2023 MATE ROV COMPETITION: PRODUCT DEMONSTRATION AND SPECS BRIEFING

MATE Competition Philosophy

The MATE ROV competition is about **student learning**.

It is designed to be an event that challenges **students** to apply the physics, math, electronics, and engineering skills they are learning in the classroom to solving problems from the workplace.

Mentors (teachers, parents, working professionals) are expected to limit their input to educational and inspirational roles and encouraged to focus on the benefits of the **learning process** and not simply on "winning" the competition.

UN DECADE OF THE OCEAN: DIVING IN TO INSPIRE SOLUTIONS BECAUSE TOGETHER OPPORTUNITY RUNS DEEP

CONTEXT & NEED

This competition season the MATE ROV Competition is celebrating! MATE Inspiration for Innovation and the Marine Technology Society are joining forces to expand our reach, leverage our collective partnerships and resources, and grow our missions. For MATE, it's a homecoming; the competition was created in 2001 in partnership with the MTS ROV Committee as a workforce development platform for the offshore maritime industry. We have evolved and expanded over the years, but the mission to inspire and develop the next generation of ocean professionals remains at our core.

In addition to the celebration, join us as we continue to highlight the United Nations Decade of Ocean Science for Sustainable Development, embrace and inspire ESG, and challenge our global community of learners to come together to imagine, innovate, and create solutions to the problems that impact us all.

As we shared last year, the United Nations proclaimed a *Decade of Ocean Science for Sustainable Development* (2021-2030) to support efforts to reverse the cycle of decline in ocean health and to gather the global community behind a common goal: creating improved conditions for sustainable use and development of our world ocean.

Like last year, the three 2023 competition mission tasks focus on SOLUTIONS – from marine renewable energies to Blue Carbon, "prescriptions" for diseased coral, conservation programs for endangered species, and GO-BGC floats to monitor ocean health. We embark on this season with 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. And with the ocean observations and scientific research to support us, we are also optimistic that we can influence mindsets and guide communities to embrace and adapt practices for the good of us all.

And again this MATE ROV Competition season the "client" is us – our global community – and each task area included within the request for proposals (RFP) aligns with one or more the 17 UN Sustainable Development Goals. While not specific to the Decade of the Ocean, these goals offer a blueprint to achieve a better and more sustainable future for all. And like last year, each task also embraces ESG – the environmental, social, and governance factors that more and more companies and organizations are

taking into consideration when making business and management decisions.

The MATE ROV Competition is challenging its community to design and build a remotely operated vehicle and the necessary sensors, tooling, and complementary technologies to combat climate change, provide clean energy, monitor ocean health, and heal and protect our aquatic habitats from the mountains to the sea so that we can "deliver, together, the ocean we need for the future we want!"

And this is where your mission begins.

Task #1: Marine Renewable Energy
UN Sustainable Development Goals:

- **#7 Affordable and Clean Energy**
- **#12 Responsible Consumption and Production**

Task #2: Healthy Environments from the Mountains to the Sea:

- ***Coral Reefs and Blue Carbon***
- ***Inland Lakes and Waterways***

UN Sustainable Development Goals:

- **#13 Climate Action**
- **#14 Life Below Water**

Task #3: MATE Floats!
UN Sustainable Development Goal:

- **#13 Climate Action**

REFERENCES

United Nations Decade of Ocean Science for Sustainable Development
17 UN Sustainable Development Goals
A Hotter Future Is Certain, Climate Panel Warns. But How Hot Is Up to Us.
ESG (environmental, social and governance)
Ocean energy: An important ally in the fight against climate change
Marine Renewable Energy
The Blue Carbon Initiative

Marine Renewable Energy
The Technology of Offshore Wind Power and the Morro Bay Wind Farm
RWE and SolarDuck to Explore and Develop Offshore Floating Solar Parks Globally
(oceannews.com)Floating Solar Anchoring and Mooring
SolarDuck – Offshore Solar Energy

Healthy Environments from the Mountains to the Sea
Coral Reefs and Blue Carbon:
Scientific breakthrough could save Florida's threatened coral reefs
Underwater 3D Imaging Helps Seafood Producers Better Understand the Seabed

Stony coral tissue loss disease (SCTLD)
New Mapping Tools Helping to Protect Seagrass
Eco-Mooring System (ecomooringsystems.com)
Studland Bay 'eco-moorings' set up to protect seahorses

Inland Lakes and Waterways:

Northern redbelly dace recovery
Northern redbelly dace release video
Summit County Water Rescue Team deploys new, state-of-the-art underwater drone to help with rescues
Peru - Denver Zoo
Lake Titicaca giant frog: Scientists join forces to save species - BBC News

MATE Floats!

