



2021 NAVIGATOR CLASS



MOTOROLA SOLUTIONS
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Good for Good



Excite, Educate, Empower:
Students Engineering
Solutions to Global Problems

2021 MATE ROV COMPETITION:

Excite, Educate, Empower: Students engineering solutions to global problems

NAVIGATOR CLASS COMPETITION MANUAL

For general competition information, including a description of the different competition classes, eligibility, and demonstration requirements, visit [Start Competing](#).

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OVERVIEW

THINK OF YOURSELVES AS ENTREPRENEURS

From the removal of plastic pollution in our oceans to the assessment of the health of coral reefs and

maintenance of healthy waterways, individuals who possess entrepreneurial skills are in high demand and stand out in the crowd of potential job candidates. What are entrepreneurial skills? They include the ability to understand the breadth of business operations (e.g., finances, research and development, media outreach), work as an integral part of a team, think critically, and apply technical knowledge and skills in new and innovative ways. Individuals who develop a mindset for innovation and collaboration will be well prepared for the global workplace and ready to tackle today – and tomorrow’s – societal and environmental challenges.

To help you to better understand and develop these skills, the MATE ROV competition challenges you to think of yourself as an entrepreneur. Your first task is to create a company or organization that specializes in solutions to real-world marine technology problems. Use the following questions as a guide.

- What is your company name?
- Who are its leaders – the CEO (chief executive officer – the leader) and 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 (R&D)?
- Who is responsible for system(s) engineering? Design integration? Testing? Operations?
- Who is responsible for fund-raising, marketing, and media outreach?
- 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?
- Who are your potential clients?

In this case, the MATE ROV Competition and the global community are your “clients” who recently released a request for proposals. A request for proposals (RFP) is a document that an organization posts to solicit bids from potential companies for a product or service. The specifics of your product design and rules of operation as well as the specifics of your product demonstration are included below.

PART 1: PRODUCT DEMONSTRATION

OVERVIEW

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

TASK #1: THE UBIQUITOUS PROBLEM OF PLASTIC POLLUTION

TASK #2: THE CATASTROPHIC IMPACT OF CLIMATE CHANGE ON CORAL REEFS

TASK #3: MAINTAINING HEALTHY WATERWAYS PART II: DELAWARE RIVER AND BAY

NOTE: Regional competitions may not include all 3 tasks of the product demonstration; regional competitions may also give companies more than one attempt at the product demonstration. Contact [your regional coordinator or visit your regional contest’s website](#) to determine what will take place at your regional

competition. Regardless, the 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)**
 - 200 points (max), plus a time bonus
 - Size restrictions
 - 10 points (max)
 - Product demonstration organizational effectiveness
 - 10 points (max)
- **Engineering & Communication**
 - Technical documentation – 50 points (max)
 - Engineering presentations – 50 points (max)
 - Marketing displays – 50 points (max)
 - Company Spec Sheet – 20 points (max)
 - Corporate Responsibility – 10 points (max)
- **Safety** – 10 points (max)

TOTAL POINTS = 410

NOTE: Regional contests may not require all of the Engineering & Communications components or offer the opportunity to earn points for Corporate Responsibility. Contact [your regional coordinator or visit your regional contest's website](#) for more information.

TIME

The time that your company will have to complete the product demonstration will depend on your regional event. Contact [your regional coordinator or visit your regional contest's website](#) to determine how your demonstration will be timed and how long you will have to set up, complete the tasks, demobilize, and exit the station.

At any time during the product demonstration you may pilot your ROV to the surface and remove it from the water for things such as buoyancy adjustments, payload changes, and troubleshooting. However, the product demonstration clock will NOT stop. The only time the clock will stop is if a judge determines that there is an issue that is beyond your control. Otherwise, the clock will only stop after all of the tasks are successfully completed, the ROV has returned to the surface under its own power so that it touches the side of the pool, and a member of your company at the product demonstration station has physically touched the vehicle. Your ROV is not required to return to the surface between tasks.

TIME BONUS

Companies will receive a time bonus for each product demonstration run if you:

- 1) successfully complete 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 product demonstration time ends.

How the time bonus is calculated will depend on your regional event. Your regional coordinator will tell you this when he/she explains how your demos will be set up and how much time you'll have to complete them.

CONTEXT

“What we have out there is all we have; there is no more.”

- Dame Ellen MacArthur, *Founder and Chair of Trustees, Ellen MacArthur Foundation*

Each year, the MATE ROV Competition brings together a global community of learners to tackle real-world problems from around the world. This year, the competition is challenging this community to tackle problems that impact the entire world. Plastics clogging our rivers, lakes, waterways, and ocean, from the surface to the bottom of the Mariana Trench. Climate change raising ocean temperatures, affecting the health of coral reefs. Contaminants in our waterways. You can find these scenarios from Pennsylvania to Portugal, Florida to Australia, the Western Pacific to the Mid-Atlantic, and Indianapolis to Indonesia.

NEED

This year the “client” is us – our global community – and the request for proposals (RFP) is simple: design and build a remotely operated vehicle and the necessary sensors and tooling to tackle the real-world problems of plastics in our ocean, climate change’s impact on coral reefs, and the consequences of poor environmental practices on our inland waterways.

In all of three of these cases, your solutions will focus on remediation, meaning, cleaning up rather than fixing the root of these problems. Addressing the actual cause will take involvement from more than just the MATE ROV Competition community; it will take government agencies, non-governmental organizations (NGOs), corporations, small businesses, research institutions, professional societies, and the general public all working together.

Fortunately, momentum is building.

More and more companies are starting to take environmental, social, and governance (ESG) factors into consideration when making business decisions. ESG factors cover a wide range of topics that are not traditionally part of financial analysis, yet may be important financially when it comes to attracting employees, business partners, and, perhaps most importantly, customers. ESG factors include how corporations respond to climate change, how good they are with water management, how effective their health and safety policies are in the protection against accidents, how they manage their product supply chains, how they treat their employees, and whether they have a corporate culture that builds trust and encourages innovation.

The term ESG was first used in 2005 in a study entitled “Who Cares Wins.” The study was lead by the United Nations and involved 20 financial institutions from around the world. Its goal was to develop guidelines and recommendations on how to better integrate ESG factors into financial markets and researching and managing investments. At the end of the study, all of the institutions committed to start talking with their stakeholders – investors and corporations – about how to implement the study’s recommendations. They were convinced that the only way to make changes and improvements is to get everyone on board.

Fifteen years later, there has been progress, but there is still a long way to go. The biggest challenge for most corporations is adapting to a new environment that favors smarter, cleaner, and healthier products and services and moving away from the mindset of the industrial era when pollution was tolerated, labor was just another cost (and not real people), and bigger was better (and meant more money). Getting everyone thinking the same way and viewing the world as Dame Ellen MacArthur does is going to take a lot more work. However, what we do here is a start.

Before launch and operations, the ROV must complete a series of “product demonstrations” staged at a swimming pool at various regional locations. (Depth requirements vary depending on competition class; see **SPECIFICATIONS** below.) Companies that successfully complete the product demonstrations and deliver exceptional engineering and communication components (e.g. technical documentation, engineering presentations, and marketing displays) will be awarded the contract.

(Visit www.youtube.com/watch?v=Tn-jUbpFV4A for sound advice from MATE judge Marty Klein. He references 2015, but his words still hold true for each and every competition season!)

REQUEST FOR PROPOSALS (RFP)

1. General

a. The Ubiquitous Problem of Plastic Pollution



Photo source: stock.adobe.com

While this image is colorful and artistic, it is also dark and disturbing – especially when you consider that plastics outnumber larval fish in some coastal nurseries. Off the Big Island of Hawaii scientists studying features called “ocean slicks” – ribbons of calm water that form on the ocean’s surface and where larval fish come to feast on prey – found that prey-sized plastics also collect in these fish nurseries, outnumbering the fish 7-to-1 and ending up in the stomachs of many. Little is known about the consequences of larval fish ingesting plastics, but it can’t be good for them. Plastic ingestion by adult fish has been linked to liver problems, tumors, malnutrition, behavioral problems, and death. Without a fully developed liver that can filter toxins, these effects could be even worse in larval fish.

So, add the following image to those of sea turtles with plastics straws stuck in their nostrils or caught in plastic nets. Along with the image, you can add the potentially far-reaching ecological and socioeconomic impacts of plastic build-up in larval fish nurseries to the list of consequences of the ubiquitous problem of plastic pollution in our oceans.



Photo source: https://i.kinja-img.com/gawker-media/image/upload/s--Vg9gBDua--/c_scale,fl_progressive,q_80,w_800/fb9osojkxv5r9qb5l8kv.jpg

Will Who Cares Really Win?

There is a growing awareness of the harmful impact of plastic pollution, and many parts of the world are taking action to curb it. Realistically, however, it is unlikely that the entire world population will stop using plastic in everyday life; in many cases plastic products have made life easier, more comfortable, and safer. In some parts of the world, access to plastic products is a symbol of economic prosperity.

But there are steps we can and are taking to limit its use (i.e., reusable plastic bags) and find alternatives (i.e., metal straws). Research into “smarter” plastics that breakdown more rapidly into less harmful molecules, or can more easily recycle into other products to eliminate single-use plastics – coupled with the development of technologies that clean-up existing plastics – can allow us to continue to use this material while applying the values of ESG. In the words of David Golden, former Senior Vice President and Chief Legal Officer at Eastman Company, “a sustainable company creates significantly more value in the world than the resources it consumes.”

Yes, who cares really will win.

Take, for example, Pete Ceglinski, CEO of the Seabin Project. An Australian surfer and water enthusiast, Pete was concerned about plastics and other pollution in the ocean. So he and a fellow surfer decided to quit their jobs and do something about it. They became entrepreneurs, researched potential solutions to clearing trash from the water, designed and developed the Seabin, and marketed it to the world.

Pictured below, the Seabin is basically a floating garbage bin. Water is sucked in from the surface by a submersible water pump then passes through a catch bag inside the bin. The catch bag is like a garbage bag liner; it can capture and retain microplastics down to 2 millimeters in size, while a pad at the bottom of the bin filters out oil and other contaminants. Once full, the catch bag can be emptied then replaced within the unit.

