in the designated location. The designated location will be a 50 cm x 50 cm square constructed of ½-inch PVC pipe and painted yellow. Companies will receive 10 points for successfully placing the hydrophone in the designated area. Successfully placing the hydrophone in the designated area is defined as the hydrophone upright and completely within the PVC square. No part of the base of the hydrophone may be on or over the PVC of the designated area. Once placed, the hydrophone must remain upright and within the designated area for the entire product demonstration run. If the hydrophone is knocked over (no longer upright) or is moved from

the designated area, companies will lose their points for placing the hydrophone in the designated area. Companies may attempt to return the hydrophone to the upright position or return the hydrophone to the designated area to regain their points.

After placing the hydrophone in the designated area, companies must pull a pin to release the hydrophone from its base so that it floats in the water column. Companies will receive 5 points for pulling the pin and successfully releasing the hydrophone. Successfully releasing the hydrophone is defined as the 2-inch PVC pipe section of the hydrophone floating above the 3-inch pipe, attached by a rope. Companies must show the station judge on a video screen that the sensor section is floating above the 3-inch pipe. (Note: Companies would not lose points for releasing the hydrophone from its base if the hydrophone is knocked over or moved from the designated area, they would only lose points for placing the hydrophone.)

## TASK 3: *MATE Floats!*

*MATE Floats!* 2025 is inspired by the National Science Foundation (NSF)-funded GO-BGC Project. The goal of GO-BGC is to build a global network of profiling floats with chemical and biological sensors to monitor circulation, chemistry, biology, and overall ocean health. Scientists, engineers, and technicians are using NSF grant funds to build and deploy 500 robotic ocean-monitoring floats around the globe. As of August 2024, 217 out of the targeted 500 GO-BGC floats have been deployed or will be deployed shortly.

**This task involves the following steps:**

**Design and construct an operational vertical profiling float**

- **Prior to the competition, design and construct a vertical profiling float – 5 points**
- **Float communicates with the mission station prior to descending – 5 points**
- **Float completes up to two vertical profiles –**
    - **Vertical profile 1**
        - **Float completes first vertical profile**
            - **Using a buoyancy engine – 10 points**
            - **Using a different mechanism – 5 points**
        - **Float communicates data to the mission station – 5 points**
        - **Data verifies that the float maintains a depth of 2.5 meters for 45 seconds – 10 points**
    - **Vertical profile 2**
        - **Float completes a second vertical profile**
            - **Using a buoyancy engine – 10 points**
            - **Using a different mechanism – 5 points**
        - **Float communicates data to mission station – 5 points**
        - **Data verifies that the float maintains a depth of 2.5 meters for 45 seconds – 10 points**
    - **Profile graphed as depth over time – 10 points**

**OR**

**Company does not design and construct a vertical profiling float or float does not communicate data to the mission station.**

- **MATE-provided data is used to graph depth over time – 10 points**

**Total points = 70 points**

**Product Demonstration Notes:**
Prior to the competition, companies must build a float capable of completing a vertical profile (i.e., traveling from the surface to a depth of 2.5 meters and back to the surface) and collecting and communicating data to the mission station.

Companies that design their float with a buoyancy engine will receive additional points. A buoyancy engine moves fluid from inside the float to outside the float, displacing seawater and changing the density of the float. Using a motor to change the volume (push or pull a syringe, pump water into or out of, or expand a section) of the float constitutes "using a buoyancy engine." Using thrusters to directly move the float constitutes "using a different mechanism." Companies that do not use a buoyancy engine to complete their vertical profiles will receive fewer points. The float must also be capable of communicating data to a receiving device (i.e., the receiver) located at the surface at the mission station. The company is responsible for designing and constructing both the transmitter on the float and the receiver that displays the data at the mission station.

Companies must submit a non-ROV device document outlining their float design, detailing its operation, and demonstrating that it does not violate any safety rules. This document must also detail the onboard battery design, fuse size for safe discharge of the current, and how the float communicates with the company's receiver at the mission station. See DOC-004 for more details. This non-ROV device document must be submitted in advance of the competition. Companies will receive 5 points for designing and building a float. Successfully designing and building a float is defined as submitting a non-ROV device document that meets the requirements of DOC-004 and transporting the float to the product demonstration station.

Companies may deploy their float by hand through the 1-meter x 1-meter square at the side of the pool. Once the float begins its first vertical profile, or descends below the surface on its own, companies may no longer retrieve the float for repairs or repositioning.

Once the float has been deployed, it must communicate to the receiver located on the surface at the mission station. Companies are responsible for constructing both the transmitter on the float and the receiver at the mission station. Companies should design their float so that the transmitter can be maintained high enough above the surface of the water to communicate with the mission station.

The float must communicate (i.e., transmit) the following information to the mission station, referred to as the defined data packet:

- Company number (provided by MATE a few weeks prior to the competition)
- Time data (UTC or local or float time [float time would be time since float starts recording])
- Pressure data and/or depth data

- Any additional data as required by the company to complete this task

Sensors onboard the float must measure pressure and/or depth and transmit at least one of those to the mission station receiver. If a pressure to depth conversion is completed by the sensor on the float, companies may transmit depth data as part of their defined data packet. Alternatively, companies may choose to only transmit pressure data as part of their defined data packet and convert pressure to depth at the mission station.

Pressure data must be displayed in pascals (pa) or kilopascals (kpa).
Depth data must be displayed in meters (m) or centimeters (cm).

Pressure and/or depth data must correlate to a set time transmitted from the float. For example, a defined data packet from PIONEER 01 could be:

PN01 1:51:40 UTC 9.8 kpa 1.00 meters

NOTE: MATE is requiring WHAT data is transmitted (i.e., company number, time, pressure, depth). Companies must determine HOW to transmit that data and should consider that there will be other companies transmitting data at same time.

While the float is in the water, no longer in contact with a company member, and still on the surface, the float must transmit the defined data packet to the receiver. The receiver should not receive transmissions from any source other than the float. The float must transmit the defined data packet before starting its first vertical profile.

Companies will receive 5 points when their float successfully transmits the defined data packet to the receiver at the mission station upon deployment. Successfully transmitting the information is defined as the station judge seeing at least ONE defined data packet from the float on a screen or display at the mission station. The float only needs to transmit one defined data package prior to descending, but companies will not be penalized for sending additional defined data packets. If the float does not transmit and has not started its first vertical profile, companies may recover the float and attempt repairs.

The float should attempt to complete two vertical profiles. A vertical profile is defined as any part of the float on or above the surface, descending in the water column to a depth of 2.5 or more meters*, then ascending to and breaking the surface once again. Companies may use a buoyancy engine, thrusters, or another means to move their float through the water. A buoyancy engine is defined as moving air or liquid from inside the float to outside the float, changing the volume and thus the density of the float. Using motors to move air or liquid does constitute a buoyancy engine. Using motors as thrusters to directly move the float, by turning a propeller or emitting a jet of water, constitutes using a different mechanism to complete a vertical profile. Companies will receive 10 points for completing their first vertical profile using a buoyancy engine, or 5 points if they use a different mechanism.

During the vertical profile, the float must collect data every 5 seconds. After the first vertical profile has been completed and the float is still at the surface, the float must transmit the defined data packets taken every five seconds to the mission station receiver. Companies will receive 5 points when the float successfully communicates to the mission station receiver. The float MUST have completed one vertical profile to receive points for transmitting data packets to the receiver. Successfully transmitting data to the receiver is

defined as the station judge seeing at least one defined data packet from the vertical profile on a screen or display at the mission station.

After successfully demonstrating that at least one data packet has been transmitted, companies must display all of the data packets transmitted by the float during the entire vertical profile so that the mission station judge can verify that the float maintained a depth of 2.5 meters* for 45 seconds. If at any time the float moves above or below 2.5 meters (+/- 50 cm), it must reestablish itself and maintain a depth of 2.5 meters (+/- 50 cm).

Companies will receive 10 points for successfully maintaining a depth of 2.5 meters (+/- 50 cm) for 45 seconds. Successfully maintaining a depth of 2.5 meters for 45 seconds is defined as the station judge seeing 10 defined data packet cycles (1 data packet every 5 seconds) where the float depth was 2.5 meters +/- 50 cm on a screen or display at the mission station. Companies should design their float so that their pressure / depth sensor maintains a depth of 2.5 meters.

The ten data packets at 2.5 meters do not need to be sequential. For example, if a float maintains depth at 2.5 meters for 15 seconds (4 data packets), descends to the bottom, but then ascends back to 2.5 meters, it would need to collect 6 more data packets (25 seconds) at 2.5 meters to arrive at a total of 10. The station judge must see 10 data packets showing the depth at 2.5 (+/- 50 cm) to receive full points; these data points do not have to be in a continuous 45 second block.

The float should then attempt to complete a second vertical profile. Companies will receive 10 points for completing a second vertical profile using a buoyancy engine, or 5 points if they use a different mechanism.

During the second vertical profile, the float must collect data every 5 seconds. After the second vertical profile has been completed and the float is still at the surface, the float must transmit the defined data packets taken every five seconds to the mission station receiver. Companies will receive 5 points when the float successfully communicates to the mission station receiver. The float MUST have completed its second vertical profile to receive points for transmitting defined data packets to the receiver. Successfully transmitting data to the receiver is defined as the station judge seeing at least one defined data packet from the vertical profile on a screen or display at the mission station.

After successfully demonstrating that at least one data packet has been transmitted after the second vertical profile, companies must display all of the data packets transmitted by the float so that the mission station judge can verify that the float maintained a depth of 2.5 meters* for 45 seconds. If at any time the float moves above or below 2.5 meters (+/- 50 cm), it must reestablish itself and maintain a depth of 2.5 meters (+/- 50 cm).

Companies will receive 10 points for successfully maintaining a depth of 2.5 meters (+/- 50 cm) for 45 seconds. Successfully maintaining a depth of 2.5 meters for 45 seconds is defined as the station judge seeing 10 defined data packet cycles (1 data packet every 5 seconds) where the float depth was 2.5 meters +/- 50 cm on a screen or display at the mission station.

Companies will receive 10 points for successfully graphing depth versus time of one vertical profile. Companies may graph either their first or second vertical profile. Successfully

graphing the data is defined as showing the station judge a graph with time on the X-axis and depth on the Y-axis. Companies must graph the data received from their vertical profile, even if their float did not maintain a depth of 2.5 meters for 45 seconds. Depth data should be graphed every 5 seconds. The depth should be measured from the pressure/depth sensor on the float. Station judges will compare the depths provided on the graph when the float is on the surface and when maintaining a depth of 2.5 meters. If the float's pressure/depth sensor is above or below the waterline when the float is on the surface, companies should communicate how far below the waterline the pressure/depth sensor is when on the surface. Company's depths must be within 50 cm of the true depth to receive points for successfully graphing the data. Companies must use a computer or device to graph the data; companies may not draw a graph by hand. Data points may be entered (or cut and pasted) to a device by hand.

If the float fails to communicate to the mission station after its first or second vertical profile, it can continue to complete vertical profiles until it successfully transmits data. For example, if the float completes its first vertical profile but fails to communicate to the mission station before descending for its second vertical profile, companies will receive points for a vertical profile, but would not receive points for communication or maintaining depth at 2.5 meters. After completing a second vertical profile, if the float communicates successfully with the surface station, companies will receive points for their second vertical profile and would receive points for communication and maintaining a depth of 2.5 meters (if the data packets verify the proper depth for 45 seconds). If the float then completes a third vertical profile and successfully communicates to the mission station, companies will not receive any additional points for the third vertical profiles, but they would receive points for the missed communicating and maintaining a depth of 2.5 meters (if the data packets verify the proper depth).

If a float communicates data to the mission station, but that data does not verify that the float maintained a depth of 2.5 meters, companies will still receive points for the tasks that they did complete during the vertical profile. If a subsequent vertical profile accomplishes additional tasks, the station judge will replace the lower score with the later score. For example, if a float completes a vertical profile and transmits data packets, but those data packets do not verify that the float maintained a depth of 2.5 meters for 45 seconds, companies would receive points for completing a vertical profile and transmitting data, but would not receive points for data verifying the float maintained depth. After completing two vertical profiles, if a subsequent vertical profile is completed by the float, and that profile verifies the float maintained a depth of 2.5 meters for 45 seconds, companies would then receive points for data that verifies that the float maintained a depth of 2.5 meters for 45 seconds. Companies MUST inform the station judge that their recent profile has additional points scored and show the station judge the data confirming a high score. The station judge is not responsible for tracking additional vertical profiles; a company member must show the judge the data verifying the additional points.

The float must be less than 1 meter in overall height.
The float may not have a diameter/length/width greater than 18 cm.
The float may not have an airline to the surface or a rope/line to the surface or the bottom.
The entire float must be less than 1 meter in length, including an antenna for broadcasting data. The float must be less than 1 meter in length for the entire mission, it cannot have

multiple compartments that separate, nor may it raise or lower any objects beyond the 1-meter limit.

The float must move independently from the ROV. The float must operate independently; it may not be connected to the shore by a tether nor can the ROV interact with the float after successful deployment. Any air used on the float must be stored on the float. Floats may not have an airline to the surface. All electrical power to the float MUST go through a single fuse. The float will operate as a non-ROV device (see 3.3.1 Non-ROV Device Power Specifications for additional rules on powering a non-ROV device). Small button batteries are allowed to power timing devices on the float. All other batteries must adhere to the non-ROV device battery rules.

Companies that do not design and construct a float can use data provided by the MATE ROV Competition to create a graph of depth versus time. Likewise, if a company's float does not transmit data back to the station receiver, companies may choose to use data provided by the MATE ROV Competition to create a graph of depth versus time. Companies that design and construct a float may still earn points for completing vertical profiles; creating a graph from MATE-provided float data replaces all points for communicating to the mission station after a vertical profile, maintaining depth at 2.5 meters and any graphing of data received from the float. Companies cannot receive points for graphing data communicated from their float AND graphing data provided by MATE.