GO-BGC | Global Ocean Biogeochemistry Array
2021 MATE Floats! | MATE ROV Competition Website
Adopt-a-Float Newsletters | GO-BGC

DESIGN BRIEF

Below is a summary of the product demonstrations organized by competition class – EXPLORER, PIONEER, RANGER, NAVIGATOR, and SCOUT. All product demonstration tasks will be attempted in one product demonstration run.

Task #1: Marine Renewable Energy

Innovative minds employed at organizations that embrace ESG are exploring the idea of installing floating solar "parks" amongst existing offshore wind farms. This would allow the solar arrays to leverage the existing infrastructure (including resident ROVs for cleaning and maintenance), tie into the grid transporting power to shore, and minimize the increase to the overall footprint of the combined assets. The last in that list will be particularly advantageous for overall management and safety, especially when it comes to ocean-going vessels and charismatic megafauna traversing the area.

EXPLORER, PIONEER, and RANGER tasks:

- Install a floating solar panel array
    - Position a solar panel array amongst floating wind turbines
    - Moor the panel array to three anchor points
    - Connect the floating solar panel array to grid
        - Remove the power port cover
        - Install the power line connector into power port
- Remove biofouling from the foundation and mooring lines of floating wind turbines
- Pilot into "resident ROV" docking station
    - Autonomously
    - Manually

NAVIGATOR tasks:

- Install a floating solar panel array

    - Position a solar panel array amongst floating wind turbines
    - Moor the panel array to an anchor point
    - Connect the floating solar panel array to grid
        - Remove the power port cover
        - Install the power line connector into power port
- Remove biofouling from the foundation and mooring lines of floating wind turbines

SCOUT tasks:

- Install a floating solar panel array
    - Position a solar panel array amongst floating wind turbines
    - Moor the panel array to an anchor point
    - Connect the floating solar panel array to power grid
        - Remove the power port cover
        - Install the power line into power port
- Remove biofouling from the foundation and mooring lines of floating wind turbines

Task #2: Healthy Environments from the Mountains to the Sea

A drop of water that begins its journey in an inland pond high in the Rocky Mountains – or in Lake Titicaca high in the Peruvian Andes, – will eventually make its way to the sea, where it could end up flowing over a coral reef and becoming a genetic "fingerprint" of the organisms that make their home there. Or where it once flowed through the gills of Redbelly Dace hiding in grasses of an emergent wetland, it could now flow over the gills of seahorses anchoring themselves on blades of seagrasses or the chain links of an Eco-Mooring System.

The water cycle is a process that most of us memorized to pass our middle school grade science test. However, if we allow it, it can also serve as a reminder of the interconnectivity of our Blue Planet and how changes thousands of miles away from a coastline, or thousands of miles away from the open seas, can impact each other in either positive or negative ways. Climate change isn't limited to oceans and coastal communities; it impacts inland lakes and remote mountain villages.

Task #2A: Coral Reefs and Blue Carbon

EXPLORER, PIONEER, and RANGER tasks:

- Create a 3D model of a coral head
        - Measure the dimensions of the coral head
        - Model the coral head
- Identify reef organisms using eDNA
    - Collect a water sample from above the coral head to simulate collecting eDNA
    - Use the eDNA data to identify coral reef fish species
- Administer Rx to diseased corals
    - Light
        - Position the simulated UV light source over the diseased area of coral
        - Irradiate the diseased area of coral with simulated UV light

    - Probiotics
        - Place a tent over the diseased area of coral
        - Insert a syringe into a port
        - Inject a “probiotic” fluid into the tent
- Monitor and protect seagrass habitat
    - Compare photos to determine the recovery of a seagrass bed from an anchor scar
    - Install an Eco-Mooring System to protect seagrass and seahorse habitat

NAVIGATOR tasks:

- Identify reef organisms using eDNA
    - Collect a water sample from above the coral head to simulate collecting eDNA
    - Use eDNA data to identify coral reef fish species
- Administer Rx to diseased corals
    - Light
        - Position the simulated UV light source over the diseased area of coral
        - Irradiate the diseased area of coral with simulated UV light
    - Probiotics
        - Place a tent over the diseased coral
        - Insert syringe into a port
        - Inject a “probiotic” fluid underneath tent
- Monitor and protect seagrass habitat
    - Compare photos to determine the recovery of seagrass from an anchor scar
    - Install an Eco-Mooring to protect seagrass and seahorse habitat