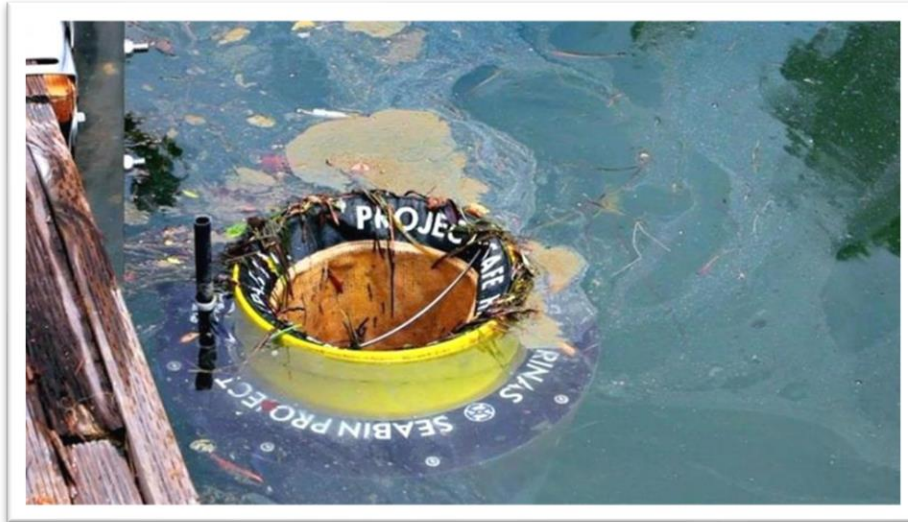


Photo source: <https://www.sail-world.com/news/219741/Fight-against-pollution-with-Ocean-Vacuums>

Since Ceglinski and his partner first started their “socially-driven business model” in 2014, nearly 900 Seabins have been installed in harbors, marinas, and commercial ports around the world. (The first Seabin on the east coast of the United States was installed in a marina in Norfolk, Virginia near Nauticus, the National Maritime Center – the organization that coordinates the MATE Mid-Atlantic Regional ROV Competition!) These are ideal locations because they tend to be in calmer waters, are areas where trash builds up, and provide easily accessible and unlimited power, which allows the Seabin to work 24 hours a day, seven days a week. As a result, to date Seabins have captured a total of 360,000 kilograms of trash.

Ceglinski and his partner are now working on a Seabin for the open water, which would allow them to tackle the gigantic “garbage patches” of plastics that collect in ocean gyres, including the infamous Great Pacific Garbage Patch. How to power those Seabins far from shore is one of the technological and logistics challenges they face, but they are exploring the use of renewable energy sources – wind, solar, and wave.

Another example is businessman and explorer Victor Vescovo, shown in the picture below. In May 2019, Vescovo became only the fourth person in history to travel to the bottom of the deepest part of the world ocean, the Mariana Trench. Working with The [Five Deeps Expedition](#) and its submersible *Limiting Factor*, Vescovo actually set a new record by traveling deeper than the previous three; he “bottomed out” at 10,928 meters. Like oceanographer and inventor Jacques Piccard and U.S Navy Lieutenant Don Walsh in 1960 and movie producer/director James Cameron in 2012, Vescovo looked out his portal when his submersible hit bottom and sent sediment swirling. When the dust settled, he found a “sublime and serene” landscape dotted with translucent fish, a new species of amphipod, and...candy wrappers. As the Washington Post reported, we are going places no one has gone before, but our trash is already there. And in the words of Vescovo, “I was disappointed to see human contamination in the deepest point in the ocean. With over 7 billion people on the Earth, the oceans are going to be impacted negatively by mankind, but I hope we can at least minimize it in the future.”



Photo source: <https://www.lonelyplanet.com/articles/plastic-waste-mariana-trench>

b. Catastrophic Impact of Climate Change on Coral Reefs



Photo source: <https://www.hawaiipublicradio.org/post/corals-are-adapting-higher-temperatures-likely-not-fast-enough#stream/0>

While not nearly as colorful or artistic as the “plastic world” image above, this photo is equally as dark and disturbing. It shows bleached and partially dead coral in Kaneohe Bay on the windward side of the Hawaiian island of Oahu. Scientists running transects of the reef documented the devastation, which results when

environmental stressors like rising water temperatures cause the coral to eject the symbiotic algae that live within their tissues, which in turn causes them to turn completely white. Without their major food source and if the environmental stress continues, the corals will die.

However, in addition to scenes like this, scientists also collected evidence that some species of coral have been adapting to warmer conditions. There are certain species in Kaneohe Bay today that are more resistant to high water temperatures than colonies from the 1970s, all through natural adaptation. While this may be reason to celebrate, adaptation may still not be enough; temperatures are increasing faster than the corals can adapt. Scientists warn that no other changes can substitute for reducing the atmospheric carbon emissions that are causing ocean temperatures to rise each year.

In addition to climate change, corals face natural threats, including predators like the Crown of Thorns sea star. The Crown of Thorns sea star is found throughout the Pacific as well as the Indian Ocean and the Red Sea. Its population is usually kept in check by the Triton's trumpet, a large species of gastropod, the harlequin shrimp, and several species of reef fish that don't appear to be bothered by its poisonous spines. However, outbreaks do occur, fueled by run-off and worsened by warmer water, conditions that also directly stress corals. Corals get a one-two punch and, too often, it is too much for them to survive.

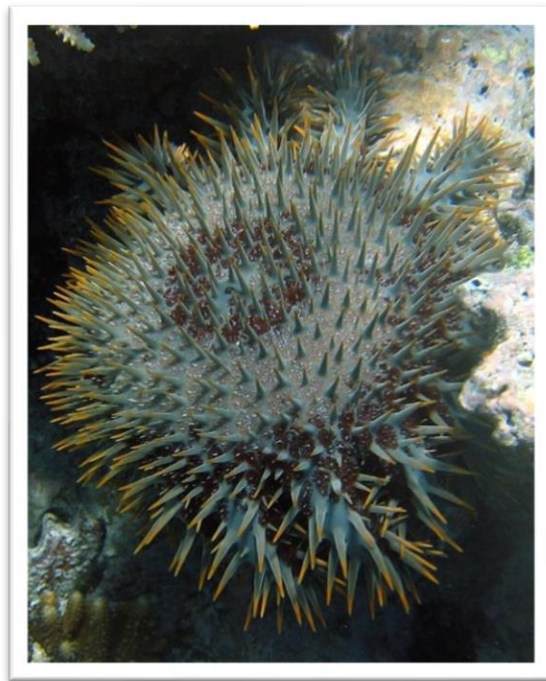


Photo source: https://en.wikipedia.org/wiki/Crown-of-thorns_starfish

Will Who Cares Really Win?

The catastrophic impact of climate change on coral reefs isn't unique to corals in Hawaii and the western Pacific. There are scenes of bleached and dying corals throughout the Caribbean and the south Pacific.

However, the way that researchers are raising and transplanting coral species to restock and repopulate the reef is. Scientists on Oahu have transplanted corals from the reef to tanks to further study how the different coral species respond to environmental stressors, including increased temperature. The hope is that those corals that demonstrate the ability to adapt to higher temperatures are grown in those tanks then returned to the reef.

In Florida, scientists are using a process called microfragmentation to repopulate reefs. Temperature-resistant corals are sliced into numerous small fragments. These fragments grow extremely quickly, over 10 times faster than normal, and, once they reach a certain size, they are transplanted back onto the reef. When transplanted next to each other, these coral fragments will fuse together into one large colony. Researchers are targeting key reefs to repopulate, including reefs that have special ecological value, are commercially important (i.e., from a fisheries point of view), or are source reefs of larvae that can naturally repopulate other reefs down current.

And in Australia scientists are using “coral nurseries,” both land-based and field-based, like the photo below, to grow coral fragments collected from wild populations. The nurseries are often started with “corals of opportunity;” fragments that have been broken off of the main coral colony by natural disturbances, such as storms, and have little chance of surviving unless stabilized on a nursery structure. Small fragments can also be taken from intact wild “donor” colonies. When the corals have grown to a size large enough to have a good chance of survival, they are then “outplanted” – moved and secured – to the reef.



Photo source: <http://reefresilience.org/restoration/coral-populations/coral-gardening/field-based-nurseries/>

So, yes, who cares really will win.

How scientists in the Western and South Pacific are managing outbreaks of Crown of Thorn sea stars is another example. Both research divers and an ROV called [RangerBOT](#) have been used to cull Crown of Thorn

sea stars when an outbreak occurs. RangerBOT has become especially effective; it uses image recognition to identify the sea stars with a 99.4% accuracy then injects them with ox bile – poisonous to them but not to the other reef organisms.

Another example is Dr. Shirley Pomponi, a researcher at Florida Atlantic University's Harbor Branch Oceanographic Institute, who has spent her career hunting sponges – or, rather, collecting small samples of sponges to search for chemical compounds that could be important in fighting cancers and infections.

In all her years of studying sponges, Dr. Pomponi has never found a tumor in one of them. However, she has found several chemicals that fight infections in humans; a potential cure for cancer may not be far behind. Over the last 40 years, more than 30,000 new chemicals with unique properties that could have medical importance have been discovered in microbes, algae, sponges, bryozoans, and other marine species. The organisms evolved these chemicals naturally and use them to defend against predators, communicate with their neighbors, or prevent algae and other encrusting species from growing on top of them.

So add the medical uses of sponges and other reef organisms to the list of reasons to curb the catastrophic climb of climate change. In the words of Dr. Pomponi, “We want to avoid a situation where the environment is damaged and some unique animal that produces a chemical that could cure cancer or other dreaded diseases is destroyed. If these remarkable sea creatures aren't protected, who knows what we'll lose.”

c. Maintaining Healthy Waterways Part II: Delaware River and Bay

When we left the South Fork of the Holston River in Kingsport, Tennessee last June, we didn't leave the idea that maintaining healthy waterways is important to the survival of benthic organisms and other species, including our own. Coincidentally, one of the research teams that conducted the water quality analysis and habitat surveys of the Holston River is from the Academy of Natural Sciences at Drexel University, which is located in downtown Philadelphia, about 20 miles from Villanova University.

Drexel scientists also monitor waterways closer to home, including the Delaware River. One organism that has gotten their attention is the American eel, pictured below. The American eel is a migratory species that spawns in the Atlantic, but spends most of its life in streams, rivers, estuaries, and lakes. This commercially and ecologically important species was facing a population decline, mainly because of the construction of dams. Notice the word *was*. Dams had drastically limited their migration routes from the ocean to upstream freshwater areas, until scientists – from Drexel University and beyond – stepped in to help the eels on their journey. They built “eel ways,” which are similar to fish ladders but designed to help the eels maneuver over the dams. They also built traps to collect the eels downstream then transport them upstream, above the dam, where the eels were released to continue on their way.



Photo source: <https://usfwsnortheast.files.wordpress.com/2014/06/american-eel.jpg>

Will Who Cares Really Win?

This assistance benefitted more than just the eels – and illustrates the interconnectedness of an ecosystem. Larval mussels need to attach to the gills of fish or other organisms in order to complete their life cycle. Some mussel species rely on American eels to survive. With fewer eels headed upstream, mussel larvae had fewer hosts to help them survive. And, in turn, fewer mussels meant poorer water quality because mussels have the ability to filter liters of water a day. So, saving one species helped to save the entire river ecosystem.

Yes, who cares really will win.

Another example are the scientists and researchers from the Delaware River Basin Commission (DRBC) who monitor the Delaware River and its tributaries as well as Delaware Bay – all pictured below. Their biological monitoring program looks at the diversity of macroinvertebrates throughout the watershed. They also monitor levels of toxic chemicals and heavy metals. In 2010, the Delaware River ranked fifth in the nation for the highest amount of total toxic discharges. Today, because of the efforts of organizations like the DRBC, the clean-up of the Delaware River is celebrated as one of the world's top water quality success stories. The river now supports year-round fish populations, as well as those returning to their “birthplace” to spawn.