Companies that do not design a float, or whose float is unable to transmit data back to the station, should inform the station judge that they are choosing to instead graph data provided by MATE. The judge will then provide a set of depth versus time data to the company. Once a company requests the MATE data, they can no longer receive points for communicating to the station after a vertical profile, for verifying their float maintained a depth of 2.5 meters or for graphing data from their own float. Companies will receive 10 points for graphing depth versus time. Successfully graphing the data is defined as showing the station judge a graph with time on the X-axis and depth on the Y-axis. Companies must use a computer or device to graph the data; companies may not draw a graph by hand. Data points may be entered (or cut and pasted) to a device by hand.

*Regional competitions may take place in pools that are shallower than 2.5 +/- 50 cm. If that is the case, contact your regional coordinator or visit your regional contest's website to determine the depth your float must reach to complete a vertical profile and what depth the float should maintain depth at.

## PRODUCT DEMONSTRATION RESOURCES

Product Demonstration resources can be found on the Competition Class page.

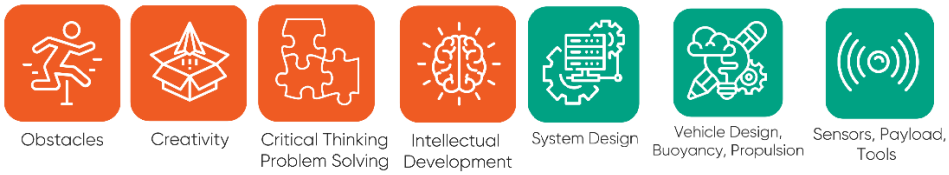
## PRODUCT DEMONSTRATION RESPONSIBILITIES

Companies are responsible for designing, building, and bringing their own operational vertical profiling float. Companies must also design and bring any tools or devices to complete the required MATE product demonstration tasks.

Companies are permitted to create a basket to collect multiple product demonstration items. Any collection basket MUST be included in weight measurements. A collection basket is considered debris if still in the pool and not under control of the ROV when product demonstration time ends. Any collection basket must be deployed and returned by the ROV; it may not be pulled to the surface by hand or a surface device.

The MATE ROV Competition will provide all of the remaining product demonstration items.

# PART 2: PRODUCT DEMONSTRATION PROP BUILDING INSTRUCTIONS & PHOTOS




The Product Demonstration Prop Building Instructions & Photos will be released with, but separate from, this competition manual.

# PART 3: VEHICLE DESIGN & BUILDING SPECIFICATIONS


## 1.0 GENERAL

IMPORTANT NOTE: Questions about competition, about the production demonstrations and design and building specifications should be posted to the MATE ROV Competition Forum Board. Questions will be answered by MATE ROV Competition officials so that all companies can see the questions and answers. This will also help to avoid duplicate questions. That said, please make sure that your question(s) has not already been asked – and answered – before posting. It is up to you and your company to read, comprehend, and comply with ALL rulings posted on the site. All pertinent rulings will be posted to the 2025 Official Rulings thread, which will be pinned to the top of the forum board.

When emailing their question, companies should reference:

- Any specific specification or rule (e.g. ELEC-002P)
- Competition class

Conventions: All values contained in this document are threshold values unless specifically stated otherwise. All water depths are given in meters (m). All dimensions and measurements utilize SI units.

# 2.0 SAFETY

Safety is the competition's primary concern and guiding principle. Any system that is deemed unsafe by competition officials will not be permitted to compete. If a safety concern is identified during the initial inspection, companies are permitted to modify their system and have it re-inspected. Companies are permitted to have their vehicle re-inspected twice. If a company fails to pass its third and final safety inspection, it is disqualified from the underwater competition portion of the event. There are NO APPEALS once an ROV has been disqualified.

***NOTE for 2025!!!***
MATE ROV Competition safety inspectors will be reinforcing the competition's emphasis on safety. Wiring discipline/workmanship (ELEC-023P) and strain relief at both ends of the tether (ELEC-024P) will be areas of particular emphasis. **Companies that do not meet these safety standards will not be permitted to compete in the in-water events**. Additional examples of wiring workmanship will be included in the MATE ROV Competition Safety Inspection Tutorial. See the Tech Bulletin – MATE Expected Work Practices for additional information.

Examples of safety violations from previous ROV competitions include:

- Companies used equipment that did not participate in and/or pass safety inspection
- The electrical SID included in the technical documentation did not show a main fuse.
- The ROV used pneumatics, but the technical documentation did not include a pneumatics diagram or pneumatic specifications.
- The ROV used pneumatics, but the company had not passed the fluid power quiz.
- Circuit boards and components were not securely fastened.

## 2.1 Jobsite Safety and Environment Analysis

Each member of the company is encouraged to read Oceaneering Americas Region HSE Employee Handbook, with emphasis placed on the following chapters.

Chapter 1 - Housekeeping
Chapter 9 - Hand Safety
Chapter 11 - Lifting and back safety
Chapter 12 - PPE
Chapter 17 - Tool Safety
Chapter 24 - Electrical Safety
Chapter 29 - Employee Observation Program
Chapter 33 - JSEA

**Jobsite Safety and Environment Analysis (JSEAs)**
***New for 2025!!!***
Companies advancing to the World Championship are required to create a JSEA and submit it along with (but as a separate document from) the Technical Documentation. Companies are also required to bring their JSEA to the onsite safety inspection; companies will not pass their inspection without this document. Companies must also bring a copy of their JSEA with them to the mission station and present it to the mission station judges prior to setting up for each of the product demonstration attempts. Companies will receive 5 points on their product demonstration score sheet for presenting the product demonstration judges with their JSEA prior to setup. Companies without a JSEA will not be allowed to compete in the product demonstration run.

A **JSEA** describes job tasks in step-by-step fashion, identifies associated hazards at each step, and outlines proper hazard controls that minimize the risk of injury or illness to the individual(s) performing that task. JSEAs are used extensively by the offshore industry.

The JSEA process follows a structured approach that comprises three (3) processes


In addition to these three processes, JSEAs should include the following information:
- The scope of the work.
- Space for specific names to be entered as responsible for implementing safeguards.
- Names and positions of all members involved in the JSEA discussion or Toolbox Talk.

- Describe Job Steps
  - Breakdown the task into basic steps. Each step should briefly describe what is done and in what order. Avoid making the breakdown so detailed that it has too many steps or making the job breakdown so general that basic steps are omitted.
- Identify the Hazards
  - Examine each step for hazards – either caused by the task to be conducted or by the work environment – or for any situation that might deviate from expected circumstances. The main activity in the JSEA procedure is to determine the hazards or potential hazardous exposures at each step of the task. Companies should strive to recognize all potential risks and plan to eliminate or reduce the hazards identified.
- Implement and Assign Safeguards
  - Safeguards must be implemented to defend against the identified hazards. Remember that Oceaneering maintains the following Safeguard Hierarchy for implementation:

- **Eliminate** the risk by avoiding it altogether, eliminating the source of risk, or substituting the source of risk with something that poses no risk or a much lesser risk.
- **Engineer** solutions that reduce the risk or eliminate exposure to it.
- Provide necessary Personal Protective Equipment (**PPE**) to protect from residual risk.

### *Assign Responsibility for Safeguards*

For safeguard implementation, it is extremely important to assign direct responsibility for each safeguard developed during the JSEA process. For example, if a task requires the replacement of a hydraulic pump, a safeguard would be to isolate the energy source feeding the pump's drive motor. The ideal method to describe this safeguard implementation on the JSEA would be: "*Tech II Bob* will apply lock-out /tag-out to *the energy source.*"

These responsibilities should be communicated to the affected personnel when the JSEA is reviewed by all the task's participants.

For more information and examples, companies can visit the following web sites:

- Shops and Trades | Office of Environment, Health & Safety (berkeley.edu) https://ehs.berkeley.edu/shops-and-trades
- SafetyWorks!: Job Hazard Analysis (safetyworksmaine.gov) https://www.safetyworksmaine.gov/safe_workplace/safety_management/hazard_analysis.shtml

**POTENTIAL HAZARDS**

| DESCRIBE JOB STEP (List the natural steps of the job. Do not make the steps too broad or too fine) | POTENTIAL HAZARDS (What are the potential hazards identified at this part of the job steps) | RECOMMEND RISK CONTROL MEASURES (describe how the identified hazards can be eliminated or reduced) | RESPONSIBLE PERSON (S) (Implementing control) | INITIAL (Of the responsible person/s) |
|---|---|---|---|---|
| Toolbox Talk | Miscommunication | **ANYONE can call ALL STOP at any point if an unsafe condition /act is perceived/observed.**<br><br>**Cell phone use is PROHIBITED in test area while testing!**<br><br>Ensure all participants are aware of procedures and roles within the procedure and sign JSEA acknowledging thusly.<br><br>Ensure that all participants are wearing correct PPE (safety glasses, safety shoes, gloves, and hard hats if crane ops are being performed)<br><br>Ensure participants/witnesses are wearing adequate clothing for weather conditions and to take breaks whenever necessary. | | |
| Hydraulic Function Testing | Stored/Trapped Energy: Up to **12,000 PSI**<br><br>Environmental Discharge<br><br>Tubing/Hose Failure<br><br>Line of Fire | Ensure all functions have pressure/flow reduced to 0 PSI when not being actively function tested.<br><br>Ensure each circuit is setup correctly before increasing pressure.<br><br>Ensure Vent hoses are properly connected to fluid containment reservoir.<br><br>Ensure all hoses are whip checked before coming up on pressure.<br><br>Ensure valves and actuators are in proper configuration before testing.<br><br>Ensure relief valves are set to relieve at the proper setting. | | |

*Example JSA task items courtesy of Oceaneering International*

***NOTE for 2025!!!***
Companies **MUST** focus their JSEA on their deck/dive operations only. **Shop safety and tool safety for building the ROV is extremely important but does not belong in this JSEA**. The submitted JSEA should focus information on potential hazards and recommended risk control measures of a company's pool side operations. This JSEA should cover topics such as:

Deck Ops/Launch and Recovery:
- Entering/exiting the pool deck area
- System set up
- Power up checks
- Pool side operations
- System breakdown

Examples of JSEAs:
- **2024 Alexandria University Aquaphoton - EXPLORER**
- **2024 Sea Cows Robotics - RANGER**

## 2.2 Safety Pre-Inspection

For companies advancing to the MATE World Championship, a safety pre-inspection will be completed before competition day. Companies will submit documentation to their regional coordinator. Safety pre-inspection document submissions will include the following:
- Technical documentation
- Company spec sheet
- SID [Electrical, Pneumatic & Hydraulic as utilized]
- Non-ROV device design document (if used)
- Non-ROV device SID (if used)
- Company safety review
- JSEA

See 2.2.1 Safety documentation requirements below for more information.

***NOTE for 2025!!!***
Once received, safety inspectors will conduct an initial safety inspection to identify potential safety violations. This inspection will be worth 20 points. Companies with violations will be notified via email. Once notified, companies must:
1. Respond acknowledging receipt
2. Layout a plan to address this violation
3. Submit new documentation if required

Onsite safety inspectors will also be informed of any potential safety violations identified during the initial safety inspection. This will allow safety inspectors to verify that any issues have been resolved.

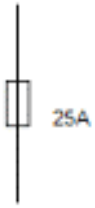
### *2.2.1 Safety documentation requirements*

Unless stated otherwise, each document MUST be submitted separately. In addition to the SID included in the technical documentation, an individual SID must be submitted for the initial safety inspection. The company safety review should NOT refer to systems shown in a submission video or detailed in the technical documentation.

DOC-001: SID Electrical: This must be an electrical diagram for all ROV systems. One section should focus on the systems above the waterline, and one section should focus on systems on the ROV (below the waterline). The SID:

- Should not exceed one 8.5" x 11" page in length (both above and below water sections, as well as any other information, should be on one page). Printed documents must be sized to fit on one side of the printed paper.
- Must be drawn with a CAD (computer assisted drawing) program. Hand drawn figures are not permitted.
- All symbols used should be standard symbols as specified by ANSI, NEMA or IEC.
- The SID must include a FUSE SYMBOL using an ANSI, NEMA or IEC symbol.
- ***New for 2025!!!***: The SID does not require fuse calculations; instead, companies must determine their full load amps (FLA) in water value and include that on the SID (see 3.3.3 Current for more information).
- The SID must not be component level schematics, but a higher-level interconnection block type diagram. Do not include individual pins on a board; the SID is a higher-level diagram.

The following ANSI and IEC fuse symbols are all acceptable for MATE documentation:

| Item | ANSI | IEC |
|---|---|---|
| **FUSE** |  |  |

An example of an acceptable SIDs can be found here:

- 48-volt SID: 2024 Long Beach City College SID (fuse size selection edited by MATE)
- 12-volt SID: 2024 Fukien Secondary School SID (fuse size selection edited by MATE)

DOC-002: SID Fluid Power: Companies using fluid power **MUST** include a fluid power diagram using industry standard symbols, showing all items, including regulators, and control valves. The diagram must document the components on the surface and the components located onboard the ROV. Fluid power diagrams must use ANSI, NEMA or IEC symbols. The fluid power diagram must also be drawn with a CAD program and should be a one 8.5" x 11" page diagram. The fluid power diagram may be included on the main electrical SID or as a separate one-page document.

DOC-003: SID Non-ROV Device: Companies utilizing an independent sensor or other electrically powered, non-ROV device to complete a product demonstration task must submit a SID for this device. The *MATE Floats!* vertical profiling float, if designed and used at

the competition, is considered a non-ROV device. This diagram must be completed to the specifications listed in DOC-001. The non-ROV device SID may be included on the main electrical SID or as a separate one 8.5" x 11" page document. Two (or more) separate pages may be used for two (or more) different non-ROV devices. Companies must include the full load amps in water value and the selected fuse size on their non-ROV device SID. Companies not designing and building a vertical profiling float or powered release container should state so in their Company Safety Review.