SCOUT tasks:

- Identify reef organisms using eDNA
    - Collect a water sample from above the coral head to simulate collecting eDNA
    - Use eDNA data to identify coral reef fish species
- Administer Rx to diseased corals
    - Light
        - Irradiate the diseased area of coral with simulated UV light
    - Probiotics
        - Place a tent over the diseased coral
        - Insert syringe into a port
        - Inject a “probiotic” fluid underneath tent
- Monitor and protect seagrass habitat
    - Install an Eco-Mooring to protect seagrass and seahorse habitat

Task #2B: Inland Lakes and Waterways

EXPLORER, PIONEER, and RANGER class tasks:

- Reintroduce endangered native Northern Redbelly Dace

    - Search two potential sites for invasive predatory fish species to determine which one is safe for release
    - Transport the fry to safe release area
    - Allow the fry to acclimate to local conditions
    - Release the fry
- Ensure the health and safety of Dillon Reservoir
    - Inspect buoy ropes for damage
    - Recover a container from the bottom of the reservoir
        - Determine the lift capability of your ROV
        - Lift the container
        - Return the container to the surface, side of the pool
- Monitor endangered Lake Titicaca giant frogs
    - Count the number of frogs in a transect
        - Fly a transect
        - Count the number of frogs
    - Install a long-term camera into the designated area on the bottom of the lake

NAVIGATOR tasks:

- Reintroduce endangered native Northern Redbelly Dace
    - Search two potential sites for invasive predatory fish species to determine which one is safe for release
    - Transport the fry to safe release area
    - Allow the fry to acclimate to local conditions
    - Release the fry
- Ensure the health and safety of Dillon Reservoir
    - Inspect buoy ropes for damage
    - Recover a container from the bottom of the reservoir
        - Attach a lift bag to the container
        - Inflate a lift bag to lift the container
        - Return the container to the surface, side of the pool
- Monitor endangered Lake Titicaca giant frogs
    - Count the number of frogs in a transect
        - Fly a transect
        - Count the number of frogs
    - Install a long-term camera into a designated area on the bottom of the lake

SCOUT tasks:

- Reintroduce endangered native Northern Redbelly Dace
    - Transport the fry to safe release area
    - Allow the fry to acclimate to local conditions
    - Release the fry
- Ensure the health and safety of Dillon Reservoir
    - Replace a damaged buoy rope
        - Recover a damaged rope and buoy

        - Place a new rope and buoy in the designated area
    - Recover a container from the bottom of the reservoir
        - Attach a lift bag to the container
        - Inflate a lift bag to lift the container
        - Return the container to the surface, side of the pool
- Monitor endangered Lake Titicaca giant frogs
    - Install a long-term camera into a designated area on the bottom of the lake

Task #3: MATE Floats!

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.

EXPLORER, PIONEER, and RANGER class tasks:

- Prior to the competition, design and construct an operational vertical profiling float
- Float communicates with the mission station prior to descending
- Float completes two vertical profiles -
    - Vertical profile 1
        - Float completes first vertical profile
        - Float communicates time to mission station
    - Vertical profile 2
        - Float completes second vertical profile
        - Float communicates time to mission station

NAVIGATOR and SCOUT tasks:

- Adopt-a-float
- Recover the float
    - Simulate the float ascending to the surface by pulling a pin
    - Recover the float to the surface side of the pool
- Analyze float data
    - Graph water temperature versus depth

SPECS

What follows is a summary of the electrical and fluid power requirements for each competition class. The complete design and building specifications will be included within the competition manual.

NOTE: Watch for new safety requirements and additional, detailed electrical specifications within the competition manuals.

EXPLORER

- 48 volts, 30 amps DC. Conversion to lower voltages must be done on the ROV, not topside.
- SBS50 Anderson Powerpoles, Littelfuse (30-amp or less) and Littlefuse fuse holders required on all vehicles. These specific components are REQUIRED.
- Pneumatics and hydraulics are permitted provided that the company follows the specifications included within the competition manual.
- Lasers are permitted provided that the team follows the specifications included within the competition manual.
- Camera is required.
- Depth requirement at the world championship: 4 meters.
- Maximum size: None. However, tasks will require companies to launch through a 1-meter x 1-meter square hole on the surface and pilot inside an 85 cubic centimeter docking station.
- Maximum weight: 35 kg. Vehicles above 35 kg will not be allowed to compete in the product demonstration. See below for additional details on weight requirements.