Photo source: <https://www.state.nj.us/drbc/basin/>

Another example is the Delaware Reef Program, which is part of an overall fisheries management effort and designed to boost fisheries habitat, benefit structure-oriented fish, and provide fishing opportunities for anglers. Over the long haul, artificial reefs are seen as a salvation for depleted or endangered fisheries.

The program began in 1995 and, to date, has 14 artificial reef sites in Delaware Bay and along the Atlantic Coast, including the Redbird Reef site, which takes its name from the "Redbird" paint-schemed subway cars donated in 2001 by New York City's Metropolitan Transportation Authority. To build the Redbird Reef, 619 of the obsolete subway cars were sunk, each of them 51 feet long by nine wide, making a considerably large bottom structure for an artificial reef.

They went to the bottom just in time, too – Delaware got that bounty of subway cars after other states rejected their use as artificial reef material. Now, with Delaware's success in establishing "luxury condominiums for fish," like the one pictured below, other states are competing for the old cars. For example, New Jersey, which was among the opponents of using them as artificial reefs, now has requested 600 subway cars from New York City.

As the old saying goes, "one person's trash becomes another's treasure." Reduce, reuse, REPURPOSE.
2021 NAVIGATOR Class

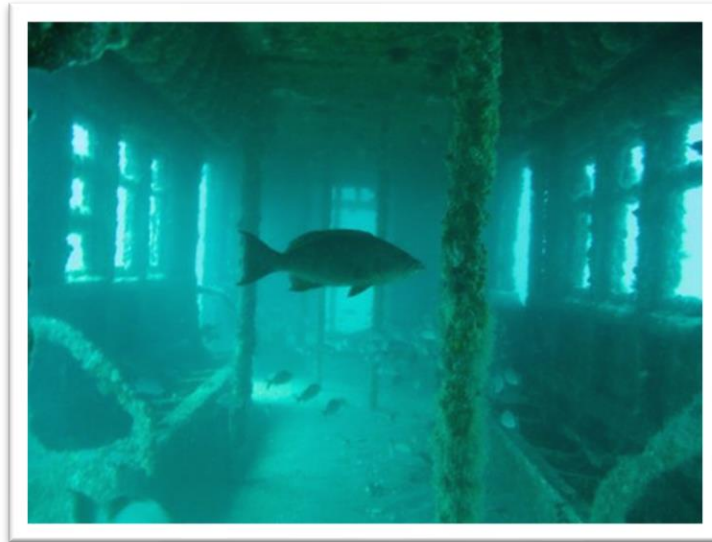


Photo source:

https://68.media.tumblr.com/bf053d69113a2d11d62532af312ef53d/tumblr_nxdh1sRpP01u2hca8o1_500.jpg

THIS IS WHERE YOUR MISSION BEGINS.

d. Mission Scope and Purpose

This and the following sections contain the technical specifications and requirements for ROV services needed to support Eastman. In 2021, ROV services include:

1) THE UBIQUITOUS PROBLEM OF PLASTIC POLLUTION

- Disconnect the power to a Seabin
- Replace an old mesh catch bag on the Seabin with a new one
- Reconnect the power to a Seabin
- Remove floating plastic debris from the surface
- Remove a ghost net from midwater
- Remove plastic debris from the bottom

2) THE CATASTROPHIC IMPACT OF CLIMATE CHANGE ON CORAL REEFS

- Fly a transect line over a coral reef
- Map points of interest on the reef
- Determine the health of a coral colony by comparing its current condition to past data
- Remove coral fragments from the nursery structure
- Outplant coral fragments into the reef
- Cull an outbreak of Crown of Thorn sea stars
- Collect samples of sponge species for pharmaceutical research

3) MAINTAINING HEALTHY WATERWAYS PART II: DELAWARE RIVER AND BAY

- Return a sediment sample to the surface
- Determine the type of contaminant present in the sediment sample
- Deploy a quadrat to estimate the number of mussels in a mussel bed
- Estimate the total amount of water filtered by the mussel bed
- Remove a trap full of eels
- Place an empty eel trap in the designated area

2. Specifications

See the specific tasks described below as well as the [VEHICLE DESIGN & BUILDING SPECIFICATIONS](#) and [COMPETITION RULES](#) sections.

3. Maintenance and Technical Support

The company will guarantee the ROV for the duration of the product demonstrations. Repair or replacement will be at the company's expense. The company will provide at least one day of technical support to deal with any issues.

4. Shipping and Storage

Delivery of the ROV will be no later than the date of the nearest regional contest.

5. Evaluation Criteria

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

6. References

a. GENERAL

- <https://www.forbes.com/sites/georgkell/2018/07/11/the-remarkable-rise-of-esg/#69fbf2881695>
- [https://www.unglobalcompact.org/docs/issues_doc/Financial markets/who cares who wins.pdf](https://www.unglobalcompact.org/docs/issues_doc/Financial%20markets/who_cares_who_wins.pdf)
- <https://sustainabledevelopment.un.org/?menu=1300>
- <https://www.ellenmacarthurfoundation.org/>
- <http://www.stephense.com/research/papers/oceans08.pdf>

b. THE UBIQUITOUS PROBLEM OF PLASTIC POLLUTION

- <https://www.nationalgeographic.org/encyclopedia/great-pacific-garbage-patch/>
- <https://www.youtube.com/watch?v=3RLrTCVmLCc>
- <https://theoceancleanup.com/great-pacific-garbage-patch/>
- <https://www.youtube.com/watch?v=ySp7HKD7jaw>

- <https://seabinproject.com/>
- <https://www.weforum.org/agenda/2019/06/underwater-robots-have-found-microplastics-from-the-surface-to-the-seafloor/>
- <https://www.washingtonpost.com/science/2019/05/15/he-went-where-no-human-had-gone-before-our-trash-had-already-beat-him-there/>

c. THE CATASTROPHIC IMPACT OF CLIMATE CHANGE ON CORAL REEFS

- <https://allencoralatlas.org/>
- <https://www.aims.gov.au/documents/30301/e4a579c7-6cb9-4484-ac9d-bd4526dd191a>
- <https://www.nrdc.org/stories/scientists-are-battling-mysterious-pathogen-destroying-coral-reefs-floridas-coast>
- <https://newatlas.com/larvalbot-replenish-great-barrier-reef/57666/>
- <http://reefresilience.org/restoration/coral-populations/coral-gardening/field-based-nurseries/>
- https://en.wikipedia.org/wiki/Crown-of-thorns_starfish
- <https://www.oma.noaa.gov/find/media/images/removal-crown-thorns-sea-stars-during-outbreak>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4325318/>
- <https://ocean.si.edu/ocean-life/invertebrates/five-questions-shirley-pomponi-medical-sponge-hunter>

d. MAINTAINING HEALTHY WATERWAYS PART II: DELAWARE RIVER AND BAY

- <https://ansp.org/research/environmental-research/projects/watershed-protection-program/>
- <https://www.state.nj.us/drbc/basin/>
- <https://www.state.nj.us/drbc/quality/>
- http://www.buckslocalnews.com/news/environmental-group-delaware-river-tops-list-of-most-polluted-waterways/article_b94c90d5-a5c1-5c8e-b39d-2319fa2a511a.html
- https://www.state.nj.us/drbc/library/documents/Yagecic_water-quality-monitoring_sept2017.pdf
- <http://www.inphotonics.com/raman.htm>
- <https://usfwsnortheast.wordpress.com/2017/08/21/mussels-making-moves-for-water-quality/>
- <https://usfwsnortheast.wordpress.com/2017/09/08/restoring-rivers-with-a-little-mussel-power/>
- <https://usfwsnortheast.wordpress.com/2014/06/20/bringing-back-american-eels-in-the-susquehanna-river/>
- <http://www.dnrec.delaware.gov/fw/Fisheries/Pages/ArtificialReefProgram.aspx>
- <https://archive.epa.gov/reg3esd1/archive/web/html/reefs.html>

IMPORTANT NOTE: Questions about production demonstrations and design and building specifications must be posted to the competition FAQs board located at <http://forums.marinetech2.org/index.php>. This allows all companies to see the questions and answers and helps 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 the companies to read, comprehend, and comply with ALL rulings posted on the FAQ board.

SIZE RESTRICTIONS

In light of some of the environments in which the ROVs will be operating, an ROV size and weight requirement has been included in the request for proposals (RFP). Smaller, lighter vehicles will be given special consideration and vehicles above a certain size and weight will not be considered.

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

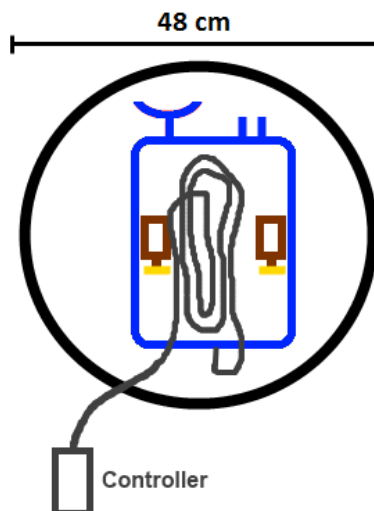
- The topside control system and 1 meter of tether going into the control system
- The quadrat for estimating the number of mussels

Vehicles will be measured in the on-deck circle 15 to 20 minutes prior to the company's product demonstration runs. Note that the vehicle will be measured before all product demonstration runs. The size bonus, if any, will be added into the product demonstration score.

2021 size parameters

Size measurements will be made using the two largest dimensions of the ROV. Two rings with diameters of 48 cm and 60 cm will be located on a table in the on deck circle. Companies will place their vehicles on the measuring table and, when ready, ask a MATE Center judge to make the size measurement. The vehicle measurement must include the vehicle, all manipulators/tools to be used in the product demonstration, and the vehicle's tether. The control system and 1 meter of tether may be outside of the measurement circle. Companies must present their completely assembled ROV for measurement; companies may NOT detach manipulator arms or other equipment for the measurement.

The size rings will be placed over the two largest dimensions of the ROV.



A NAVIGATOR class vehicle, with tools attached and tether coiled on top, inside the 48 cm diameter ring. This vehicle would earn the company +10 bonus points on the product demonstration score.

Competition officials will use the following chart to award points:

Size	
< 48 cm diameter	+10 points
48.1 cm to 60 cm	+5 points

Vehicles above 60 cm in diameter will still be allowed to compete, but will receive 0 points for size.

Size Protocol

Only the four designated product demonstration company members will be allowed into the on-deck circle during and after the size measurement. Once a company's vehicle has been measured, 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 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 size and weight measurements) may be added to the vehicle. If it is discovered that a company added equipment that was not included in the measurements, that company will not be permitted to compete in that product demonstration run.

Videos showing simulated size and weight measurements are posted [here](#).