DOC-004: Non-ROV device design: Companies will be required to submit a written and photographic description of their non-ROV device. This document is limited to 2 pages in length. Companies must measure the full load current of the float and select their fuse size from their full load amps value. This non-ROV device design document must contain:

- A photo or diagram of the non-ROV device.
- The type of battery used.
- A photo of the battery pack.
- A photo of the fuse(s) used on the non-ROV device.
- A table of the measurements showing full load current.

For the *2025 MATE Floats!* task, this document must also include:

- A description of the buoyancy engine used to complete vertical profiles
- A description of how the float communicates with the shore side receiver. If any commands are given to the float after deployment, those communications must be described too.
- A description of how the battery pack was designed to safely fulfill the full load current needs and the voltage requirements of the float device.

A SID of the non-ROV device document must be included with the non-ROV device design document. This SID must be one page in length and is in addition to the 2 pages for the non-ROV device design document (i.e. DOC-004 can be a total of 3 pages, 2 pages for a description, 1 page for a SID). The SID must include:

- A fuse using a standard fuse symbol.
- Full load amps in water value and fuse size selected.

***NOTE for 2025!!!***

Any electrical or fluid powered device on the ROV MUST be documented on a SID. Depending on the type of device, it may be on the main ROV SID, an independent sensor SID, a Non-ROV device SID, or a Fluid SID. Any such device not represented on a SID cannot be used in the competition.

DOC-005: Company safety review: PIONEER companies submitting a company safety review MUST show compliance with the following specifications:

- If using 48-volts, an SBS50 Anderson Powerpole connector is the main point of connection to the MATE supply. If using 12-volts, a red-black Anderson powerpole connection is the main point of connection to the MATE supply (ELEC-010P).
- A properly sized fuse is within 30 cm of the main point of connection to power. If the company is using 48-volts, a properly sized Littelfuse must be used. If the company is using 12-volts, a properly sized ATO blade or Mini blade fuse must be used. The company must use a ruler to show this distance (ELEC-008P).

- Full load amps value and fuse size selected (ELEC-008P).
- The inside of the control box does not have exposed wiring (ELEC-017P), the control box is neatly laid out with attention to workmanship (ELEC-022P), a separation and identification of 120VAC wiring from DC and control voltages (ELEC-023P). If AC wiring is not used in the control box, include a statement saying no AC is used. Note: Companies using a computer or laptop should state that they are using a laptop and include the type of controller (Joystick, Xbox controller, etc.).
- The tether leading to control system has adequate strain relief (ELEC-024).
- The tether leading to the ROV has adequate strain relief (ELEC-024).
- If used, hydraulic / pneumatic systems include a pressure release valve, shut-off valve and regulator in the system (FLUID-004, FLUID-008), and that any pressurized cylinder, pressure storage device meets the MATE specifications.
- ***Note for 2025!!!*** If used, the specifications and details of the hydraulic / pneumatic components used, including pressure ratings of hoses and components (FLUID-003, FLUID-004, FLUID-007, FLUID-008).
- Any watertight housing on the vehicle can withstand pressure at 5 meters (MECH-001).
- All propellers are shrouded and have propeller guards (MECH-006).
- The ROV has no sharp edges or elements of the ROV that could cause damage (MECH-006, ELEC-017P).

The following photos MUST be included within the company safety review:

- Anderson powerpole connector within 30 cm of the fuse (show fuse, ruler and connectors).
- Inside of the control box with wires labeled or control system (and controller) for those using a computer or laptop.
- Strain relief where the tether connects to the control system.
- Strain relief where the tether connects to ROV.
- Compressor or pump (if pneumatics/hydraulics are used) including release valve, shut-off valve and regulator.
- Propeller shrouds (front and back of one propeller).
- The entire vehicle

The company safety review should include an explanation of how each system meets the safety specifications and include photographs of the relevant systems for review by the MATE ROV Competition officials.

Examples of Company Safety Reviews using 48-volt systems:

- **Purdue University Company Safety Review_2023**
  This company includes all components in their company safety review
- **Colorado School of Mines Company Safety Review_2023**
  This company does not use fluid power or a non-ROV device, and clearly state that fact in the company safety review.

Examples of Company Safety Reviews using 12-volt systems:

- **St. Francis Geneseas Company Safety Review_2023**
  This company includes all components in their company safety review

- **Oostburg High School Company Safety Review_2023**
  This company does not use fluid power or a non-ROV device, and clearly state that fact in the company safety review.

**Initial Safety and Documentation Review points**
Penalty points will be deducted from the initial safety and documentation review if:

- Companies do NOT submit ALL the required documentation by the given date. See KEY DEADLINES.
- Submissions are not within the given file size or page limit, submissions do not use the proper naming conventions or are not submitted as PDFs. See DOCUMENTATION for more information.
- The SID does not show a fuse, or the fuse does not use an ANSI, NEMA or IEC symbol.
- Full load amps value and fuse selected are not shown on the SID.
- The vehicle uses fluid power, but a fluid power diagram is not included.
- A non-ROV device is used but is not shown on any SID.
- A non-ROV device is used but not properly documented (including all required photos and descriptions).
- Companies not using fluid power, or not attempting a task requiring a non-ROV device, do not state this fact in the company safety review.
- The company safety review does not show compliance with all of the specifications.

The initial safety and documentation review rubric can be found here.

## 2.3 Onsite Safety Inspection

Companies must complete their onsite safety inspection before their vehicle enters the water.

Companies advancing to the World Championship must complete their initial on-site safety inspection immediately after checking in. A sign-up form with specific dates and time frames will be circulated in advance of the World Championship. Companies should review this form carefully and select the date and time frame that aligns with their travel plans. Companies that ship their ROV should also consider the expected delivery date and time when making their selection; without a vehicle present, the company will fail their initial safety inspection. Companies are required to check in and undergo their first safety inspection on the Tuesday, June 17th or Wednesday June 18th prior to the MATE World Championship competition. Accommodations will be made for companies that experience travel delays beyond their control (i.e., a cancelled flight or flight delay), but these will be the exceptions and not the norm.

At the World Championship, companies MUST pass their safety inspection by the end of the first day of the competition. Companies that do not pass their safety inspection by the end of the first day will be disqualified from the underwater product demonstration component.

***NOTE for 2025!!!*** A power supply will be available; companies will power up their control system and vehicle during the safety inspection. The inspector(s) will reference the list of violations as he/she conducts the safety inspection of the vehicle using the safety inspection rubric.

## 2.4 Safety Inspection Protocol

1. Before entering the water for practice or a product demonstration run, the ROV system must go through a safety inspection. Once a company successfully passes inspection, they will turn in their safety inspection sheet to the safety inspector and receive a Blue PASSED Card with their company number on it. Companies must present the Blue PASSED Card to the pool practice/product demonstration coordinator before their vehicles are permitted to enter the water.
2. Competition staff will conduct a safety inspection of the vehicle using the safety inspection rubric.
3. If the safety inspector(s) identify a safety violation, companies will have the opportunity to address it. The pool practice or product demonstration run schedule will NOT change to allow companies more time.
4. If during the second safety review the
    a. violation has not been properly addressed or
    b. another violation is revealed

   companies will have ONE additional opportunity to address the issue.
5. If during the third safety inspection a violation still exists, safety inspectors will request that the Chief Judge(s) review the violation. If the Chief Judge(s) confirms the violation, companies will not be permitted to participate in the underwater product demonstration component of the competition. However, companies can still participate in the engineering and communication (technical documentation, engineering presentation, and marketing display) component.
6. Reminder: All companies must present the Blue PASSED Card to the pool practice or product demonstration judge before placing their vehicles in the water. In addition, product demonstration station judges and competition officials can pause or stop a product demonstration run at any time if they feel that there is a potential safety concern.

***Note for 2025!!!***
All items used on the ROV MUST participate in and pass safety inspection. Companies that use a device that did not participate in and pass the safety inspection will be disqualified.

## 2.5 Safety Inspection Points

The safety inspection is worth 30 points. Each time a company fails its safety inspection it loses 10 points. After a company fails its second inspection, it must meet with the chief safety inspector to discuss a plan of action prior to returning to its workstation. THREE STRIKES and a company

a. Receives 0 points for the safety inspections and
b. Is disqualified from the underwater product demonstration component

# 3.0 SPECIFICATIONS

The ROV system (or “system”) must meet the following requirements:

## 3.1 Operational

### *3.1.1 Multiple Vehicles*

OPER-001: PIONEER class companies are required to design and build ONE ROV that can complete the necessary product demonstration tasks. "Floating eyeballs" or other vehicles that are not hard connected to the frame of the main vehicle are NOT permitted. Cameras designed to provide a "birds-eye view" are permitted provided that these cameras are hard connected to the frame of the main vehicle. "Hard connection" does not include the wiring between the camera and the ROV.

### *3.1.2 Environmental*

OPER-002: The ROV system must be able to function in fresh, chlorinated water with temperatures between 15°C and 30°C. The water should be considered conductive of electrical currents.

OPER-003: The pool will not be covered or purposefully darkened in any way, although the specific product demonstration tasks may require that your ROV operates in low-light.

OPER-004: Depending on the venue, pressurized pool filtration system outlets may cause unexpected currents.

OPER-005: The pool venue at the World Championship has a sloping, rough bottom.

OPER-006: At the World Championship, the water level may up to 45 cm below the level of the deck. Companies may need to lift their ROV or float over a wall 1-meter high to reach the tank. Companies should plan accordingly.

### *3.1.3 Service Requirements*

OPER-007: Companies shall provide a crew of at least 3 but not more than 6 people on the pool deck to operate the ROV System. Companies can send a larger crew complement, but no more than six can be on the deck at any time. More information about this "product demonstration team" is provided in the COMPETITION RULES.

### *3.1.4 Maintenance and Calibration Requirement*

OPER-008: All measurement devices shall be calibrated according to manufacturer recommended calibration procedure and performed by company members only. Company mentors or advisors are not permitted to perform calibration procedures. More information about mentor restrictions is provided in the COMPETITION RULES.

OPER-009: System maintenance during field operations shall be conducted by ROV personnel at their workstations. Work of any kind must not be done by company mentors or advisors. All maintenance parts and equipment necessary to meet the operation requirements shall be provided by the company. More information about these regulations is provided in the COMPETITION RULES.

## 3.2 Mechanical/Physical

This section of the document provides specifications for the mechanical properties of the ROV system.

### *3.2.1 Materials*

MECH-001: At the World Championship, any electronics housings on the ROV shall be capable of operating to depths of 7 meters.

### *3.2.2 Size and Weight*

MECH-002: ROVs are limited to a maximum weight, in air, of 35 kg. Vehicles over this weight will not be allowed to compete. Product demonstration tasks will limit the size of the vehicle. Companies must be able to personally transport the vehicle and associated equipment to the product demonstration station and to the engineering presentation room. ROV systems must be capable of being safely hand launched. Additional points will be given to lighter vehicles (see WEIGHT RESTRICTIONS).

### *3.2.3 Tether Length*

***Note for 2025!!!***

MECH-003P: At the World Championship, ROVs must be capable of operating in a maximum pool depth of 5.5 meters (18 feet). All underwater product demonstrations will take place within 8 meters from the side of the pool. The product demonstration station will be no more than 3 meters from the side of the pool. Tether length should be calculated accordingly.

### *3.2.4 Vehicle Deployment and Recovery*

MECH-004: The ROV system must be launched and recovered manually; no powered winches or portable cranes can be used. Hand-powered lifts and levers may be used to launch and recover the vehicle. The vehicle and any associated equipment must not damage any part of the pool or pool deck.

MECH-005: Any hand-powered lift or levers that are used as a launch and recovery system (LARS) must be detailed in the technical documentation and must be part of the safety inspection procedure. Any LARS equipment that is deemed unsafe at the safety inspection will not be allowed. Ladders, tripods, or other bracing equipment are not permitted as part of a LARS.

### *3.2.5 Propellers*

MECH-006: Propellers must be shrouded and have thruster guards. ROVs that have propellers exposed without thruster guards will not pass the safety inspection and will not be allowed to compete. A shroud must completely encircle the propeller and extend at least 2 mm in front of and behind the propeller. Thruster guards must completely cover any openings on the thruster and should have a mesh size that meets IP-20 standards (solid particulate protection level 2). This IP code equates to a mesh size <12.5 mm. To pass safety inspection, the shroud and propeller guard should meet this standard. If your finger can touch the propeller, then it is not properly guarded.

Teams may construct thruster guards, 3D print thruster guards, or may purchase commercially available thruster guards. All motors on the ROV must be protected with shrouds and thruster guards on all sides.

See https://www.thingiverse.com/thing:1498338 for an example of an acceptable thruster guard.

## 3.3 Electrical

PIONEER class companies may design their ROV to run off 48-volts or 12-volts. Depending on which option is chosen, by PIONEER class companies, certain rules will apply. Companies must choose to power their ROV from 48-volts **OR** 12-volts. Companies may not use both sources of power.

ELEC-001P: All power provided to the ROV system through an external connection for any purpose during the competition must be obtained from the MATE competition power supply. This includes dedicated lines for cameras, manipulators, and any other devices. This is a singular point of connection; all power to the ROV must pass through the MATE-provided fuse AND the single in-line fuse as specified in this section.

***NOTE for 2025!!!***
Circuit breakers are not allowed as the primary circuit protection on the ROV system, but they could be used "downstream" of the primary fuse.

If a company is using 48-volts, that company must use one of the following inline fuses that are rated for the amperage used on a 48-volt ROV.

30-amp fuse or 30-amp fuse
25-amp fuse
20-amp fuse or 20-amp fuse
Fuse holder

**COMPANIES ARE REQUIRED TO USE ONE OF THE LITTELFUSES AND THE LITTEL FUSE HOLDER LINKED TO ABOVE.**
These specific components are required. Companies without these components will not pass any of the following:

- video qualification
- initial safety inspection
- onsite safety inspection

If companies cannot purchase these components from the above sources, companies may purchase fuses and fuse holders from the SeaMATE Store.