PIONEER

- 48 volts or 12 volts, 30 amps DC. If 48 volts is used, conversion to lower voltages must be done on the ROV, not topside.
- 48 volt systems must use SBS50 Anderson Powerpoles and Littelfuse (30-amp or less) and Littlefuse fuse holders on all vehicles. These specific components are REQUIRED if the vehicle is using 48 volts.
- Pneumatics and hydraulics are permitted provided that the company follows the specifications included within the competition manual.
- Lasers are permitted provided that the team follows the specifications included within the competition manual.
- Camera is required.
- Depth requirement at the world championship: less than 2 meters.
- Maximum size: None. However, tasks will require companies to launch through a 1-meter x 1-meter square hole on the surface and pilot inside an 85 cubic centimeter docking station.
- Maximum weight: 35 kg. Vehicles above 35 kg will not be allowed to compete in the product demonstration. See below for additional details on weight requirements.

RANGER

- 12 volts, 25 amps DC. Conversion to lower voltages is permitted topside and on the ROV.
- Pneumatics and hydraulics are permitted provided that the company follows the specifications included within the competition manual.
- Lasers are permitted provided that the team follows the specifications included within the competition manual.

- Camera is required.
- Depth requirement at the international competition: less than 2 meters. Depth requirement may vary at regional competitions. Contact your regional coordinator or check your regional competition information document.
- Maximum size: None. However, tasks will require companies to launch through a 1-meter x 1-meter square hole on the surface and pilot inside an 85 cubic centimeter docking station.
- Maximum weight: 25 kg. Vehicles above 25 kg will not be allowed to compete in the product demonstration. See below for additional details on weight requirements.

NAVIGATOR

- 12 volts, 15 amps DC. Conversion to lower voltages is permitted topside and on the ROV. Any onboard electrical power source is not permitted.
- Manually powered hydraulics and pneumatics are permitted. Pneumatic systems cannot exceed ambient pool pressure and must follow the fluid power specifications included within the competition manual.
- Lasers are NOT permitted.
- Camera is required.
- Depth requirement: Varies depending on the regional event. Contact your regional coordinator or check your regional competition information document.
- Anderson Powerpole connectors are required on all vehicles.
- Maximum size: None. However, tasks will require companies to launch through a 1-meter x 1-meter square hole on the surface.

SCOUT

- 12 volts, 15 amps DC. Conversion to lower voltages is permitted topside and on the ROV. Any onboard electrical power source is not permitted.
- Manually powered hydraulics and pneumatics are permitted. Pneumatic systems cannot exceed ambient pool pressure and must follow the fluid power specifications included within the competition manual.
- Lasers are NOT permitted.
- Depth requirement: Varies depending on the regional event. Contact your regional coordinator or check your regional competition information document.
- Anderson Powerpole connectors are required on all vehicles.
- Maximum size limit: None.

WEIGHT POINT VALUES

Considering 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. Certain product demonstration tasks will also limit the overall size of the vehicle.

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

- The topside control system and the tether
- EXPLORER, PIONEER, and RANGER vertical profiling floats

EXPLORER & PIONEER

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

Vehicles that cannot fit through the hole on the surface, or vehicles greater than 35 kg in weight will not be allowed to compete in the product demonstration.

RANGER

Weight (in air)	
< 15 kg	+10 points
15.01 kg to 20 kg	+5 points
20.01 kg to 25 kg	+0 points

Vehicles that cannot fit through the hole on the surface, or vehicles greater than 25 kg in weight will not be allowed to compete in the product demonstration.

NOTE: In addition to the weight limitations described above, companies must be able to transport the vehicle and associated equipment to the product demonstration station and to the engineering presentation room. The ROV systems must be capable of being safely hand launched.

RESOURCES

Teams are permitted to use the materials of their choice provided that they are safe, will not damage or otherwise mar the competition environment, and are within the defined design and building specifications.

Teams are encouraged to focus on engineering a vehicle to complete the product demonstration tasks, when considering design choices, teams should ask themselves which one most efficiently and effectively allows them to solve the problem. Re-using components built by previous team members is permitted provided that the current team members evaluate, understand, and can explain their engineering and operational principles. Using or re-using commercial components is also permitted, provided that team members evaluate, understand, and can explain their engineering and operational principles. Teams will be questioned extensively on their overall design and component selections during their engineering presentations.

TIME

The complete competition manual will be released in December 2022; teams have from that date until the regional events in the spring of 2023 to construct their vehicles and prepare the engineering and communication components (technical documentation, engineering presentations, and marketing displays). Visit www.materovcompetition.org or join the MATE competition listserv to ensure a timely delivery.