PRODUCT DEMONSTRATION

TASK 1: THE UBIQUITOUS PROBLEM OF PLASTIC POLLUTION

This task involves the following steps:

1.1 Seabin – “Cleaning up our ocean one marina at a time”

- Disconnecting the old power connector to the recently installed Seabin – 5 points
- Removing a previously installed Seabin's mesh catch bag – 10 points
- Installing a new mesh catch bag into the Seabin – 10 points
- Reconnecting the power connector to the recently installed Seabin – 10 points

1.2 Remediation: Removing plastic pollution from top to bottom

- Removing floating plastic debris from the surface –
 - Removing all 6 pieces of debris – 15 points
 - Removing 3 to 5 pieces of debris – 10 points
 - Removing 1 to 2 pieces of debris – 5 points
 - Removing 0 pieces of debris – 0 points
- Removing a ghost net from midwater
 - Pulling a pin to simulate cutting the ghost net free – 10 points
 - Return the pin to the surface – 5 points
 - Removing the ghost net from the water – 5 points

- **Removing plastic debris from the bottom of the Mariana Trench – 5 points each, 10 points total**

Total points = 80 points

Product Demonstration Notes:

Companies must do the steps of the Seabin – “Cleaning up our ocean one marina at a time” task in order. Companies may not skip any steps of the Seabin task. Companies may complete the steps of Remediation: Removing plastic pollution from top to bottom in any order.

Task 1.1 Seabin – “Cleaning up our ocean one marina at a time”

Companies must conduct maintenance on a Seabin recently deployed in open water. The body of the Seabin will be constructed from a 5-gallon bucket. A ½-inch PVC framework will be secured inside the bucket approximately 5 cm from the top. The mesh catch bag will be simulated by [mesh netting](#) attached to a framework of ½-inch PVC pipe. The framework of the catch bag will sit on the ½-inch PVC framework secured inside the bucket. The power port for powering the Seabin will be constructed from 3-inch ABS pipe attached to ½-inch PVC framework. The power port will be located adjacent to the Seabin. Both the Seabin and the port will be weighted and sitting on the bottom of the pool.

Companies must first disconnect the power connector from the port on the Seabin. The connector will be constructed from ½-inch PVC pipe. A handle will act as a grab point on the connector. A length of rope will run from the connector to the surface. Companies will receive 5 points for successfully disconnecting the power connector from the port. Successfully disconnecting the old power connector is defined as the power connector under control of the ROV, and no longer in contact with the power port or the Seabin. Companies cannot pull the power connector from the port by hand.

Companies that cannot remove the power connector cannot continue with the Seabin task.

The old power connector will weigh less than 5 Newtons in water.

Once the power to the Seabin has been disconnected, companies must remove the old mesh catch bag and install a new one. Both the old and new mesh catch bag will be identical in construction, but the old mesh catch bag will contain plastic debris. The mesh catch bags will be constructed of mesh netting attached to a framework of ½-inch PVC pipe. The PVC pipe framework of the mesh catch bag will rest inside the top of and on the PVC framework inside the Seabin. A PVC handle will act as a grab point for the mesh. The PVC handle will extend above the top opening of the 5-gallon bucket.

Companies must first remove the old mesh catch bag from the inside the Seabin. Companies will receive 10 points when the old mesh catch bag is successfully removed. Successful removal of the old mesh catch bag is defined as the old bag removed from the water and placed on the pool deck.

Once the old mesh catch bag has been removed from the Seabin, companies must install the new mesh catch bag. The new mesh catch bag will be located at the surface, side of the pool during the product demonstration set up time. Companies will receive 10 points for successfully installing the new mesh catch bag. Successfully installing the new mesh catch bag is defined as the mesh catch bag no longer in contact with the ROV, and the ½-inch PVC framework of the mesh catch bag completely inside and resting on the PVC framework secured inside the Seabin.

Note that companies must remove the old mesh catch bag from the Seabin before installing the new one, but companies do not have to return the old mesh catch bag to the surface before installing the new one. For example, companies could remove the old mesh catch bag and hold it in a gripper or set it on the bottom. Companies could then install the new mesh catch bag. Then companies could return the old mesh catch bag to the surface, side of the pool.

Mesh catch bags will weigh less than 5 Newtons in water.

Once the new mesh catch bag has been installed, power must be restored to the Seabin. If the new mesh catch bag has not been installed, companies may not attempt to reconnect the power connector. Companies must reconnect the power by inserting the connector back into the power port. Companies that dropped the power connector to the bottom of the pool after disconnecting power may attempt to pick it up using the ROV or may use the rope to pull it to the surface by hand and reattach it to the ROV. Companies will receive 10 points for successfully installing their power connector into the power port. Successfully installing the power connector is defined as the power connector no longer in contact with the ROV and sitting within the 3-inch pipe of the power port.

Task 1.2 Remediation: Removing plastic pollution from top to bottom

Companies must remove floating plastic debris from the surface of the pool. Six ping-pong balls will be floating on the surface, contained within a 1 meter square ½-inch PVC framework. The framework will be attached to the side of the pool by a length of ½-inch PVC pipe to keep it from drifting. Companies must remove the ping-pong balls (plastic debris) from the surface and return them to the side of the pool. Companies that successfully remove all six ping-pong balls will receive 15 points. Companies that successfully remove only 3 to 5 ping-pong balls will receive 10 points. Companies that successfully remove only 1 or 2 ping-pong balls will receive 5 points. Successfully removing the plastics debris from the water is defined as the ping-pong balls being removed from the framework under control of the ROV and placed on the pool deck.

Each ping-pong ball will have less than 5 Newtons of buoyant force in water.

Companies must remove a ghost net from midwater. The net will be constructed from ½-inch PVC pipe and [decorative cloth netting](#) attached to the pipe with cable ties. The net will be located midwater in the pool. The net will be positively buoyant, and secured to a weight on the bottom by a rope. Companies must pull a pin to simulate cutting the rope and releasing the net from the weight on the bottom. Companies will receive 10 points when they successfully pull the pin. Successfully pulling the pin is defined as the pin no longer in contact with the PVC pipe or netting of the ghost net.

After pulling the pin, companies must return it to the surface. Companies will receive 5 points when they successfully return the pin to the surface. Successfully returning the pin to the surface is defined as the pin completely out of the water and placed on the pool deck.

Companies must also return the ghost net to the surface, side of the pool. Companies will receive 5 points when they successfully remove the ghost net from the water. Successfully removing the ghost net is defined as the PVC pipe and netting completely out of the water and placed on the pool deck. The weight and PVC pipe securing the net to the bottom do not need to be removed from the pool.

The ghost net will have less than 5 Newtons of buoyant force in water.

Companies must remove plastic debris from the bottom. The plastic debris on the bottom will consist of two 1-gallon plastic Ziploc bags. ½-inch PVC pipe inside the bag will provide weight to keep the bag from drifting. The PVC pipe will be secured to the inside of the Ziploc bag with industrial strength Velcro. A 50 cm length of rope will act as a grab point on each Ziploc bag. The Ziploc bag will be open at the top, allowing it to fill with water; it will not contain air bubbles. Companies must remove this plastic debris from the bottom and return it to the side of the pool. Companies will receive 5 points for each bag successfully removed from the water, 10 points total. Successfully removing the debris from the water is defined as placing it on the pool deck.

The Ziploc bag and PVC will weigh less than 5 Newtons in water.

TASK 2: THE CATASTROPHIC IMPACT OF CLIMATE CHANGE ON CORAL REEFS

This task involves the following steps:

2.1 Flying a transect line over a coral reef and mapping points of interest

- **Flying a transect line over a coral reef – 15 points**
- **Mapping points of interest on the reef – 5 points**

2.2 Determining the health of a coral colony by comparing its current condition to past data – 10 points

2.3 Propagating corals onto the reef

- **Removing coral fragments from the nursery structure – 5 points each, 10 points total**
- **Outplanting coral fragments to designated locations on the reef – 5 points each, 10 points total**

2.4 Culling an outbreak of Crown of Thorn sea stars – 5 points each, 10 points total

2.5 Collecting samples of sponge species for pharmaceutical research

- **Collecting a sample of the sponge – 5 points**
- **Returning the sample to the surface – 5 points**

Total points = 70 points

Product Demonstration Notes:

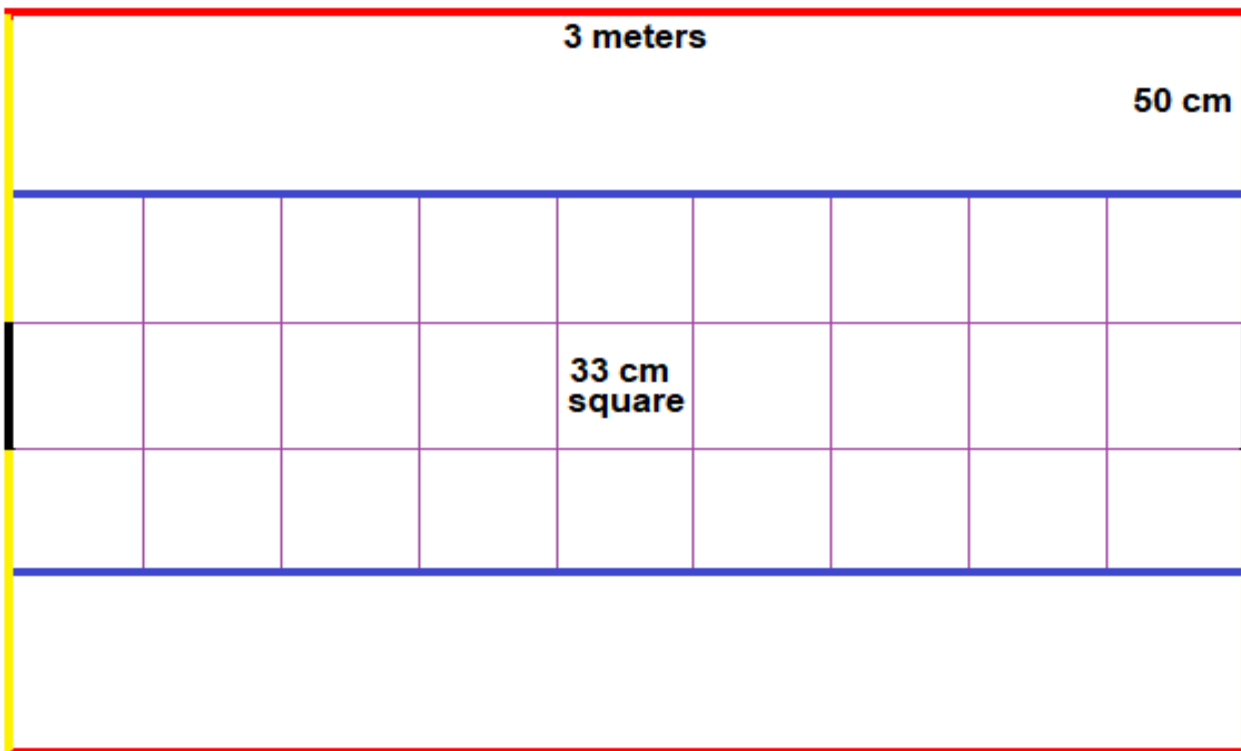
Companies may complete the steps of Task 2: The Catastrophic Impact of Climate Change on Coral Reefs in any order.