If a company is using 12-volts, that company MUST use ATO type blade fuses or MINI blade fuses. These fuses provide easy visual inspection for amperage using industry standard color codes.

Fuse Reference: ATO fuse MINI fuse

These fuses are all rated for 32VDC and are color coded for amperage. All blade fuses MUST correspond to the standardized color codes listed on the fuse links above.

**COMPANIES USING 12 VOLTS WITHOUT A PROPER BLADE FUSE WILL NOT PASS SAFETY INSPECTION!**

ELEC-002P: The ROV system must be capable of operating off the power provided by a MATE supply. Two options will be available to PIONEER class companies. One MATE supply will provide a nominal voltage of 48-VDC. This voltage may be as high as 56 volts. The other MATE supply will provide a nominal voltage of 12-VDC. This voltage may be as high as 14.8 volts. Companies may use either, but not both, power supplies. Power supplies will be a fixed output voltage and will not be "turned down" to accommodate other than the specified voltage for the class. All references to 48-VDC and 12-VDC in this document are the nominal voltage of 12-VDC or 48-VDC, which must be within the ranges specified in this paragraph. At the World Championship, power for the PIONEER class will be provided by isolated power supplies.

ELEC-003P: If using 48-VDC, the ROV system must deliver the supply voltage to the ROV as provided and without modification. No conversion of this voltage is allowed prior to it arriving at the ROV system bus. Methods on the surface such as DC/DC converters, voltage drop resistors, and Pulse Width Modulation (PWM) are not allowed to be used between the ROV and the power source. ESCs and H-bridges are not allowed on the surface. Power supplies and conversion devices are not allowed on the surface if they operate the ROV.

MATE strongly urges companies to refrain from sending reduced voltage signals from the ROV back up the tether to power devices on the surface. This is not done by ROVs in industry and therefore is discouraged by the MATE ROV Competition.

If using 12-VDC, the ROV system may deliver any voltage to the ROV at or below the nominal voltage provided. Conversion of this voltage is allowed prior to it arriving at the ROV.

ELEC-004P: If using a 12-volt supply, ROV systems may use any voltage desired up to 12 volts. If using a 48-volt supply, ROV systems may use any voltage desired up to 48 Volts, but any conversion to a lower voltage must be made on board the ROV. Companies will not be permitted to operate a 48-volt ROV that reduces the voltage on the shore-side/top-side end of the ROV tether.

ELEC-005P: Voltage may not be increased above the nominal 12-volts or 48-volts anywhere in the ROV system.

ELEC-006P: Sonar or other systems that may have DC/DC conversion resulting in voltages above 12V or 48V nominal are not permitted.

ELEC-007P: Voltages in excess of the class parameters set forth in this specification are not allowed on the ROV system at any time other than any inductive spikes that are caused by the switching on/off of motors, solenoids and other inductive devices. Companies should design their systems to handle these voltage spikes but will not be penalized for the presence of these in a system. For additional information on this, companies can research

back electromotive forces (back EMF), collapsing magnetic motor fields, and transient suppression.

### *3.3.1 Non-ROV Device Power Specifications*

***NOTE for 2025!!!***

Systems that qualify as a non-ROV device in 2025:

- vertical profiling float

No other devices qualify as non-ROV devices.

ELEC-NRD-001: The vertical profiling float cannot be powered from the surface. If the float is powered, it must use onboard batteries. Voltage is limited to 12 VDC maximum; amperage is limited to 5 amps maximum. All power for the non-ROV device must go through a single fuse (see ELEC-NRD-005).

ELEC-NRD-002: The vertical profiling float non-ROV device may utilize thrusters but may not include any cameras. Vertical profiling floats cannot use a camera onboard to take images or video of pressure data and transmit those images/videos to the surface station.

***NEW for 2025!!! New battery limitations are in place. Read the following information carefully!***

ELEC-NRD-003: Onboard power is allowed for non-ROV devices. If onboard batteries are being used, the following specifications must be met.

- AAA, AA, C, D and 9V alkaline batteries are allowed. See table below for maximum amperage allowed for each battery type.
- NiMH (Nickel Metal Hydride) batteries and AGM (Absorbed Glass-Mat) batteries are also allowed.
- No other size or chemical composition is allowed. 12-volt outdoor, re-chargeable batteries are not allowed. **High discharge LiPo batteries are not allowed**.
- Batteries are mounted in a manner that they are not loose inside the container.

All alkaline batteries are limited to the maximum allowed current shown in this table. Above this current, batteries will overheat.

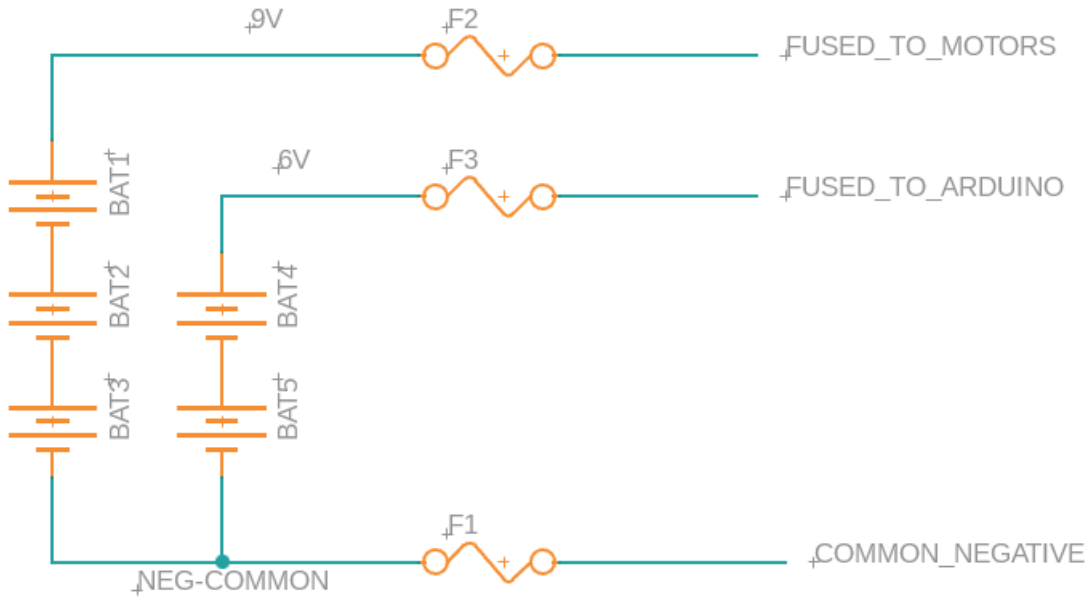
| Battery Type | Amps | Ohms | Maximum amps | Maximum Fuse Size | Fuse Link |
|---|---|---|---|---|---|
| AAA | 0.294 | 5.1 | 0.588 | 500mA | 500mA fuse |
| AA | 0.353 | 4.25 | 0.706 | 750mA | 750mA fuse |
| C | 0.517 | 2.9 | 1.034 | 1.0 A | 1.0 A fuse |
| D | 0.682 | 2.2 | 1.364 | 1.25 A | 1.25 A fuse |
| 9V | 0.05 | 180 | 0.1 | 100mA | 100mA fuse |

For the NiMH and AGM batteries:

- Maximum nominal voltage is 12V
- Maximum overall current and fuse size is 5 amps

ELEC-NRD-004: Battery fusing for non-ROV devices is an important consideration and the following rules must be adhered to.

- A single fuse must be utilized that will shut down all power sources in the non-ROV device if the fuse blows.
- A fuse (5 amps max) must be installed within 5 cm of the battery positive terminal.
- All fuses, when installed, must be able to be visibly inspected for amperage through a clear housing or immediately after an opaque NRD device housing is removed without the need to uncover the fuse.
- ***New for 2025!!!*** Cartridge fuses MUST be used for fusing alkaline batteries. Use a link from the above table for the fuse for alkaline batteries. All cartridge fuses must be readily accessible and must have the current stamped on the end of the fuse. Minimum DC voltage for the fuse must be 32 volts.
- ***Note for 2025!!!*** ATO type blade fuses or MINI blade fuses MUST be used for fusing NiMH and AGM batteries. The fuses to select from are 1A, 3A and 5A fuses. These fuses provide easy visual inspection for amperage using industry standard color codes. Fuse Reference: ATO fuse MINI fuse
  These fuses are all rated for 32VDC and are color coded for amperage.
- All blade fuses MUST correspond to the standardized color codes listed on the fuse links above. All cartridge fuses must have the current stamped on the end of the fuse.
- The maximum distance from a battery pack to any fuse is 5 cm.
- Batteries in Series: No voltage over a nominal 12V is allowed. This means no more than eight 1.5V alkaline batteries in series.
- Batteries in Parallel: Batteries may be placed in parallel to increase the current available to the system within the following limits:
  - In no case shall the current from the pack exceed 5A.
  - The number of series strings in parallel is used as a multiplier to determine the fuse size. For example, using C batteries, the maximum fuse size is 1.0 amps. If three battery strings are placed in parallel, the maximum fuse size is 3 amps (3 * 1.0A = 3.0 Amps).
- For systems with multiple battery packs, the battery packs should be connected on the negative terminals with the fuse (5 amps max) located off of the common negative terminal connection. Each individual battery pack should also be fused with the properly sized fuse for that battery pack.




ELEC-NRD-005: Full Load Amps Value. Companies MUST measure the full load amps (FLA) of their device during waiting mode (motors off) AND during buoyancy change mode (motors on). The type of battery pack allowed for their system can be determined using the full load amps measurement (See ELEC-008P for more information).

Using the non-ROV device full load amps values, companies should select the standard fuse closest to their FLA.

ELEC-NRD-006: The enclosure housing must be designed so that it will open if the pressure inside the housing is greater than the outside pressure.

There are two allowable methods for pressure relief:

1. A pressure relief hole of a minimum of at least 2.5 cm in diameter. This hole can be plugged up with a rubber stopper but must be friction fit. Threads or other fastening methods are not allowed. Holes less than 2.5 cm in diameter will not pass safety inspection.
2. The enclosure is built in a manner that an end cap will pop off if under pressure. This can be an internal or external cap with O-rings to provide sealing. The sealing diameter of the end cap must be 2.5 cm in diameter or greater (this limits the smallest ID of an enclosure to 2.5 cm).

Additional notes:

- Under no condition should the housing be built with fasteners to hold the housing together. There must be at least one 2.5 cm or larger opening that serves as a pressure release.

- ***Note for 2025!!!*** Utilization of pressure release valves are not acceptable as they cannot be tested at the competition site.
- ***Note for 2025!!!*** Pop-off end caps that utilize a tightening mechanism (hose clamp, Twist-Tite) are not allowed.

ELEC-NRD-007: A SID must be submitted for any non-ROV device that uses electrical power

### *3.3.2 Independent Sensors*

Certain product demonstration tasks may require a sensor that is independent of the vehicle. These electrically powered sensors will operate under the following independent sensor rules.

ELEC-IS-001: Independent sensors must be powered from the surface; no onboard batteries are allowed.

ELEC-IS-002: Companies may use USB to connect their sensors to a computer. Companies may also use surface battery packs (limited to 12 volts maximum) or the MATE supply to provide power for their independent sensor.

ELEC-IS-003: The independent sensor may only contain the intended sensor; thrusters, cameras, or other systems MAY NOT be attached unless specified in the PRODUCT DEMONSTRATION section.

ELEC-IS-004: Companies that use an independent sensor must provide a 3 amp (or less) fast blow fuse on the positive side of their connection. Companies using USB only to power an independent sensor may utilize the built-in current limiting of USB and do not need to add an additional fuse.

ELEC-IS-005: A SID must be submitted for any independent sensor that uses electrical power.

### *3.3.3 Current*

ELEC-008P: ROVs utilizing the 48-volt supply will be limited to 30-amps at 48-volts. ROVs utilizing the 12-volt supply will be limited to 25-amps at 12-volts.

**How to select the proper fuse size for your ROV**

MATE is modifying its specifications on how fuse size is selected for the ROVs. Past methods allowed currents well beyond the class maximum fuse due to the time delay of the fuses. For 2025, companies must measure the full load amperage (FLA) of the ROV while in water and then select the next standard size fuse that is both above the FLA and equal to or below the class maximum fuse size. To measure the full load amperage, companies should:

- Submerge your ROV in water and apply full down and full forward on all motors (this should be your highest current draw)
- Measure the Full Load Amperage (FLA) with an ammeter
- Select the next higher standard fuse size from the table below

Companies should not itemize individual device currents, only report the actual measurement of the FLA. Do not multiply by 150% as in past years.

For companies using 48-volts:

| 48V Full Load Amps | Fuse Size | JCASE Color |
|---|---|---|
| < 20.5 A | 20 A | Blue |
| 20.6 A to 26.3 A | 25 A | White |
| 26.4 A to 33.2 A | 30 A | Pink |

For companies using 12-volts:

| 12V Full Load Amps | Fuse Size | ATA Fuse Color |
|---|---|---|
| < 3.5 A | 3 Amp | Violet |
| 3.5 A – 4.5 A | 4 Amp | Pink |
| 4.5 A – 5.5 A | 5 Amp | Tan |
| 5.5 A – 8 A | 7.5 Amp | Brown |
| 8 A – 10.5 A | 10 Amp | Red |
| 10.5 A – 15.5 A | 15 Amp | Blue |
| 15.5 A – 20.5 A | 20 Amp | Yellow |
| > 20.5 A | 25 Amp | Transparent |

If the ROV FLA exceeds the maximum current, companies should limit their ROV current to prevent blowing the fuse during the competition. An example of this would be limiting the maximum PWM applied to the thrusters.

***New for 2025!!!***

Full load amps values must be included on any SID and in the Company Safety Review. Full load amps and fuse selection should be reported as follows:

**ROV Full Load Amps (FLA) in water = _____**
**Fuse size selected based upon FLA = _____**

SIDs without FLA values or without fuse size selections will have points deducted from their initial safety inspection. Also, SIDs without FLA values will not pass the safety inspection. All FLA values must be measured with the motors in water.