Task 2.1 Flying a transect line over a coral reef and mapping points of interest

Companies must fly a transect line over a coral reef. The coral reef will be simulated by a ½-inch PVC pipe rectangle 3 meters long by 1 meter wide. A grid of 27 squares, 33 cm per side, will be created within this rectangle using [Pink Braided Nylon Mason’s Line](#). The 3-meter lengths of PVC pipe that make up the “top” and “bottom” of the reef will be painted blue. The 1-meter “ends” of the coral reef will be divided into three 33 cm sections. The middle 33 cm section will be painted black, while the two outer sections will be painted yellow.

The 1-meter “ends” of the coral reef will be divided into three 33 cm sections. The middle 33 cm section will be painted black, while the two outer sections will be painted yellow.

An additional 3-meter length of PVC pipe will be located 50 cm from the top and bottom of the reef. These additional lengths of pipe will be painted red. The coral reef area will be located on the bottom of the pool.



A diagram of the coral reef. The blue, red, yellow, and black lines are painted 1/2-inch PVC pipes. The purple lines are braided Mason’s Line.

Companies must fly a transect line over the coral reef, displaying the video image of the transect on a display screen for the station judge. Successfully flying a transect over the coral reef is defined as starting at one end of the transect and moving to the other end of the transect. Starting at one end of the transect is defined as the ROV directly above the black length of PVC pipe on either end of the coral reef.

The ROV must also remain at a certain height over the reef during the transect. While flying the transect over the coral reef, both blue painted PVC pipes must be in the video display at all times and neither red line may be visible in the video display. If any section of red pipe is seen in the video display, or both blue pipes are not seen in the video display at all times, the ROV has failed to successfully fly the transect.

A video showing successful and unsuccessful flying of the transect line can be seen [here](#).

Companies may pilot their vehicle to move over the coral reef from one end to the other. Companies that successfully fly the transect line will receive 15 points. Successfully flying the transect line is defined as the vehicle, under control of the pilot, moving from one end of the transect to the other. The station judge must be able to see the vehicle moving through the water and must be able to see both blue PVC pipes but neither of the red pipes in the video display at all times during the flight of the transect. If the vehicle fails to fly the transect, companies may reposition their vehicle at one end of the coral reef, above a black painted length of PVC, and try again. Either end of the coral reef may be the starting point for the transect. There is no limit to how many times the company may try to fly the transect.

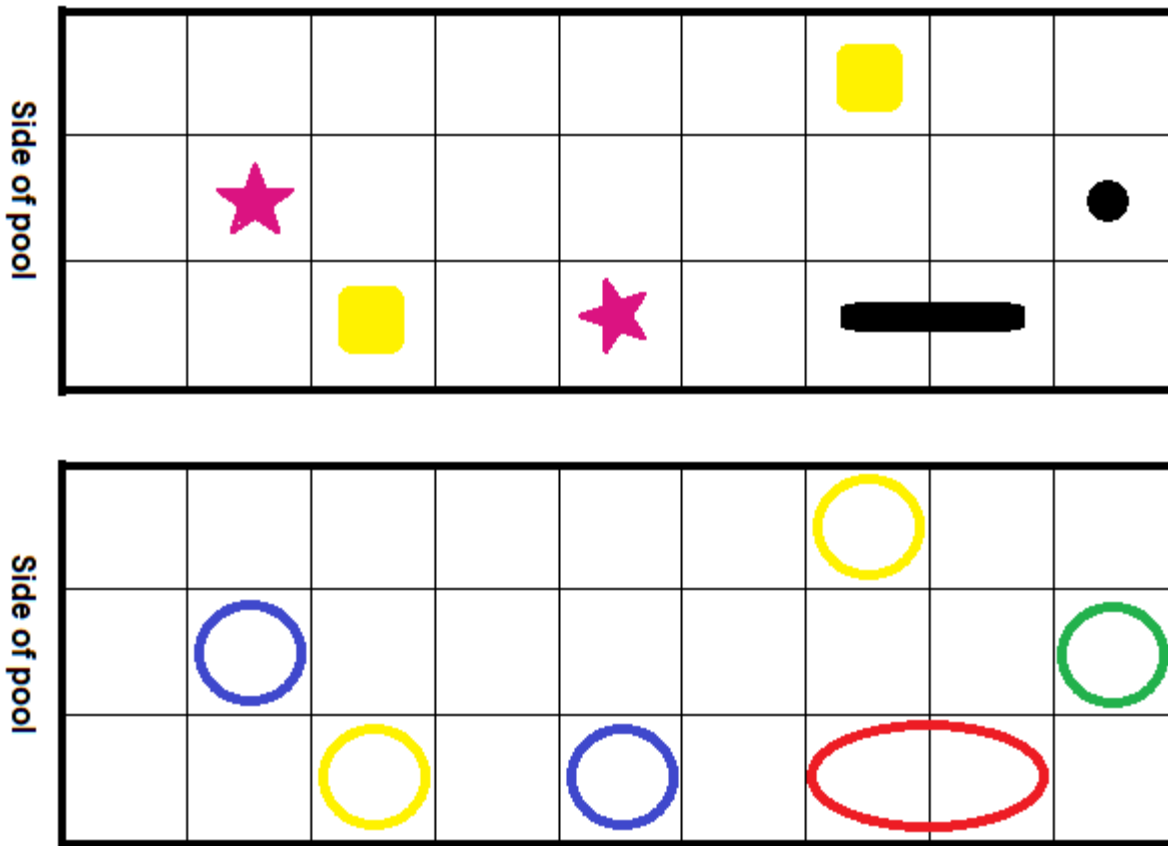
Companies must also map points of interest on the coral reef. There will be six points of interest located within the coral reef. These points of interest are related to the other steps of Task 2. Descriptions of the items will be detailed with those tasks. The six points of interest are:

- One larger coral colony (occupying two adjacent squares)
- Two designated areas for outplanting coral fragments
- Two crown of thorn sea stars
- One sponge

Companies must map the six points of interest. MATE will provide a blank map of the grid with 27 squares. The squares will be arranged in a nine x three grid copying the orientation of the coral reef grid in the pool. The grid map will contain a legend, detailing the colors for each point of interest. Companies must draw the appropriately colored or labeled circles into the proper squares for each point of interest (the larger coral will encompass two squares and each square should be marked). The two adjacent squares containing the larger coral colony should each be drawn with a red circle, or a circle with the letter C inside of it. Companies may use two circles or an oval (elongated circle) to mark the coral colony. The two squares containing designated areas for outplanting coral fragments should each be drawn with a yellow circle, or a circle with the letter F inside of it. The two squares containing the Crown of Thorn sea stars should each be drawn with a blue circle, or a circle with the letters COTS inside of it. The square containing the sponge should be drawn with a green circle, or a circle with the letter S inside of it. Colored markers or pencils may be provided, or companies may need to provide their own colored markers. Contact [your regional coordinator or visit your regional contest's website](#) to find out if colored markers will be available.

Alternatively, companies may use art programs such as Photoshop, MS Paint, or others to create the grid on a video screen before the competition. During the competition company members may overlay the proper colored or labeled circles over their pre-designed grid map.

Companies will receive 5 points for successfully mapping the location of the six points of interest. Successfully mapping the locations is defined as all circles overlaid in the proper grid squares. Companies may use two circles or one oval (elongated circle) to overlay the coral colony that occupies two squares. Companies must show their map to the station judge during the 15-minute demonstration period. Companies may explain the map's orientation to the station judge. Companies only receive one opportunity to create the map with all six points of interest. Companies that cannot successfully create the map with all six points of interest will not receive points for mapping.



Top: Reef with coral colony, two locations for outplanting coral fragments, two sea stars, and a sponge.
 Bottom: Colored circle overlays in the proper squares to match the organisms on the reef.

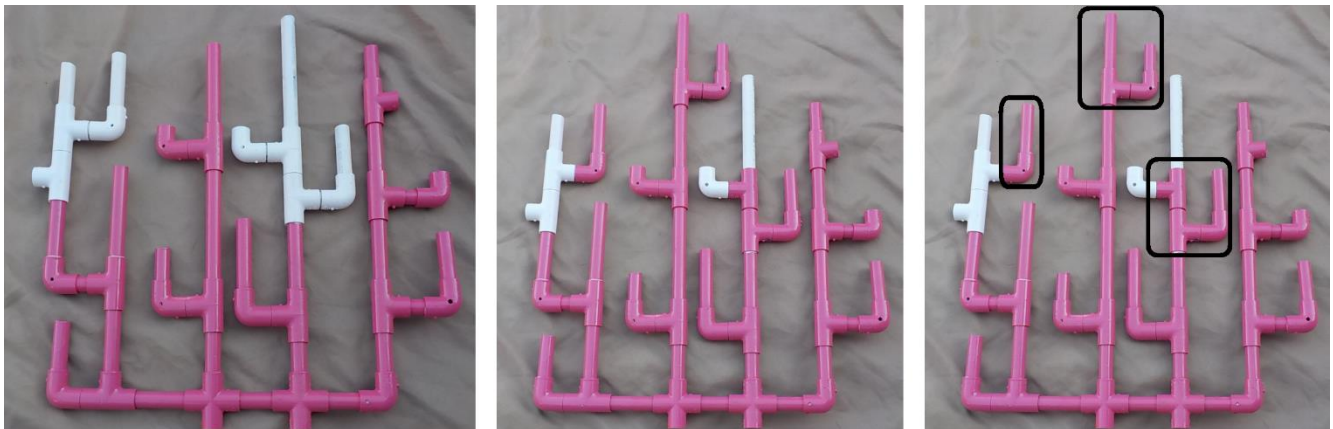
Task 2.2 Determining the health of a coral colony by comparing its current condition to past data

A large coral colony will be located in the reef. The coral colony will be constructed from ½-inch PVC pipe. The base of the coral will be located in two squares in the coral reef grid. Companies must determine the health of the coral colony by comparing the current image to an image taken one year ago. Companies must compare images to assess whether the coral has grown, is damaged/has died, is bleached/blotched, or has recovered from bleaching/blotching. Growth is defined as the coral colony having new pink branches not seen in the previous image. Damage or death is defined as the coral colony missing branches that were seen in the previous image. Coral bleaching or blotching is defined as pink colored branches from the previous photo

having turned white. Recovery from bleaching or blotching is defined as white branches from the previous photo now being colored pink.

Companies will receive 10 points when they successfully determine the health of the coral colony by comparing the current image to the image from one year ago. Successfully determining the health of the coral colony is defined as informing the station judge of all changes on the coral colony photo from one year prior and what type of changes have taken place. The company member informing the judge of the type of change should use the terms growth, death or damage, bleaching/blotching, or recovery from bleaching/blotching.

A “before” [photo of the coral colony](#) will be provided to all companies. This photo will represent the image of the coral colony from one year ago. Every coral colony will have two to four areas of change, but only one or two categories of change. For example, a coral colony may have two areas of growth, and one area of recovery from bleaching and blotching (three areas of change, but only two categories of change). Or a coral colony may have four instances of bleaching/blotching (4 areas of change, but only one category of change).



Left: The coral colony photo from 1 year prior.

Center: The coral colony as it is today.

Right: The coral colony with all areas of change identified. There is one area of growth, and two areas of recovery from bleaching/blotching.

Task 2.3 Propagating corals onto the reef

Companies must propagate corals onto the reef. Coral fragments will be constructed from ½-inch PVC pipe. A 3/8-inch-16, 3-inch bolt will be attached inside the ½-inch pipe of the coral fragment. Four coral fragments will be located on a nursery structure. The nursery structure will be constructed from ½-inch PVC pipe. The coral fragments will sit upright on the nursery structure, with the 3/8-inch bolt sitting loosely in an upright section of ½-inch pipe on the nursery structure. Companies must remove two coral fragments from the ½-inch pipe of the nursery structure. Companies will receive 5 points for each coral fragment successfully removed from the structure, 10 points maximum. Successfully removing a coral fragment from the nursery structure is defined as the ½-inch pipe and 3/8-inch bolt under control of the ROV and no longer in contact with the ½-inch pipe of the nursery structure. Companies will not get additional points for removing more than two coral fragments from the nursery structure.

Coral fragments will weigh less than 5 Newtons in water.

Once the coral fragments have been removed from the nursery structure, they must be outplanted onto the coral reef. Two designated areas will be located within the coral reef area. Designated areas will be constructed from a ½-inch PVC pipe framework covered with a yellow-colored corrugated plastic sheet. A section of 1-inch PVC pipe will rise vertically from the designated area. Companies must insert the coral fragment into the 1-inch PVC pipe. Companies will receive 5 points for successfully outplanting each coral fragment, 10 points total. Successfully outplanting a coral is defined as the 3/8-inch bolt of the coral fragment positioned inside the vertical 1-inch pipe and the PVC pipe of the coral fragment in contact with the vertical 1-inch pipe of the designated area. The coral fragment(s) must remain successfully outplanted into the designated area for the entire product demonstration run. If the coral fragment is displaced from the designated area at any time during the product demonstration run, the company will not receive points for successfully outplanting the coral fragment. If a coral fragment is displaced from the designated area, companies may attempt to outplant the coral fragment again. Companies may try outplanting the same coral fragment, or may retrieve a different coral fragment from the nursery structure and outplant that fragment.

Task 2.4 Culling an outbreak of Crown of Thorn sea stars

Companies must also cull an outbreak of Crown of Thorn sea stars. Two Crown of Thorn sea stars will be located in the coral reef area. Sea stars will be constructed from ½-inch PVC pipe. Sea stars are culled by injecting them with ox bile. For the purposes of the product demonstration, the ox bile injection will be simulated by a Velcro to Velcro stick. A 5 cm x 5 cm square of Velcro loops will be attached to the center of each sea star. Companies must attach an injection device of Velcro hooks to the Velcro loops on the Crown of Thorn sea stars.

The MATE ROV Competition will provide two injection devices of Velcro hooks at each product demonstration station. These devices provided by the competition will be a 4 cm x 4 cm square of Velcro hooks attached to a ½-inch end cap. The end cap will have a length of rope attached to it as a grab point. However, companies may construct and use their own sea star injection devices of Velcro hooks. Company created Velcro hook must not exceed 6 cm x 6 cm square, should be large enough for the judge to determine that it has been attached to the sea star, and should be black in color. The station judge must be able to see the Velcro hooks attached to the Velcro loops on the sea star. Any additional objects attached to the Velcro hooks should not obscure the judge's view of the Velcro connection.

Companies will receive 5 points when they successfully inject each Crown of Thorn sea star, 10 points total. Successfully injecting the Crown of Thorns sea star is defined as the Velcro hooks on the injection device attached to the Velcro loops on the sea star. The Velcro hooks must remain attached to the sea star for 10 seconds after being released by the ROV. If the hooks fall off the sea star, companies may try again.

Each MATE Competition injection device will weigh less than 5 Newtons in water.

Task 2.5 Collecting samples of sponge species for pharmaceutical research

Companies must also collect samples of sponge species for pharmaceutical research. The sponge will be constructed from three 2-inch couplings, with weight inside, stacked on top of each other. A length of green tape around the middle of each coupling will help it to stand out from the pool bottom. The top most coupling will have a 40 cm length of rope attached to the top of it as a grab loop. Companies are required to collect only the top most coupling. The remainder of the sponge, i.e., the bottom two couplings, must remain on the pool bottom and cannot be knocked over.

Companies will receive 5 points when the top coupling of the sponge is successfully removed from the stack. Successfully removing the top coupling is defined as the uppermost 2-inch coupling under control of the ROV and no longer in contact with the two couplings on the pool bottom. The two couplings on the pool bottom must remain stacked on top of each other for the entire product demonstration run. If at any time the remaining stack is knocked over, companies will not receive the points for collecting the sample of the sponge.

Once the sponge sample is collected, companies may return the sponge sample to the surface. Companies will receive 5 points when they successfully return the sponge sample to the surface, side of the pool. Companies that do not receive points for collecting the sponge due to knocking over the stack, may still receive points for returning the sample to the surface, side of the pool.

With weight, the sponge sample will weigh less than 5 Newtons in water.

Companies may not destroy or knock over any portion of the coral reef area. Companies that knock over the remaining portion of the sponge sample will not get points for collecting the sponge. Companies that displace coral fragments from the designated locations will not receive points unless those coral fragments are replaced before the product demonstration time expires. Companies that knock over the large coral colony, or drag it from its location on the reef, will be penalized 5 points. At the end of the product demonstration period, the station judge will examine the coral reef area to determine if any items have been disturbed or displaced. The station judge will confirm with the company whether points are removed or penalized due to disturbing or displacing objects in the coral reef area.

TASK 3: MAINTAINING HEALTHY WATERWAYS II: DELAWARE RIVER AND BAY

This task involves the following steps:

3.1 Retrieving a sediment sample from inside a drain pipe to analyze for contaminants

- **Returning a sediment samples to the surface –10 points**
- **Determining the two types of contaminants present in each sediment sample – 5 points each, 10 points total**

3.2 Estimating the number of mussels in a mussel bed

- **Deploying a quadrat and counting the number of mussels in the quadrat – 5 points**
- **Estimating the number of mussels and the total amount of water filtered by the mussel bed – 5 points**

3.3 Eel restoration

- Removing a trap full of eels from a designated area – 10 points
- Placing an empty eel trap in a designated area – 10 points

Total points = 50 points

Product Demonstration Notes:

Companies may complete the steps of Task 3: Maintaining Healthy Waterways II: Delaware River and Bay in any order.

Task 3.1 Retrieving a sediment sample from inside a drain pipe to analyze for contaminants

Companies will be required to retrieve a sediment sample from the bottom and determine the types of contaminants in the sample. The sediment sample will be constructed from 1 ½-inch PVC pipe with end caps on both sides. A length of rope will act as a grab point on the 1 ½-inch pipe. Companies will receive 10 points when they successfully collect the sample. Successful collection is defined as returning the water sample to the surface, side of the pool.

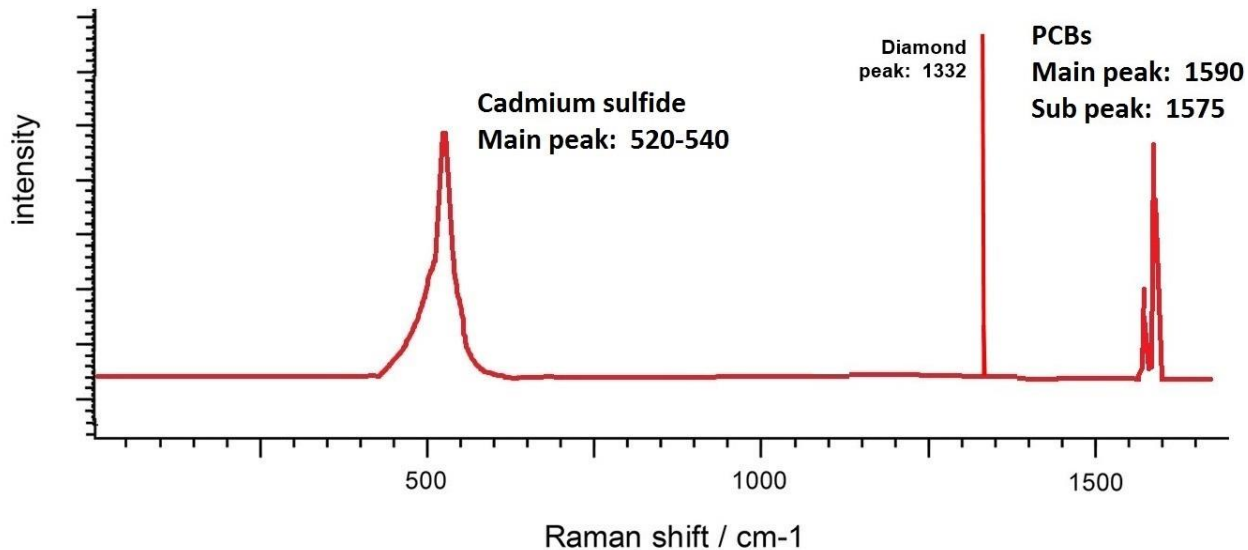
Once the sediment sample is at the surface, companies can retrieve the sediment’s Raman spectrum.* In this case, the spectrum will be printed on a laminated sheet and rolled up inside the 1 ½-inch pipe of the sediment sample. Companies must compare the sample’s spectrum to a chart of peaks and sub peaks of known chemical contaminants. A copy of the chart will be available at the product demonstration station. Companies must evaluate the spectrum and the chart to determine what type of contaminants are present in the sediment. Companies will receive 5 points for each contaminant successfully identified, 10 points total. Successfully determining the contaminants is defined as showing the station judge which chemical contaminants from the chart match the peaks and sub peaks of the spectrum retrieved in the sediment sample. The spectrum will contain peaks and sub peaks for two chemical contaminants.

*Note: Raman spectroscopy is commonly used in chemistry to determine the chemical composition of an object or substance. It can identify and quantify molecules and produce a chemical “fingerprint” of that object or substance. The chemical fingerprint, also known as the spectrum, is generated when the scattered Raman photons pass into a detector where they are broken into their respective wavelengths and plotted. For more information about Raman spectroscopy, see the REFERENCE section of the competition manual.

In Raman spectroscopy, diamonds are used as reference peaks in spectra from unknown sources. The spectrum will have a diamond spike for reference purposes. Diamond is not considered a contaminant.

<u>Chemical contaminant</u>	<u>Main Peak (cm⁻¹)</u>	<u>Sub Peak(s) (cm⁻¹)</u>
Arsenic Sulfide	385	420
Cadmium Sulfide	520 – 540	
Copper Oxide	297	
Diamond	1332	

Lead	1054	
Mercury	547	435
Polyflouroalkyl	1560 to 1580	1325
PCBs	1590	1575



Raman spectrum of sediment contaminated with CdS (520-540 cm⁻¹) and PCBs (1590 and 1575). Note the diamond peak (1332 cm⁻¹).