The MATE power supply will be protected by a 30-amp fuse; however, the ROV system must also have its own properly selected fuse.

***Note for 2025!!!***

The power supplies used by the MATE ROV Competition have integrated circuit protection. Under most conditions, this protection will activate before a company's fuse blows. If a company experiences a power supply circuit protection event during a product demonstration run, it will be assumed that there is an electrical fault within the ROV system. It will be at the discretion of the lead safety inspector or their designate whether the company may continue the product demonstration, and whether the ROV will need to be reinspected by a safety inspector.

ELEC-009P: ROV systems are allowed one replacement fuse during the product demonstration. In the event that the ROV system blows the second fuse during the demonstration, the demonstration will be over, and no additional points will be earned. Companies should have adequate replacement fuses on hand, MATE will not provide replacements. Standard sizes for fuses are 15, 20, 25 and 30 amps. Additional standard fuse sizes are 1, 3, 4, 5, 7.5, and 10 amps.

***Note for 2025!!!***
The required Littelfuse (48-volt systems) or ATO or mini fuse (12-volt systems) **MUST** be within 30 cm of the connection to the MATE power supply. There should be no other components between the Anderson powerpole connections that connect to the MATE supply and the fuse. Companies choosing to use E-stops or control boxes must locate their fuse before any of these components.

### *3.3.4 Power Connections*

**IF CONNECTING TO A 12-VOLT SUPPLY**
ELEC-010P(12V): Power supply connections will be red/black Anderson Powerpole Connectors. Companies' ROV system power wires must have proper connectors to obtain power. The Anderson Powerpole Connectors must be connected to the ROV power wires securely; use of a proper mechanical crimper is required. Hand crimp tools do not have the force necessary to ensure proper and safe connections. MATE will not provide companies with connectors or adapters at the 2025 World Championship.

***NOTE for 2025!!!***
The red and black pole pieces must be attached. Loose Powerpoles (those not attached) will not pass safety inspection.

30 Amp Permanently Bonded Red/Black Anderson Powerpole Connectors | Powerwerx
or
30 Amp Unassembled Red/Black Anderson Powerpole Connectors | Powerwerx
or
ASMPP30-1X2-RK Anderson Power Products, Inc. | Connectors, Interconnects | DigiKey

These are two-piece connectors as shown in the picture below.

ELEC-011P(12V): The power supply may be located up to 1 meter from the station table and may be located on either side of the table. MATE recommends a power cable long enough to reach the power supply up to 3 meters from your control system.

**IF CONNECTING TO A 48-VOLT POWER SUPPLY**

ELEC-010P(48V): Power supply connections will be Anderson Power Connectors. Companies' ROV system power wires must have proper connectors to obtain power. The Anderson Power Connectors must be connected to the ROV power wires securely; use of proper (hydraulic) tooling is required. Hand crimp tools do not have the force necessary to ensure proper and safe connections. MATE will not provide companies with connectors or adapters at the 2025 World Championship.

***NOTE for 2025!!!***

**COMPANIES ARE REQUIRED TO USE THE ANDERSON SBS50 LINKED TO BELOW.**

This specific component is required. Companies without an Anderson SBS50 connector will not pass their video qualification, will not pass their initial safety inspection, nor will they pass their onsite safety inspection.

Housing: Anderson SBS50BLU-BK

DigiKey: SBS50BLU-BK Anderson Power Products, Inc. | Connectors, Interconnects | DigiKey

Mouser: SBS50BLU Anderson Power Products | Mouser

Newark: SBS50BLU-BK - Anderson Power Products - Connector Housing, SBS50 Series, Plug

Online Components: SBS50BLU-BK - Anderson Power Products - Authorized Distributor

Additional online sources for the Anderson SBS50BLU connector:

Blue SBS50 Standard Housings Up to 110 amps Bulk (andersonpower.com)

Pins: The proper pin for your tether conductors

12 or 10 AWG: Anderson 1339G3-BK

8 AWG: Anderson 1339G5-BK


http://leeselectronic.com

MATE strongly discourages the use of Anderson Powerpole "knock-offs." These connectors do not meet electrical specifications and have the potential to melt under load.

***NOTE for 2025!!!***
If companies cannot purchase an Anderson SBS50BLU from the above online sources, companies may purchase a kit with these connectors (and the proper Littelfuses/fuse holder) from the SeaMATE store.

Either power supply may be located up to 1 meter from the station table and may be located on either side of the table. MATE recommends a power cable long enough to reach the power supply up to 3 meters from your control system.

### *3.3.5 Tether Voltages*

The signals in the tether must meet the following specifications:

ELEC-012P: If using a 12-volt system, DC main-supply at a nominal voltage of 12 VDC as provided by the MATE power supply. If using a 48-volt system, DC main-supply at a nominal 48VDC as provided by the MATE power supply.

ELEC-013P: Low voltage, low current AC or DC control or sensor signals. Low voltage is defined as a voltage equal to or less than the maximum supply voltage per class specification. Low current is defined as being less than 500mA. Examples include video signals, control signals for electrically powered manipulators, sensor signals, etc.

Note: Companies concerned about how voltage loss will affect their camera(s) should consider adding a separate line in the tether to supply the camera from the main power source. This dedicated line for cameras is permitted, provided it runs through the single fuse.

ELEC-014P: Ethernet, USB, or other ANSI or IEC accepted serial protocol signals.

ELEC-015P: NTSC or PAL Video signals

ELEC-016P: Fiber optic cabling of any type may be used.

***NOTE for 2025!!!***
At the World Championships, PIONEER class companies should include a video splitter in their line at the surface control station so that their ROV camera view can be incorporated into the livestream. MATE ROV competition officials will connect to this splitter and broadcast the ROV camera view on the livestream. Optionally, companies may also provide a split view of their GUI and/or non-video displays to be broadcast over the livestream.

An HDMI connection box will be available at the product demonstration station. During the 5-minute setup, companies should connect their split video connector to this connection box. Companies should prepare their system to ensure that their video feed is not interrupted by splitting it out to the livestream feed.

MATE HDMI Connection Box:


The following are examples of video splitters. Companies may choose devices other than those provided below to split their video. Companies with analog or other non-HDMI cameras should consult with the livestream group prior to their mission runs. Contact the livestream coordinator if you have questions or require a converter to HDMI.

- OREI HDMI Splitter 1 input 2 output 1080p with EDID (HD-102)
- OREI 4K 1x2 HDMI Splitter: 1-in 2-out, EDID (HDS-102)
- OREI HDMI Splitter 1 in 2 out with Downscaler (UHDS-102C)
- Amazon Basics HDMI Splitter 1 In 2 Out
- Rasfox AV/RCA to HDMI Converter and Upscaler
- GAOZHOU Capture Card with 4K Pass-Through, USB3.0 1080P 60FPS
- NZXT Signal HD60 Full HD USB Capture Card with Zero-Lag Passthrough
- Elgato HD60 X – Capture Card

### *3.3.6 Exposed Connections and Disposable Motors*

ELEC-017P: ROVs with electrical connections that are exposed to water and not sealed are not permitted to enter the water. Taping a connection with electrical tape only does not constitute a sealed connection. The process of sealing electrical connections must include methodologies such as, but not limited to, Silicone RTV, hot melt glue, epoxy, self-vulcanizing tape, and enclosure of the connections in a housing.

ELEC-018P: “Disposable motors” are not permitted, these are exposed motors with no waterproofing.

Brushless motors must be properly waterproofed. Companies must show manufacturer documentation showing their brushless motors are waterproof, or companies must properly waterproof their motor and provide documentation showing their methodology. Non-sealed brushless motors will not pass safety inspection.

See the MATE Technical Bulletin for proper methods to waterproof a brushless motor.

## 3.4 Onboard Electrical Power

ELEC-019P: Onboard electrical power (i.e., power not provided by the tether) is not allowed on the primary ROV. See the Non-ROV Device Power Specifications regarding onboard power.

NOTE: Water leaking into a closed battery container can result in the generation of hydrogen gas. This gas can build up inside a pressure housing and create an unsafe situation. Any battery housing must be designed to open if the pressure inside the housing is greater than the outside pressure to meet the MATE safety standards. See the non-ROV device onboard battery rules (3.3.1 Non-ROV Device Power Specifications) for more information.

## 3.5 Power Shutdown

ELEC-020P: For safety purposes, any ROV system that is disconnected from the surface supply must stop functioning in less than 5 seconds. This applies to electrical, pneumatic, and hydraulic power sources. Any filters, capacitors or accumulators must be sized accordingly to meet this specification.

## 3.6 Fluid Power

Any vehicle using fluid power must provide a fluid power diagram. Fluid power is defined as hydraulic pumps (water) or pneumatic pumps (air) on the vehicle or on the surface.

### *3.6.1 Hydraulic Power*

FLUID-001: Hydraulic fluid: Water only.

FLUID-002: Maximum Hydraulic pressure allowed: 10.33 bars (150 psig).

***NOTE for 2025!!!***

FLUID-003: Hydraulic system: All lines, fittings, and hydraulic devices must be rated for a minimum pressure of two (2) times the maximum supply pressure. Hydraulic component specifications must be included in the Company Safety Review.

FLUID-004: Hydraulic pumps must be part of the safety inspection.

- They must have a pressure relief valve with a maximum setting of 300 psig or less installed before the pressure regulator.
- The pump must have a regulator in place and set to 150 psig or less.

- Pumps with any sign of external rust or deterioration will not be accepted.
- All wiring must be secure.
- All guards must be in place.
- Hydraulic pumps may run off of the 15 A 115 VAC outlet provided for command and control as long as the hydraulic fluid is not used to propel the ROV. The hydraulic fluid is to be used for grippers and actuators only.

Companies using hand/manually powered hydraulic systems do not need a pressure relief valve or regulator in their system. The hand/manually powered hydraulic system must be included on a SID.

### *3.6.2 Pneumatic Power*

FLUID-005: Pneumatic fluid: Compressed air or inert gas only

FLUID-006: Maximum pressure allowed: 2.75 bars (40 psig)

***Note for 2025!!!***

FLUID-007: Pneumatic system: All lines, fittings, and pneumatic devices must be rated for a minimum pressure of two and a half (2.5) times the maximum supply pressure. For example, if an 83 bar (1200 psig) tank is regulated to 2 bars (30 psig), then all system components must have a minimum rating of 5.17 bars (75 psig)**.** Pneumatic component specifications **MUST** be included in the Company Safety Review. Note: Aquarium tubing is not generally rated for the pressures associated with compressed gas systems and should not be used in a pressurized pneumatic system.

FLUID-008: Air compressors must be part of the safety inspection.

1. The company's system must have a pressure regulator, shut-off valve and manual pressure release. See Compressed air at the MATE ROV Competition for more information.
2. The regulator must be set to 40 psig for less.
3. Compressors with any sign of external rust will not be accepted.
4. The tank drain valve must open.
5. If more than 5 ml of water exits upon opening the drain valve, the compressor will not be accepted.
6. All wiring must be secure.
7. All guards must be in place.
8. Air compressors may run off of the 15A 115VAC outlet provided for command and control as long as the air is not used for motor thrust. The air is to be used for buoyancy/ballast, grippers and actuators only.

At the World Championship competition, MATE ROV will provide compressed air at each station. Companies using compressed air MUST attach to the provided compressed air; companies may not use their own compressor. See 3.9 MATE Provided Equipment for more information.

### *3.6.3 Pressurized Cylinders / Unpressurized Containers*

***New for 2025!!!***

FLUID-009: Pressurized cylinders (SCUBA tanks) are not allowed.

***Note for 2025!!!***
FLUID-010: Electronic housings and other enclosures on the ROV must operate at surface pressures. Companies may not pressurize their electronics housing.

### *3.6.4 Unpressurized Cylinders*

FLUID-011: Companies may fill containers on the ROV with air provided those containers never exceed ambient pressure. Any such container is required to have at least one ¼-inch (6.35 mm) hole drilled into the bottom of the container to allow excess air to escape.

### *3.6.5 Pressure Storage Devices (Pressure Accumulators)*

FLUID-012: Pressure storage devices are allowed on the ROV if they do not exceed 1.25L in total storage and do not store pressure higher than the allowed pressure for air or hydraulics. It is recognized that a company may not be able to purchase a pressure accumulator that has the proper rating and fits in the space needed. In that case, the company must show that their designed accumulator is capable of withstanding the specified pressures without rupture.

### *3.6.6 Chemical Creation of Gases*

The chemical creation of gases is not allowed.

### *3.6.7 Fluid Power Quiz*

FLUID-013: PIONEER class companies planning to use hydraulics and/or pneumatics (i.e., fluid power) are required to take and pass an online quiz with a score of 100%. Companies ONLY using manual pumps and unpressurized containers are not required to take the Fluid Power Quiz but must still submit documentation regarding their fluid power system.

NOTE: The quiz was developed by MATE ROV Competition technical support staff and competition judges and is designed to ensure that companies understand basic information on these topics and can apply that knowledge to safe practices. The intention is not to add yet another "requirement," but rather to provide a safe and successful learning experience and competition environment.

The quiz should be completed by the STUDENT company members. Each member of the company does NOT have to take the quiz; students can work together and make it a group effort. **ONLY ONE TEST PER COMPANY.** The company's instructor or mentor can provide guidance and advice, but the questions should be answered by the students participating on the company. The quiz will be scored, and the results provided instantaneously. A score of 100% is considered a passing grade. Companies can take the quiz as many as 5 times to achieve this score.

**The quiz must be completed with a passing grade by April 30th, 2025. NO EXCEPTIONS OR EXTENSIONS!** Companies with regional competition prior to April 30th due date should plan to take the fluid power quiz at least 2 weeks prior to their competition. If registration for your regional competition opens after the fluid power closing date, you must still take the quiz before April 30th. Companies failing to complete this quiz within the given time frame

will NOT be permitted to use fluid power during their competition event. **NO EXCEPTIONS OR EXTENSIONS! See 6.2 KEY DEADLINES.**

To purchase and take the fluid power quiz, click here.