Task 3.2 Estimating the number of mussels in a mussel bed

Companies must estimate the number of mussels in a mussel bed. The area of the mussel bed will be constructed from a square of corrugated plastic approximately 1.2 m x 1.2 m attached to a PVC framework. The mussel bed will lay flat against the bottom of the pool. Small, painted plastic disks will simulate the mussels. Companies are required to create their own 0.5 meter x 0.5 meter quadrat and place it on mussel bed. The inner dimensions of the quadrat **MUST** be 50 cm x 50 cm square. Companies that do not have a quadrat within 1 cm of those dimensions will not be able to complete the task. All edges of the quadrat must be completely on the corrugated plastic of the mussel bed. No portion of the quadrat may rest over the side of the corrugated plastic sheet. Companies that do not successfully deploy their quadrat may try again, but once the quadrat is successfully placed, it should not be moved (i.e. repositioned to get a different mussel count). The quadrat, if separate from the ROV, must be carried down by the ROV. The company-built quadrat is not considered debris. Companies will not be penalized for leaving their quadrat in the pool at the end of mission time and, if asked, divers can retrieve the quadrat and return it to the company without penalty after the mission time ends.

Once the quadrat has been deployed, companies must count the number of mussels inside the quadrat. Companies must show the product demonstration station judge the quadrat and report the mussels within that quadrat. Companies should count every mussel that has any part of its "shell" inside the dimensions of the quadrat. For example, if only a small section of the plastic disk (mussel shell) shows inside the quadrat, it

still should be counted. Companies will receive 5 points when they successfully count the number of mussels inside the quadrat and inform the station judge of that number. Successfully counting the number of mussels in the quadrat is defined as counting the same number of mussels in the quadrat as the station judge.

Companies receive one chance to count the mussels; if the company count is incorrect (i.e., not the same as the judge's count), companies will receive 0 points for counting the mussels. If the count is incorrect, the mission station judge will inform the team they are incorrect and share the actual count of mussels in the quadrat.

When the company has counted the number of mussels within the quadrat, the station judge will provide the company with the dimensions of the mussel bed and the average filtration rate of the mussels. Companies should assume the mussel bed is rectangular. The dimensions given will be length and width (in meters) of the bed. Filtration rate of the mussels will be given in liters per hour. Companies must first use their mussel count and the area of the mussel bed to estimate the total number of mussels in the bed. Companies will receive 5 points for successfully estimating the number of mussels in the bed and the total amount of water filtered by the mussel bed every hour. A successful estimation of the number of mussels in the bed is defined as the total number of mussels being within 5 mussels of the actual count. A successful calculation of the total amount of water filtered by the mussel bed is defined as the total amount within 5 liters of the actual amount. Companies must report their total number to the station judge.

For example, if the overall size of the mussel bed is 43 meters by 8 meters, and the company counted 7 mussels in their 50 cm x 50 cm quadrat, the total number of mussels in the bed is 9,632. If the filtration rate of a single mussel is 0.97 liters per hour, the total amount of water filtered by the mussel bed in one hour is 9,343.04 liters.

Task 3.3 Eel restoration

Companies must remove a trap full of eels and replace it with an empty trap to aid in eel restoration. Both eel traps will be identical. The framework for the eel trap will be constructed from ½-inch PVC pipe. Plastic mesh will surround the framework. A #310 U-bolt will act as a grab point for the eel trap. At the start of the product demonstration run, a trap with eels in it will be located in a designated area on the pool bottom. Another, empty trap will be located on the surface, side of the pool.

Eels will be simulated by 1-inch PVC pipe. The designated area will be constructed from ½-inch PVC pipe.

Companies must remove the trap full of eels from the bottom and return it to the surface, side of the pool. Companies will receive 10 points for successfully removing the trap. Successfully removing the trap full of eels is defined as removing the trap from the water and placing it on the pool deck.

Companies must place the empty eel trap in the designated area on the bottom. Companies will receive 10 points for successfully placing the trap in the designated area. Successfully placing the trap is defined as the trap no longer in contact with the ROV, upright, and completely within the designated area. No portion of the trap may be sitting on top of any part of the designated area.

Both the full and the empty eel trap will weigh less than 5 Newtons in water.

Time bonus:

If a company has successfully completed all product demonstration tasks and is returning to the surface with the Seabin mesh catch bag, plastic debris, the pin, the ghost net, sponges, or the full eel trap, the product demonstration time will stop when a member of the company touches the vehicle. These items may be detached and set on the pool deck after the clock has stopped. If any of these items is subsequently dropped from the vehicle and sink to the bottom, the company will not receive points for returning the item to the surface, time will not restart, and the company will not receive a time bonus. Contact [your regional coordinator or visit your regional contest's website](#) for information about how time bonuses will be calculated.

PRODUCT DEMONSTRATION RESOURCES

The [NAVIGATOR coral reef map](#) will show the nine x three grid of squares of the coral reef.

The [NAVIGATOR Coral Colony photo](#) will show an image of the coral colony taken one year prior.

The [NAVIGATOR Raman spectrum chart](#) notes the peaks and sub-peaks of various chemical contaminants.

NOTE for 2021!!!

PRODUCT DEMONSTRATION RESPONSIBILITIES

Companies are responsible for providing their own quadrat for counting mussels. The MATE ROV Competition will provide sea star injection devices, but companies may design and bring their own versions. Companies must also design and bring any tools or devices to complete the required MATE product demonstration tasks.

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

Companies are allowed to create a collection basket to collect multiple product demonstration items. Any collection basket MUST be included in size & 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 can be deployed by either the ROV or by lowering it into the pool, but it must be returned by the ROV; it may not be pulled to the surface by hand or a surface device.

PART 2: PRODUCT DEMONSTRATION PROP BUILDING INSTRUCTIONS & PHOTOS

The [Product Demonstration Prop Building Instructions & Photos](#) have been made their own, separate document. This document will be released with, but separate from, this competition manual.

PART 3: VEHICLE DESIGN & BUILDING SPECIFICATIONS

1.0 GENERAL

Questions about vehicle design and building specifications, as well as competition rules, should be posted to Competition Help within the MATE Forum Hub (<http://forums.marinetech2.org/>). This ensures that all companies can view the questions and answers and helps to avoid duplicate questions. That said, companies should make sure that their questions have not already been asked – and answered – before posting. When posting their question, companies should reference the specific specification (e.g. ELEC-002N).

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.

[Your regional coordinator or your regional contest's website](#) will inform you of any specific requirements or changes for your regional.

2.0 SAFETY

Safety is the competition's primary concern and guiding principle. Any system that is considered unsafe by competition officials will not be allowed to compete. If a concern is found during the first safety inspection, companies are permitted to attempt to correct it and have their ROV re-inspected. However, the competition schedule will NOT change to allow companies more time. Companies are allowed 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 your ROV has been disqualified.

Examples of safety violations from previous ROV competitions include:

- The ROV does not use Anderson Powerpole connectors to attach to main power.
- No SID was provided at the safety check.
- The ROV does not have a main fuse.
- The SID did not show a main fuse.
- The ROV used pneumatics, but the technical documentation did not include a pneumatics diagram.
- Sharp items, or potentially sharp items, (fishing hooks, glass bottles, Mercury thermometers) were included on the vehicle.
- The vehicle motors were not waterproofed.
- Propellers were not protected inside the framework or were not shrouded.

2.1 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 revealedcompanies will have ONE additional opportunity to address the issue.
5. If during the third safety review a violation still exists, 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, product 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.

Your regional competition may use a system other than a Blue PASSED Card, but all companies must pass a safety inspection before entering the water. Contact [your regional coordinator or visit your regional contest's website](#) to determine if a Blue PASSED Card or another system will be used for safety verification.

2.1.1 System Interconnection Diagram (SID)

To pass the safety inspection, companies must provide a system interconnection diagram (SID) of their vehicle control system. An SID is an electrical diagram of their wiring, including their control box, motors, and any other electrical systems on their vehicle. The SID should separate and show what systems are on the surface and what systems are on the vehicle. The SID must not exceed one page in length. **The diagram MUST show an ROV system fuse. SIDs that do not show a fuse, utilizing an ANSI, NEMA or IEC symbol, with the size of the fuse marked, will not pass their safety check.**

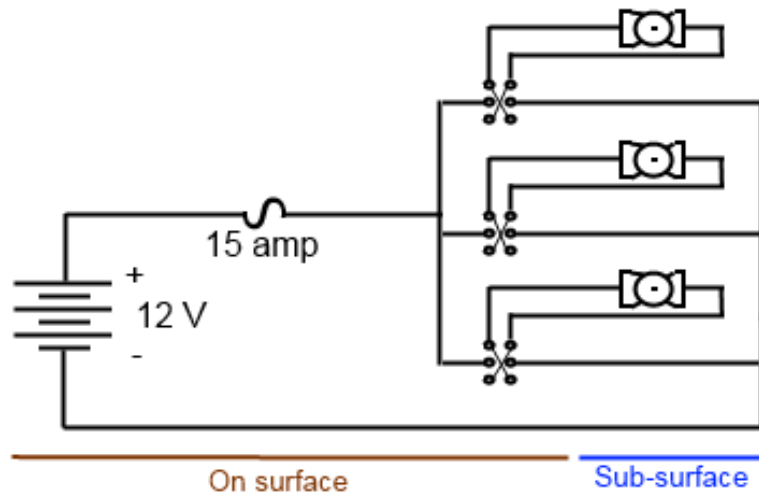


Diagram: An example of an acceptable SID.

Companies should create their own SID. Do not simply copy the above SID, or another SID produced by MATE. SIDs help to understand how electricity flows through your system and will provide a better understanding of ROV operations.

DOC-004: Any electrical diagram should use ANSI, NEMA, or IEC symbols as often as possible; it is required for the fuse. They should be neatly hand drawn or created using a CAD software program.

Item	ANSI	IEC
FUSE		

ANSI: American National Standards Institute

IEC: International Electrotechnical Commission

NEMA: National Electrical Manufacturers Association

Note: Companies that do not hand draw their SID may use free drawing software such as MS Paint or [OpenOffice](#) to create their diagrams.

2.2 Safety Inspection Completed

Companies must complete their safety inspection before entering the water for practice or a product demonstration run on the day of the competition.

3.0 SPECIFICATIONS

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

3.1 Operational

3.1.1 Multiple Vehicles

OPER-001: MULTIPLE VEHICLES ARE NOT PERMITTED. 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: No water currents will be intentionally created. However, depending on the venue, pressurized pool filtration system outlets may cause unexpected currents.

Contact [your regional coordinator or visit your regional contest’s website](#) to learn more about the environmental operating conditions of the competition pool. Some pools may have sloping bottoms or other features that could affect your ROV’s performance.

3.1.3 Service Requirement

OPER-005: Companies shall provide a product demonstration team of at least 3 but no more than 4 people to operate the ROV on the pool deck. Companies may have more than 4 people, but only 4 company members are allowed on the pool deck to operate the vehicle.

3.1.4 Maintenance and Calibration Requirement

OPER-006: 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](#).

OPER-007: All measurement devices shall be calibrated according to manufacturer recommended calibration procedures 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](#).

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: Any electronics housings on the ROV shall be capable of operating to depths of 4 meters.

3.2.2 Size

MECH-002: ROVs are not limited to a maximum size, but 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 smaller, lighter vehicles (see [size restrictions](#)).