The following are sources of information on hydraulics and pneumatics. This is not intended to be an exhaustive list, but rather a starting point to encourage companies to seek out additional information and resources:

- Underwater Robotics: Science, Design, and Fabrication (Revised Edition – SeaMATE, published by the MATE Center and MATE Inspiration for Innovation
- What is Fluid Power? (nfpa.com)
- Full Guide to Air Compressor Safety | Quincy Compressor

## 3.7 Control Systems

ELEC-021P: PIONEER class ROVs are expected to utilize computer- (or electronic-) based control methodologies and H-Bridge or BLDC controllers for the thrusters. Systems using surface switch box controllers are not permitted.

ELEC-022P: Surface control stations must be built in a neat and workmanship-like manner. Loose components and unsecured wires will not pass safety inspection.

ELEC-023P: Surface control stations by nature may combine 120VAC and 48VDC wiring. The surface control stations must be wired in a manner such that the 120VAC wiring is physically separated from the DC wiring, the 120VAC wiring is clearly identified from the DC and control voltages, and every conductor is insulated in a manner that no conductor is exposed. Identification can be through signage and/or wire color schemes. All 120VAC wiring colors must use ANSI, NEMA or IEC standard wiring colors appropriate to each voltage. There must be a sign inside the surface control station indicating which wiring standard is being utilized. Companies that do not have adequate separation of AC wires and components and DC wires and components will NOT pass safety inspection. It is recommended that separation be designed into the control system to keep power systems separate. Wiring should be clear, neat and easy to follow by inspectors. Wiring “rat’s nests” or “spaghetti wiring” will not pass safety inspection.

ELEC-024P: Companies must use proper strain relief and abrasion protection where wires and the tether enter the vehicle. The ROV should be capable of being lifted by the tether without damaging the tether connection to the ROV. Tape, glue, zip ties, and other quick methods of strain relief are not acceptable. The intent is to see the wires pass through a connector specifically designed to provide strain relief.

Companies must use proper strain relief at the surface where wires and the tether enter the control system. Pulling on the tether should not strain the wires entering the control system or computer/laptop.

Examples of some acceptable strain reliefs for the ROV side include:

Hubbell Strain Relief
Strain relief grip
Kellums strain relief cord grip

***NOTE for 2025!!!***
Additional information on expected and accepted practices for design and wiring of your system, including proper strain relief, can be found in the following MATE ROV Competition Tech Bulletin:

- **MATE ROV Competition Tech Bulletin – MATE Expected Work Practices**

ELEC-025P: Any connectors utilized in the surface control station and elsewhere in the ROV system must be properly type rated for their application. AC rated connectors must not be used for DC. The connectors must also be rated at or above the voltage and current used in their application.

## 3.8 Command, Control, & Communications (C3)

### *3.8.1 Power Provided*

CCC-001: Surface power: MATE will provide one GFI-protected outlet with a nominal 115 Volts AC (60 Hertz) and 15 amps maximum. This outlet is intended to provide power for pumps and other surface support equipment (e.g. video displays & control boxes). This AC power source CANNOT be used to directly or indirectly power the vehicle.

CCC-002: If hydraulic or pneumatic power is used for vehicle thrust, the power for the pump must come from the MATE supplied DC power supply.

CCC-003: In addition to electric pumps, hydraulic, and pneumatic systems can be powered by manual pumps (e.g. bicycle tire pump) or supplied from a pre-pressurized cylinder. Companies that are only using manual pumps must still comply with all hydraulic and pneumatic specifications, including the creation of a fluid power SID.

### *3.8.2 Cameras*

***NOTE for 2025!!!***
CCC-004P: Cameras are required to pilot the ROV. ROV pilots will be penalized for looking into the pool when piloting their ROV.

All cameras, including USB cameras, must be powered by the MATE supply. Powering a USB camera from the MATE supply can be accomplished by using a USB repeater / extender that has a separate power input at the far (ROV) end. The ROV would then provide the power to the device from the MATE supply. USB cameras plugged directly into laptops are not allowed. Be sure to denote camera power on your SID.

### *3.8.3 Displays*

CCC-005P: Companies are not limited to the number of display screens used for video feeds or ROV status information. Display devices may be made up of any combination of TVs, monitors, laptops, and/or computer displays.

CCC-006P: These display devices may be powered by the MATE provided GFI-protected 115-Volt AC (60-cycle) and 15-amp AC power source described in CCC-001, Surface power.

CCC-007P: A company's C3 station may include devices like video recorders. All C3 devices must be able to run on the single AC power outlet provided or on its own internal battery power. Any device plugged into this AC power outlet can only provide C3 functions and cannot provide power to the ROV.

CCC-008P: A company's C3 station should have all items stable or secured to the station. Large monitors not secured to and stable in the product demonstration station are not permitted. Monitors and other C3 devices with glass faceplates are not permitted.

## 3.9 MATE Provided Equipment

MATE will **NOT** provide video monitors at the product demonstration stations.

In 2025, the MATE ROV Competition will supply compressed air at each station during the World Championship. Companies may connect to this compressed air via a standard ¼-inch NPT male fitting. See the Compressed Air Guidelines for more information on what MATE ROV provides and what companies are required to provide for their compressed air systems. For companies demonstrating at a regional event, contact your regional coordinator or visit your regional contest's website as to whether compressed air will be provided at your regional competition.

### *3.9.1 Companies Sharing Equipment*

Companies may share the following equipment during the competition event: monitors and joysticks/controllers.

Companies may NOT share the following equipment during the competition event: control systems and payload tools (e.g. grippers, manipulators).

Companies that plan to share equipment during the World Championship event must notify the Competition Technical Manager at least 4 weeks prior to the event so that this can be considered when creating the schedule. MATE will do its best to accommodate companies sharing equipment.

## 3.10 Laser Safety Rules

LASR-001: **Companies must forward the specifications of their laser to the Competition Technical Manager by April 30th, 2025.** Specifications MUST include a link to the laser being used. The link should include a photo of the laser and the laser specifications. A notification will be sent to the company when the laser is approved. Companies must also bring a copy of their laser specifications to their safety checks. If the laser is being used at a regional event or pool practice, notification will also be sent to the regional competition coordinator.

LASR-002: All lasers must operate in the visible range at either the 630-680 nm (red) or near the 532 nm (green) wavelength. All lasers must fall into the Class I, Class II, or Class IIIa category. Red lasers must operate at 5mW or less. Green lasers must operate at 1 mW or less.

LASR-003: Companies should include detailed specifications of their laser in their technical documentation as well as have that information ready and available during their safety inspection and engineering presentations.

LASR-004: Lasers must have an on/off switch. This switch must be on the surface controller.

LASR-005: All lasers must be powered by the MATE surface power supply. Batteries, including batteries for powering lasers, are not permitted on the vehicle.

LASR-006: Companies using lasers cannot increase the voltage or the current to increase the power of their lasers. Lasers must use the voltage and current set in their specifications.

LASR-007: When out of the water, the laser should have a shield or enclosed beam stop attachment within 30 cm of the laser. This means that the laser beam should not travel more than 30 cm before reaching the shield. This is a requirement at all times when the laser is out of the water. ***NOTE for 2025!!!*** The beam stop must be attached to the ROV at all times. Companies may not remove the beam stop by hand when the ROV enters the pool. The beam stop should be designed so it floats or moves out of the way of the beam when the ROV is in the water. The shield must be painted with FLAT BLACK paint.

LASR-008: At no time should the laser be focused or deviate from a collimated beam.

LASR-009: When testing the laser at a workstation, companies must display a sign telling others that a laser is being operated.

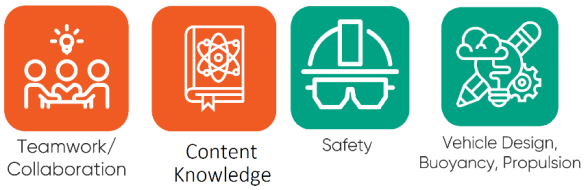
LASR-010: Operators working with the laser while the ROV is out of the water should wear appropriate laser safety glasses at all times. This requirement is for all laser types. Search online to find laser safety glasses appropriate for the wavelength being used.

**Companies must forward the specifications of their laser safety glasses to the Competition Technical Manager by April 30th, 2025.** Specifications MUST include a link to the laser safety glasses being used. The link should include a photo of the laser glasses and the laser glasses specifications. A notification will be sent to the company when the laser safety glasses are approved. Companies must also bring a copy of their laser safety glasses specifications to their safety checks. If more than one brand of glasses are used, a copy of each specification sheet should be provided.

The following lasers are acceptable to use in the MATE ROV Competition, although companies may choose to use alternate lasers. NOTE: **ALL COMPANIES MUST STILL FORWARD SPECIFICATIONS TO THE COMPETITION TECHNICAL MANAGER, EVEN IF ONE OF THE FOLLOWING ACCEPTABLE LASERS IS USED.**

- Amazon.com: HiLetgo 10pcs 5V 650nm 5mW Red Dot Laser Head Red Laser Diode Laser Tube with Leads Head Outer Diameter 6mm : Industrial & Scientific
- Amazon.com: Quluxe 650nm 5mw Laser Head Laser Tube Adjustable Focus 3~5V Red Laser Tube, Laser Head Industrial Laser (Pack of 3) : Industrial & Scientific

# PART 4: COMPETITION RULES




## 4.1 GENERAL

- All members of the company and their supporters must follow the safety regulations of the ROV competition, pool facility, and event venue.

- All company members and their supporters are expected to conduct themselves in a professional and responsible manner during the competition. Disrespectful behavior towards the judges, officials, pool staff, audience, or other companies will lead to penalty points or disqualification.

- Sabotaging, stealing, or pilfering equipment of other companies will lead to disqualification. Companies found cheating will also be disqualified.

- The MATE ROV competition is, at its core, designed to be an educational and inspirational event for **STUDENTS**. It is designed to challenge them to apply the physics, math, electronics, and engineering skills they are learning in the classroom to solving practical problems from the marine workplace. (See the MATE Competition Philosophy.)

  It is expected that all "adults" (non-students; e.g. teachers, mentors, parents) involved in the competition limit their input to educational and inspirational roles. Actual construction of the ROV (particularly in the complex electrical and software areas) must be completed by the students. Adults should teach and advise students about design, electronics, software, and construction, but not complete the work for the students. Throughout the process adults are encouraged to focus on benefits to the students from the process and not simply winning. If it becomes apparent that adults exercised more than an advisory role, judges reserve the right to deduct points or, in extreme cases, disqualify companies from the competition.

  ALL work done on the vehicle must be conducted by company members. This includes any work done at home, at school, or during the MATE ROV competition (World Championship and regional). Teachers, mentors, parents, and non-competing students are not permitted to work on the ROVs. They may provide advisory input, but they may not work on the ROV directly. This includes writing or editing software code. All mechanical, electrical, and software modifications and/or repairs to the ROV must be completed by students.

With learning at its core, the MATE competition encourages students to utilize and build upon their skill sets to find creative solutions to designing and building their ROV. Students gain valuable skills and knowledge when creating a component from "scratch," which is apparent to judges as they review the technical documentation and engineering presentation. However, as they move through the process of analyzing their designs and identifying building materials, students may decide to either build a component from "scratch" or purchase it from a commercial vendor.*** So, while original solutions are encouraged, the use of commercial components is acceptable, provided 1) that the components adhere to the design and building as well as safety specifications for the particular competition class and 2) more importantly, that the students can provide a reasonable, logical explanation for buying versus building.

The competition scoring rubrics are designed to reflect this; points are awarded based on students' abilities to explain and justify how all of the components and systems work together as an integrated ROV, regardless if they purchased them, pulled them from public libraries, or made them themselves.

***Note "commercial vendor" includes the SeaMATE store and other competition programs that sell educational robotics kits. SeaMATE kits were created to remove barriers to participation for teachers and schools unable to easily 1) find parts and materials and 2) set up accounts with multiple vendors. The kits are part of a larger educational package that includes curriculum materials, videos, and other resources to support and enhance learning. And learning is what students who use SeaMATE (or other) kits will be expected to demonstrate during and through the ENGINEERING & COMMUNICATION components.

It should be noted that purchasing and competing with complete, assembled, commercial ROVs is not permitted.

## 4.2 PROCEDURAL

- Companies must compete during their assigned time slots. Your company is **NOT** permitted to switch time slots with another company. Failure to show for your scheduled product demonstration or for your company's engineering presentation will result in "no score" for that particular competition category. **No exceptions.** Assigned time slots will be sent out in advance so that any scheduling concerns can be addressed prior to the event.

- Companies must complete their weight measurements before each product demonstration run. The weight measurements are included as part of the product demonstration score. Companies should be at the weigh in area at least 20 minutes before their scheduled product demonstration run.

- While there is no limit to the number of students who can compete as part of a company, **the product demonstration team (aka demo team) is limited to six students**. The

demo team is defined as the team of students who operate the vehicle and its associated equipment during the product demonstration. Only six students will be allowed to enter the product demonstration station, launch, pilot, and perform the tasks. Instructors, mentors, and/or non-student members cannot participate as part of the demo team. **Companies may alternate students on the demo team for the two product demonstration attempts.** (All members of the company should participate in the ENGINEERING & COMMUNICATION components.)

- Only the demo team members and judges are allowed at the product demonstration station during the product demonstration, which includes the set-up and demobilization periods. Other members of the company, instructors, mentors, audience members, and observers (press or special invited guests) must remain outside the product demonstration station or in designated viewing areas.

- Instructors, mentors, parents, and "fans" are **NOT** permitted at the safety inspection stations or repair tables. Two warnings will be issued before individuals not heeding this rule will be asked to leave the venue.

- In addition, instructors, mentors, parents, and fans are **NOT** permitted to work on the ROV. Individuals who are seen working on the ROV who are not student company members will be issued a warning. Two warnings will be issued before individuals not heeding this rule will be asked to leave the venue. If companies choose to take their ROVs off the competition grounds for maintenance and repair, they are expected to observe this rule in the interests of the spirit of the competition.

- To help enforce this, teachers, mentors, parents, and non-competing students MAY have limited access to the workstation areas. Contact the MATE ROV Competition officials for more information.

- Video devices may be used to record the underwater activities for entertainment and learning purposes **only**. Video will not be used as an instant replay to review judges' decisions or to challenge product demonstration timing.

- Product demonstration stations will be roped off and marked. Product demonstration stations will contain 2-3 chairs and one 6-foot table long table for companies to use. This table will be within 3 meters of the pool edge. Product demonstration stations will be set up to prevent the pilot(s) from looking at the ROV in or under the water except through the ROV cameras.

- Companies will compete in one product demonstration that will consist of three tasks. Companies will get TWO attempts at the one product demonstration. The higher of the two scores will be added to the engineering and communication score to determine the total, overall score for the competition.

- The product demonstration time consists of a 5-minute set-up period, a 15-minute performance period, and a 5-minute demobilization period. If the demo team and all of

their equipment are not out of the product demonstration station at the end of the 5-minute demobilization period, the company will be **penalized 1 point for each additional minute**.

- Manipulating the tether to free it from underwater obstacles is permitted. Pulling on the tether to speed up the recovery of items or to return your vehicle more quickly to the surface is not permitted and will result in penalty points. Judges will issue one warning if tether pulling occurs. Each future infraction will result in **5** points deducted from the final product demonstration score.

- SCUBA diver assistance will be available at the World Championship. If help is required, the company CEO or pilot must ask a station judge and divers for assistance. Each diver assist will incur a 5-point penalty. The product demonstration clock will not stop if a company is receiving diver assistance.

- Pilots can only leave the product demonstration station and move poolside to repair, adjust, or alter a vehicle if the ROV is surfaced and at the side of the pool.

- Companies are not permitted to leave debris in the pool. Any debris must be recovered by the ROV before time has expired or the company will be penalized. Debris is defined as pieces of the ROVs, weights, floats, or other items created by the company. Task props are not considered debris unless noted in the Product Demonstration section. The product demonstration notes section may cover special items that can be left in the pool after time has expired.

- No demo team member shall enter the water to complete an object recovery. Only arms and hands are allowed into the pool to retrieve an object or to retrieve the vehicle. Companies will be disqualified or penalized depending on the severity of the infraction.

- Communication between demo team members at the pool edge and demo team members piloting the vehicle will be limited. Only tether management issues (e.g. how much tether is out, how much is remaining on the pool deck) can be discussed. Those team members at the pool edge cannot give any directional or product demonstration task information to the pilot. Judges will issue one warning regarding illegal communication. Each future infraction will result in **5** points deducted from the final product demonstration score.

- Communication using cell phones, text messaging, and online social media tools such as Teams, Zoom, Skype, Facebook, Twitter, instant messaging, etc. is NOT permitted during the product demonstration, either between the demo team members at poolside or between any demo team member and anyone outside of the product demonstration station. The ROV and/or the ROV control system is not allowed to broadcast video or other information to anyone outside of the product demonstration area. No exceptions. Companies found broadcasting any data to those outside of the product demonstration

area will be disqualified.

- **Product demonstration judges and other competition officials will only communicate with students.** Judges and officials will NOT communicate with mentors, parents, or other non-student members regarding product demonstration information, challenges, or other issues except during pre- and post-competition briefing sessions.

  Companies that wish to issue a challenge during the product demonstration run should immediately communicate this challenge to the product demonstration judges. The judges will discuss and attempt to resolve the issue. If a decision cannot be made, the product demonstration judges will consult with the head judges and competition technical manager to resolve the issue.

  ***NOTE for 2025!!!***
- Once a chief judge rules on a challenge, that ruling is final. NO EXCEPTIONS, including appeals to other competition officials. Penalty points may be given if companies continue to pursue the challenge beyond the chief judge's final ruling.

## 4.3 DESIGN & SAFETY CONSIDERATIONS

- The competition coordinators and host venues stress the importance of safety practices and procedures to all companies. The score sheets and rubrics will reflect the MATE ROV Competition's efforts to encourage and reward companies that demonstrate exceptional safety practices and procedures.

- **ALL ROVS MUST PASS A SAFETY INSPECTION CONDUCTED BY COMPETITION OFFICIALS PRIOR TO ENTERING THE POOL.** These inspections will be conducted topside to ensure that ROV systems meet the design and building specifications and do not pose a risk to the integrity of the event venue. See PART 3: VEHICLE DESIGN & BUILDING SPECIFICATIONS for additional information.

- Radio transmitters that operate on a separate battery are permitted. No batteries are permitted to be in or on the water. No exceptions.

  Companies should be aware of all the implications of these wireless devices. There is no assurance that an adjacent company's wireless controller will not interfere with your control systems. Adjacent wireless controllers with a battery that has a higher charge than the nearby controller have demonstrated the ability to "hijack" the nearby control signals. In addition, all wireless controllers are susceptible to external sources of electronic interference. Your system may work fine in your home environment, but not in the industrial environment of the competition. MATE will not stop the clock to resolve wireless control issues. Companies deciding to utilize wireless controllers do so at their own risk.

- Keep an eye out for tripping hazards in the product demonstration station and at your company's workstation. Make sure power cords are not laying in pools of water on the deck.

- During your product demonstration, be sure to secure any equipment so that it does not fall off the product demonstration station table, damage the deck, or cause injury.

- Loose fitting clothing, jewelry, and long hair could all become safety issues. Consider securing long shirts or baggy pants, removing jewelry, and tying back long hair when working on or operating your ROV.

- ROVs may be constructed out of materials of your company's choice, provided they meet the design and building specifications and safety regulations. Warning labels should be posted on potentially hazardous components of your ROV system.

- Close-toed shoes are required on the pool deck. Safety glasses are required when working on the vehicle.

- Personal flotation devices (PFDs) will not be required at the World Championship. No personal flotation devices will be provided by MATE or the host venue. Regional events may require PFDs.

# PART 5: ENGINEERING & COMMUNICATION


***NOTE for 2025!!!***
MATE has created an ROV Competition Marketing Kit that includes logos and guidelines for their use.

The ability to communicate information about your vehicle and the design and building process is equally as important as how well your vehicle performs. Strong communication skills are an essential part of good business practices and one of the most in-demand skills in the constantly evolving, ever-changing workplace.

To emphasize this point, the competition requires the following five engineering and communication components:

- Company spec sheet
- Technical (written) documentation (Examples of spec sheets and technical documentation from previous competitions can be found in the MATE ROV Competition Archives.)
- Engineering (oral) presentation (Videos of engineering presentations can be found on the MATE Vimeo site: Jesuit High School (EXPLORER 2019), 404 Engineering (EXPLORER 2021), Hawks Engineering (RANGER 2021), Deep Ocean Robotics (RANGER 2021) and Sea Life Technologies (RANGER 2021.)
- Marketing display (Top marketing displays from the 2024 World Championships): Hong Kong UST EPOXSEA (EXPLORER 2024), Miramar College (PIONEER 2024), St. Francis Catholic High School (RANGER 2024.)
- Corporate Responsibility (OPTIONAL)

**NOTE: Regional contests may not require all of the Engineering & Communication components.** Contact your regional coordinator or visit your regional contest's website for more information.

See TIPS FOR EFFECTIVE WRITTEN AND ORAL COMMUNICATION for additional information.

***NOTE for 2025!!!***
Your company should refer directly to the scoring rubrics posted under Scoring for details on what is required for your company spec sheet, technical documentation, engineering presentation, marketing display, and corporate responsibility. The judges will use the rubrics to evaluate and score these engineering and communication components.

## 5.1 COMPANY SPEC SHEET

The purpose of the company spec sheet is to provide the judges with a "snapshot" of your company. It includes basic information about your company and vehicle.

Company spec sheets will be reviewed by MATE competition coordinators. Companies will receive up to 20 points for submitting a spec sheet that is **one page** in length, follows the file size and naming specifications, and contains **all** of the following information:

**COMPANY SPECS**

- **Company and school, club, or community organization name**
- **Home state and/or country**
- **Distance required to travel to the World Championship**
- **History of MATE ROV competition participation.** Be sure to specify if your company and/or the members of your company are "new" or "returning."
- **Company photo and caption indicating members' names and roles (e.g. CEO, CFO, Design Engineer, Pilot, etc.).** This photo should include all of the members of your company.
- **Range of grade/college levels represented by the members of your company**

**ROV SPECS**

- **ROV name** if applicable
- **Total cost.** You must include the approximate cost of any donated items.
- **Size and weight measurements**
- **Total student-hours to design and build.** This should include the number of hours that each and every member of the company worked on the vehicle.
- **Safety features**
- **Special features**
- **Photo of the vehicle**

**REMINDER!!!** If all of the above information is included, the specifications for length, size, and naming conventions are followed carefully, and the document is submitted on time, this is an "easy" 20 points! You can find the company spec sheet scoring rubric posted here.

## 5.2 TECHNICAL DOCUMENTATION

The purpose of the technical documentation is to challenge you to effectively and efficiently communicate information using clear and concise text along with graphics, illustrations, and data that add to and complement (and not distract from) the information. Your company must organize and present the information in a way that is logical and complete. The document should focus on the technical and safety aspects of your ROV/ROV systems, the design rationale behind your engineering decisions, and a critical analysis of testing and troubleshooting done on the vehicle. You should consider this document a reference for both judges and future team members (part of the company's institutional knowledge).

Your company's technical documentation will be reviewed and evaluated by a panel of working professionals – individuals who represent science, exploration, government, and industry. (Don't assume that these same individuals will evaluate your company's engineering presentation!)

Each judge on the panel will award a score (100 points max). Judges' scores and comments will be returned to you shortly after the event.

**NOTE: The judges will not review and rescore revised versions of your technical documentation during the competition.**

**Use the technical documentation scoring rubric posted here as the guideline for the required components for the technical documentation. This rubric will be posted by March 1, 2025. In the meantime, companies may refer to the previous year's rubrics for a general idea of the categories and points.**

## 5.3 ENGINEERING PRESENTATION

The purpose of the engineering presentation is to challenge you to effectively and efficiently communicate information with words and "props" (i.e., the ROV). Your company must organize and present the information in a way that is logical and covers the development and testing of your ROVs and the formation and development of your team. The

presentation should be delivered as a "technical brief," with references to the technical documentation for additional details. The presentation is THE opportunity your company has to 1) communicate directly and in person your critical thinking, creativity, and engineering reasoning (including build vs. buy) and 2) demonstrate your individual and collaborative contributions to the creation of the vehicle.

During the competition, your company will have 15 minutes to deliver your presentation to a panel of working professionals – individuals who represent science, exploration, government, and industry. (Don't assume that these same individuals will evaluate your company's technical documentation!) After the presentation, the judges will take up to 15 minutes to ask the members of your company questions about your ROV. The judges will evaluate both your presentation and responses to their questions. Each judge on the panel will award a score (100 points max). Judges' scores and comments will be returned to you shortly after the event.

**All student members of your company must be prepared to participate in this presentation and the question and answer (Q&A) period.** You are required to have your ROV with you. For larger companies, the main presentation may be done by a subset of the overall company. During the Q&A, all members of the company should be prepared to answer. However, if one student is better suited to answer a specific question, the others may defer the question to that student to answer. For example, if a judge calls on the pilot to answer a question about the tether, the pilot can respond by informing the judge that the tether manager was the lead on that system and allow the tether manager to answer without penalty or loss of points.

**NOTE:** The engineering presentation is designed to be a face-to-face interaction where students and representatives from industry become engaged in conversation. MATE will not provide audio visual aids, such as slide projectors, computer projection screens, white boards, etc.; however, you are welcome to distribute handouts to help judges better understand the information that you are presenting. Electronic forms of presentation (e.g. PowerPoint or Keynote slides) **are NOT permitted.**

**Instructors, mentors, family members, friends, and members of other companies are permitted to attend.** However, we ask that those in attendance be respectful and courteous throughout the presentation and follow-up question and answer period. Be mindful that this presentation may be a stressful time for the students. If the room becomes crowded or the spectators become distracting, it is up to the judges' discretion to request that some or all spectators leave the presentation. **While they are permitted to attend, instructors and mentors are not allowed to participate.**

**Use the engineering presentation scoring rubric posted here as the guideline for the required components for the engineering presentation. This rubric will be posted by March 1, 2025. In the meantime, companies may refer to the previous year's rubrics for a general idea of the categories and points.** Judges may ask questions regarding any of these topics not covered in the presentation as well as other questions about the vehicle, the mission theme, or the company.

**Preparing for your engineering presentation and Q&A**

- Make sure that every member of your company has a good, general working knowledge of your vehicle, even though they may have specialized in one specific aspect of its design and construction.
- Make sure that all the members of your company are familiar with your technical documentation. Ask every member to read it over to catch any errors or omissions. This exercise will help to familiarize everyone with all aspects of the project.
- Generally, you will have more to say about your ROV than can be presented in 15 minutes. That is why it is critical to organize your material and practice communicating it. However, avoid coming across as having memorized your presentation verbatim. Judges want to see that you are prepared and understand the information, not that you can simply regurgitate a rehearsed speech from memory. Ask your instructors or mentors to give you feedback.

**Other important items**

- If during the engineering presentation it becomes apparent that instructors, mentors, and other adults associated with your company exercised more than an advisory role, judges reserve the right to deduct points or, in extreme cases, disqualify companies.

## 5.4 MARKETING DISPLAY

The purpose of the marketing display is to challenge you to present technical information in a way that appeals to and is understood by a non-technical audience. It is the promotional piece – you must not only present information about your ROV and your company, but you must also use graphics and design to publicize and "sell" (convince viewers, including the general public, of their value and excellence) your products and people.

During the competition, your company's display will be evaluated and scored by a completely different group of working professionals – individuals who will represent science, business, government, industry, and education/outreach.

While some judges will have a technical background, others will have a communications, marketing, or public relations background. In addition, there will be visitors to the competition who may not completely understand what an ROV is or how it is used. Think of these visitors as potential future clients who may authorize funding for your work but have a limited understanding of the technology (i.e., you need to explain your technology, the tasks at hand, and "sell" them on YOUR products and services). Design your display to communicate to this type of audience.

Each judge will award a score (50 points max). Judges' scores and comments will be returned to you shortly after the event.

**NOTE FOR WORLD CHAMPIONSHIP COMPETITION ONLY!**
**The MATE ROV Competition will NOT supply display boards**.

**You must provide your own display board. The space that the text and photographs/graphics occupy CANNOT exceed 36" tall by 48" wide. For example, company names CANNOT be mounted above the display board. NO EXCEPTIONS!**

At the World Championship, tables will be provided for the displays. Two companies will share a six-foot table. Companies should create their marketing displays so that they can be exhibited on either a table or an easel.
MATE will continue to provide scissors, tape, glue sticks, adhesives, and other means of attaching display items to the presentation board, although you are also welcome to bring your own.

**Use the marketing display scoring rubric posted here as the guideline for the required components for the marketing display. This rubric will be posted by March 1, 2025. In the meantime, companies may refer to the previous year's rubrics for a general idea of the categories and points.**

**Creating an effective marketing display:**

- Address the overall theme and make real-world connections (how could your company and ROV solve these real-world problems?).
- Address the UN Sustainable Development Goals and ESG.
- Reflect your company's personality and mindset.
- Make key points and be concise.
- Keep the general public in mind.
- Make sure to label any and all figures, graphs, diagrams, and photographs and credit the source.
- Maximize the use of the 36" by 48" display space.
- Make sure that it is both informational and aesthetically pleasing.

**Note:** "Accessories" such as video footage, PowerPoint slide presentations running on laptop computers, video projections, etc. are permitted but should be used with discretion. Remember that the judges will have a limited amount of time to evaluate your marketing display and may find excessive use of audio or video presentations distracting.

However, if you do make a video of your ROV building or competition experience, please submit information about it to the MATE ROV Competition officials so that it can be shared via MATE's YouTube and Vimeo channels.

## 5.5 CORPORATE RESPONSIBILITY

The MATE ROV Competition uses underwater robotics to inspire and encourage students' interest in STEM (science, technology, engineering, and math) education and careers. Recognizing that the students who participate in MATE competitions are powerful ambassadors for the program as well as effective leaders in raising awareness of important issues and bringing about positive change, companies have the opportunity to earn up to 20 points for "corporate responsibility."

Corporate responsibility includes, but is not limited to, the following:

- **Education focused initiatives** consists of, for example, providing guidance to other students in your area who are designing and building an ROV for the competition or a science or other project.

  This follows the industry trends of engaging in educational partnerships and STEM outreach to students. Specific examples of education-focused initiatives include:
  - Mentor newer/less experienced MATE ROV Competition teams
  - Support local schools/organizations
  - One-time / short-term educational activities
    - MATE regional competition volunteer
    - Science fair judging
  - Structured presentations or exhibits that specifically showcase marine technology
    - Career day presentation/talk

  Education-focused initiatives will be scored on the number of events, with continual interactions preferred over one-time events, and the reporting of measurable impacts on the participants of the initiatives. Measurable impacts include how many students were mentored, whether mentored students participated at a regional competition or other event, etc.

- **Engaging the community** includes demonstrating your ROV and sharing information about your company at festivities and other community-wide events. Presenting to a Rotary Club or your school district's board of directors are examples.

  This follows the industry trends of participating in STEM outreach to the community and media engagement. Specific examples of engaging the community include:
  - One time / short-term outreach activities such as a STEM activity booth at community events
  - Media engagement
    - Press release distribution
    - Media coverage secured

  Engaging the community will be scored on the number of events participated and the reporting of measurable impacts. Measurable impacts include how many people visited a booth or the amount of media coverage that resulted.

- **Environmental Impact** consists of conducting environmental monitoring and organizing or participating in environmental cleanup activities.

  This follows the industry trends of focusing on environmental monitoring and ocean conservation. Specific examples of environmental impact outreach include:
  - Scientific data collection and monitoring projects
    - Water quality monitoring
    - Marine habitat assessment
  - Organize/participate in beach, waterway or environmental cleanups

  Environmental impact outreach will be scored on the number of events. Scientific data collection projects will emphasize an ongoing long-term data collection project with regular data collection and proper calibration of instruments. Public sharing of data will be emphasized as well. Environmental cleanup events will be scored on the

number of events, with an emphasis on teams organizing over participating in an event. Additional emphasis will be placed on properly disposing of waste and of proper safety protocols being followed.

- **Knowledge sharing** consists of providing open-source data on your vehicles code and design specifications and engaging social media to follow your company's journey to the competition.
  This follows the industry trends of emphasizing open access to data and technology.
  Specific examples of knowledge sharing include:
    - Publishing document code on GitHub/GitLab/other public source
    - Technical resource creation, including tutorial videos and technical blog posts
    - Maintaining an active project website/blog
    - Social media engagement and video documentation
        - Regular updates on company progress
        - Educational content sharing
        - Industry/STEM news sharing
        - Project development videos

  Knowledge sharing will be scored on the number of activities, with emphasis on open-source documentation links, and activities being tagged as MATE ROV Competition.

Here are some general guidelines for working with the media. They are specific to the World Championship but can be easily modified for regional events.

Corporate responsibility efforts will be reviewed by competition coordinators and awarded 0 to 20 bonus points, depending on the number and scope of the outreach and awareness activity(s), i.e., the number of other students or members of the community engaged, the number of mentoring sessions, etc.

Make sure to include the following information in your write up:

- Type of activity (e.g. education-focused activity, engaging the community, environmental impact, knowledge sharing.)
- Locations, dates, and the amount of time spent on the activity.
- Number of students or community members (if a large event, this can be an approximate) involved.
- Description of your actions, outcomes, and other information that helps to demonstrate the quality of your time and efforts. Emphasis will be placed on the impacts and outcomes of the event.
- For media outreach, please submit a copy of your press release, a copy of your media contacts list, and a summary of news articles, TV or radio coverage, etc. that your company received. Include copies of articles and URLs, and list any television or radio coverage. Be sure to include name of outlet, date, and a summary of the coverage.

**Use the Corporate Responsibility scoring rubric posted here as the guideline for your Corporate Responsibility submission. This rubric will be posted by March 1, 2025.**

## TIPS FOR EFFECTIVE WRITTEN AND ORAL COMMUNICATION

Communicating ideas about how to solve a problem and evaluating those ideas against competing alternatives is a critical skill for anyone entering the workplace. It is a skill that is directly linked to decision making about whether or not to hire (or fund) us and our ability to influence the work that we do.

The key to a successful technical documentation and engineering presentation is the way that critical thinking and engineering reasoning are communicated. You can think of the process as technical "storytelling."

Technical storytelling includes the use of text, images, schematics, and data to effectively communicate the "story" of how your company brainstormed and evaluated ideas to come up with your solution (e.g. ROV, payload tools, and operational strategies) to the problem at hand (product demonstration tasks). It also involves organizing content to efficiently present your work and justify why you did what you did.

However, you should choose details with care. Each detail should help to answer the question "why is what you did the best solution for your company and for this competition?" Describe why a component in the system is critical and how you chose it. Include specifications or dimensions only if they help to explain the "why" and "how" you made choices. Keep in mind that a mechanical drawing with dimensions can replace a lot of text and in many cases do a better job telling details of the story than text.

That said, if something is hard to describe clearly and completely with two to three sentences, consider whether using an image may help. A good technical document balances text and images to provide lots of information concisely, which for a detailed understanding while being quick and easy to read. Remember that your reader is new to your design and needs to understand both what your design is and the process you used to get there. Present text and images in a logical order that helps readers follow your development process and results.

Maintaining a project notebook is a good business practice that will help to capture ideas and document your company's progress – including your research, designs, trade studies, experiments, data, vehicle specifications, testing, expenditures, and donations. The notebook is also a place to keep track of your company member's contributions (time, support, etc.).

Along with your notebook, here are some items to consider as you prepare to tell your story:

- What was your company's "work breakdown structure" (tasks, time, and people)?
- What were the greatest constraints (schedule, budget, equipment, labor, logistics, etc.) on your design process?
- How did the product demonstration tasks and rules influence your design and decisions?
- What systematic process, such as a tradeoff matrix, did you use to evaluate competing design solutions?
- What were the most important design decisions you made and why?

- How did you arrive at your final power budget? What concessions, if any, did you have to make and why?
- How do you calibrate your sensors?
- If your vehicle uses software, where does the code execute? Describe the flow and format of the data.
- Did you have a noteworthy troubleshooting experience? Any problem or procedure that takes more than 20 minutes to figure out is worth understanding and writing down.
- How did the mission theme influence your choices across the ROV? What choices would have big impacts had this been in a less controlled environment?

***Note for 2025!!!***
The Engineering & Communications components are 40% of a company's overall score. Working on these components early and preparing thoroughly (practicing your engineering presentation, proofreading your technical documentation and marketing display) can increase your chances of achieving a higher score.

# PART 6: SUBMISSION GUIDELINES AND KEY DEADLINES


## 6.1 DOCUMENTATION

Companies are required to submit technical documentation, a company spec sheet, a SID, a fluid power diagram (if fluid power is used), a JSEA, and a company safety review. In addition, companies may submit documents supporting their corporate responsibility efforts. If companies are using a non-ROV device, they must submit a non-ROV device design document and a non-ROV device SID.

NOTE: By submitting your documentation, you are giving the MATE ROV Competition permission to publish these documents on its web site.

DOC-006: All required documentation sent to the MATE ROV Competition officials MUST be in searchable PDF format (see SearchablePDFs.pdf (rackcdn.com) for information about creating searchable PDFs).

DOC-007: The technical documentation may be up to 8 MB in size, the other documents are restricted to a maximum file size of 2MB. Consider resizing the images in your documentation to lower the overall size of the document.

DOC-008: All documents should use the following naming convention: School or organization name_company name_DOCUMENT TYPE_2025.pdf, where DOCUMENT TYPE is technical documentation, spec sheet, SID [type – electrical or fluid], non-ROV device design, company safety review, or JSA.

See Documentation Submissions Guidelines for information on submitting your documentation. **Submit all of your final documents** in one email. Revised documents submitted at a later date will not be accepted. The MATE competition will use the date-stamp on your form to determine your initial submission.

Before submitting documentation, check to verify that all the files have been attached. Once submitted, companies should verify that all the proper documents were uploaded. If there was an error while submitting your documents, contact the MATE ROV Competition and upload ALL documents again.

DOC-009: For the World Championship, due date for the required documentation is 11:59 PM, Hawaii Time Zone, on May 21, 2025.

***NOTE for 2025!!!***
DOC-010: Companies will lose points on their initial safety and documentation review if documents:

- Are submitted late
- Exceed the size limit or page limit
- Use improper naming conventions
- Are not submitted on ONE form

### 6.1.1 Video Demonstration Requirements

DOC-011: See Documentation Submissions Guidelines for information on submitting your demonstration videos.

DOC-012: For the World Championship, due date for the video demonstration submissions is 11:59 PM, Hawaii Time Zone, on May 15, 2025.

DOC-013: Videos must be submitted as links to a YouTube or Vimeo post. Companies may submit the specification and product demonstration as two separate videos. Note that the product demonstration portion must be a complete, uncut video.

The video MUST indicate the school/organization and the company name, as well as the competition year, 2025.

MATE competition organizers will review the videos and respond by May 19th. Video submissions will NOT be accepted after May 15th – NO EXCEPTIONS. Video conferences will not be scheduled after May 15th. If the video does not clearly demonstrate that the company's vehicle meets the specifications and accomplishes the tasks, the company is not eligible to participate in the World Championship. No extensions past the due date will be given for any reason.

**MATE strongly encourages companies to submit their videos or arrange for a video conference with a MATE official well before May 15th.** That way, if an issue is found, companies will have the opportunity to address the issue and submit an updated video, or schedule another video conference, before the May 15th deadline. **Note that it may take MATE up to 5 working days to evaluate a video submission or respond to a request to schedule a video conference.**

NOTE: By submitting your video demonstration links, you are giving the MATE ROV Competition permission to publish these videos links on its website.

### 6.1.2 Corporate Responsibility Documentation

DOC-014: See Documentation Submissions Guidelines for information on submitting your corporate responsibility documentation.

DOC-015: The following naming convention should be used for corporate responsibility documentation: School or organization name_company name_Corporate Responsibility ##_2025, where ## is the number of the document uploaded. You can upload a variety of file types (pdfs, jpegs, etc.) and multiple files, but the size of each file should not exceed 2MB. Number each file to distinguish between them.

Before submitting documentation, companies should verify that all the files have been attached. If companies experience an error when submitting documents, contact the MATE ROV Competition and upload ALL documents again. Revised documents submitted at a later date will not be accepted. The MATE competition will use the date-stamp on your form to determine your initial submission.

DOC-016: For the World Championship, due date for the corporate responsibility documentation is 11:59 PM, Hawaii Time Zone, on May 21, 2025.

NOTE: By submitting your documentation, you are giving the MATE ROV Competition permission to publish these documents on its website.

## 6.2 KEY DEADLINES

Below is an updated summary of key dates and deadlines for the 2025 MATE ROV competition season.

- December 1, 2024: Registration opens (note that registration for the World Championship and individual regional competitions will open as locations and dates are secured).
- April 30, 2025: Last day to register for the fluid power quiz. Last day to submit laser specifications.
- May 15, 2025: PIONEER class video demonstration submission deadline.
- May 21, 2025:
    - Technical documentation
    - Company spec sheet
    - SIDs (including electrical, fluid, Non-ROV Device)
    - Non-ROV device design document

- Company safety review
- Job site safety analysis
- Corporate responsibility documentation (optional)