3.2.3 Tether Length

MECH-003N: ROVs must be capable of operating in a maximum pool depth of 4 meters (13 feet). All underwater product demonstration 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.

Note: Many NAVIGATOR class competitions are held in water less than 4 meters deep. Contact [your regional coordinator or visit your regional contest's website](#) to determine the maximum depth of the NAVIGATOR competition.

3.2.4 Vehicle Deployment and Recovery

MECH-004N: The product demonstration team (up to 4 people) must be able to carry the entire vehicle by hand. The crew must be able to hand launch and recover the ROV. No lifts or levers may be used to launch the ROV.

3.2.5 Propellers

MECH-005N: Propellers must be enclosed inside the frame of the ROV or shrouded. Companies that have propellers protruding outside of their frame will not pass the safety inspection and will not be allowed to compete.

3.3. Electrical

ELEC-001N: All power provided to your ROV system must be obtained from the MATE competition power supply. This is a singular point of connection; all power to your ROV must pass through the MATE-provided fuse on the supply AND the single fuse in your wiring.

ELEC-002N: MATE will provide a nominal 12 volt power source at the product demonstration station. This power source may be a battery or a power supply. Nominal voltage may be as high as 14.8 volts.

ELEC-003N: Voltage may never be increased above the nominal 12 volts anywhere in the ROV system.

3.3.1 Current

ELEC-004N: ROVs will be limited to 15 amps.

The ROV **MUST** have a 15A maximum fuse in the positive power supply line within 30 cm of the positive Anderson Powerpole connector. The SID must show this fuse, using a proper fuse symbol, and include the amperage rating of the fuse.

NOTE for 2021!!!

ELEC-005N: ROV systems are allowed only one replacement fuse during the product demonstration run. In the event that the ROV system blows the second fuse during the product demonstration, time will stop, the product demonstration run will be over, and no additional points will be earned. Note: Companies must provide their own replacement fuses. MATE will not provide replacement fuses.

3.3.2 Power Connections

ELEC-006N:

The MATE Center requires that all ROVs use Anderson Powerpole connections

(<https://seamate.org/collections/power-related-products/products/seamate-angelfish-pufferfish-power-kit-with-powerpole-connectors>, <https://powerwerx.com/anderson-powerpole-connectors-30amp-bonded>).

Power supply connections at all regional competitions will be red/black Anderson Powerpole Connectors.

Anderson Powerpole connections are two-piece connectors as shown in the picture below.



NOTE for 2021!!!

The red and black Powerpole pieces must be attached together. Loose Powerpoles (those not attached together) will not pass safety inspection.

Part specification and part numbers

Anderson Powerpole – red and black connector with 30 amp contacts

Red is connected to power supply positive.

Black is connected to power supply negative.

Since Anderson sells the connectors in 2500 and 200 piece quantities, these connectors are available from distributors.

Powerpole Assembly Instructions

<http://www.powerwerx.com/assembly.asp>

<http://www.wb3w.net/powerpoleinst.htm> (see the section on using the TriCrimp tool)

YouTube video for Assembly

Part 1: https://www.youtube.com/watch?v=8_DPPuQN8R4

Part 2: <https://www.youtube.com/watch?v=EsSsr2zGFqI>

ELEC-007N: The power supply may be located up to 2 meters 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.

3.3.3 Tether Voltages

The signals in the tether must meet the following specifications:

ELEC-008N: 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 500 mA.

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 or circuit breaker.

ELEC-009N: DC main-supply at a nominal voltage of 12VDC as provided by the MATE power supply.

ELEC-010N: Ethernet, USB, or other ANSI or IEC accepted serial protocol signals.

NOTE for 2021!!!

All cameras, including USB cameras, **MUST** be powered by the MATE supply. Power 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 directly plugged into laptops or surface computers are not allowed.

ELEC-011N: NTSC or PAL Video signals

ELEC-012N: Fiber optic cabling of any type may be used.

3.3.4 Exposed connections and disposable motors

ELEC-013N: All electrical components going into the water must be waterproofed. ROVs with electrical connections that are exposed to the water and not sealed will not be permitted to enter the pool. Disposable motors (motors with no waterproofing) are not permitted. Taping a connection with only electrical tape 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 enclosing the connection inside a housing.

ELEC-014N: “Disposable motors” are not permitted; these are exposed motors with no waterproofing.

3.4 Onboard Electrical Power

ELEC-015N: Onboard electrical power (i.e., power not provided by the tether): Onboard battery powered devices are NOT allowed under any circumstance.

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. For this reason, onboard batteries are NOT allowed under any circumstance. Any device that needs power must obtain that power directly from the ROV tether. For devices that operate at a voltage other than the tether voltage, an onboard ROV converter may be included. The converter must be sealed and not exposed to water. This rule includes commercial “watertight” battery containers; no battery of any type is permitted on any competition vehicle.*

3.5 Power Shutdown

ELEC-016N: 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

NOTE for 2021!!!

Companies may choose to use powered air compressors or hydraulic pumps that meet MATE's fluid power safety standards. Companies using compressors or electrically powered air pumps must take and pass the 3.6.7 FLUID POWER QUIZ and meet all the safety standards in the fluid power section. Companies may still use manually powered pumps as well. Companies using manually powered pumps do not need to take the fluid power quiz, but must still comply with all the MATE fluid power safety rules.

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-002: Hydraulic fluid: Water or biodegradable food-grade fluid, only.

FLUID-003: If a biodegradable food-grade fluid is used, a Material Safety Data Sheet (MSDS) must be provided at the safety inspection. The MSDS must show the type of fluid used and its compatibility with the Biodegradable Food-Grade specification. Companies using water do not need to provide an MSDS.

FLUID-004: The following fluids are approved for use in hydraulic systems:

- a. Water
- b. Biodegradable Food-Grade Hydraulic Oil ISO Grade 32/46, SAE Grade 20, McMaster-Carr part# 3499K22

All other biodegradable food-grade fluids must be approved by the [Competition Technical Manager](#) by April 1, 2021.

FLUID-005: Maximum Hydraulic pressure allowed: 10.33 bars (150 psig).

NOTE for 2021!!!

FLUID-006: Hydraulic system: All lines, fittings, and hydraulic devices must be rated for a minimum pressure of two (2) times the maximum supply pressure.

FLUID-007: Hydraulic pumps must be part of the safety inspection.

1. They must have a pressure relief valve with a maximum setting of 300 psig or less installed before the pressure regulator.
2. The pump must have a regulator in place and set to 150 psig or less.
3. Pumps with any sign of external rust or deterioration will not be accepted.
5. All wiring must be secure.
6. All guards must be in place.

7. 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.

3.6.2 Pneumatic Power

FLUID-008: Pneumatic fluid: Compressed air or inert gas only

FLUID-009: Maximum pressure allowed: 2.75 bars (40 psig)

NOTE for 2021!!!

FLUID-010: 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).

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-011: Air compressors must be part of the safety inspection.

1. They must have a pressure relief valve installed before the pressure regulator.
2. The compressor must have a regulator in place and set to 40 psig or 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 15 A 115 VAC 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.

3.6.3 Pressurized Cylinders

FLUID-012: Pressurized cylinders may be used, but must remain above the water surface and meet the following specifications:

- a. Approved by US DOT (Department of Transportation) or TC (Transport Canada). For regional competitions taking place outside of the US, check with your regional coordinator for approval.
- b. Have a current official inspection/test sticker and/or stamp.
- c. Stamped with the maximum allowable pressure.
- d. Contain a pressure relief safety device.
- e. May be filled up to the maximum allowable pressure of the cylinder.
- f. Must be regulated at its output to a maximum of 2.75 bar (40 psig).
- g. Must have an easily accessible shut-off valve that is clearly marked with instructions.
- h. May only be stationed on the surface, not on the ROV.

- i. Must be secured in a safe manner such that they will not fall or roll around. If the judges feel that a cylinder is unsafe, they have the discretion to prevent its use.
- j. SCUBA tanks are permitted. They must meet all the above specifications and have a current visual inspection sticker, or “fill permit” visible.

NOTE for 2021!!!

Electronic housings and other enclosures on the ROV must operate at surface pressure. Companies may not pressurize their electronics housing.

3.6.4 Unpressurized Containers

FLUID-013: Companies may fill containers on the ROV with air provided those containers never exceed ambient pressure. Any such container should have at least one ¼-inch (6.35 mm) hole drilled into the bottom of the container to allow excess air to spill out.

3.6.5 Pressure Storage Devices (Pressure Accumulators)

FLUID-014: Pressure storage devices are allowed on the ROV if they do not exceed 1.25 L in total storage and do not store pressure higher than the allowed pressure for air or hydraulics. It is understood that companies 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 permitted.

3.6.7 FLUID POWER QUIZ

FLUID-015: RANGER 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 March 15th, 2021. NO EXCEPTIONS OR EXTENSIONS!

Companies will be able to purchase and take the fluid power quiz beginning December 1st. The [fluid power quiz may be purchased here](#). Note that if registration for your regional competition opens after the fluid power closing date, you must still take the quiz before March 15th. 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!**

FEE TO TAKE THE FLUID POWER QUIZ! The fee to take the fluid power quiz is \$25 for five attempts (no discounts for fewer attempts). Companies will receive immediate access to the fluid power quiz once it is purchased. The link will be included in their receipt.

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 & Fabrication, published by the MATE Center and MATE Inspiration for Innovation – (see www.marinetech.org/underwater_robotics)
- <https://www.nfpa.com/home/About-NFPA/What-is-Fluid-Power.htm>
- <https://www.quincycompressor.com/tips-for-working-safely-with-compressed-air/>
- Parker Hannifin Corporation – <http://www.parker.com/> (look for technical literature links)

3.7 Control Systems

ELEC-017N: NAVIGATOR companies are not limited to the type of control system they may use provided it complies with the other MATE design and safety specifications.

ELEC-018N: Surface control stations must be built in a neat and workmanship like manner. Loose components and unsecured wires will not pass safety inspection.

ELEC-019N: Surface control stations by nature may combine 120 VAC and 12 VDC wiring. The surface control stations must be wired in a manner such that the 120 VAC wiring is physically separated from the DC wiring, the 120 VAC 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 120 VAC 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 the 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-020N: 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.

3.8 Cameras and monitors

CAM-001N: Companies are limited to ONE video display screen. This display screen may be powered by the MATE provided GFI-protected 115-Volt AC (60-cycle) and 15-amp AC power source described in CAM-002, Surface power.

CAM-002: 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 the video monitor. This AC power source CANNOT be used to directly or indirectly power the vehicle.

3.8.1 MATE Provided Equipment

MATE will not provide monitors at NAVIGATOR product demonstration stations this year. Companies are responsible for providing their own video monitor.

3.9. Lasers

NAVIGATOR class companies may NOT use lasers on their vehicle

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 (international 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 offered by the MATE Center 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 product 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. . Contact [your regional coordinator](#) at least four weeks before the competition if you know you have a scheduling concern.
- Companies must complete their size measurements before each product demonstration run. The size measurements are included as part of the product demonstration score. Companies should be at the size in area at least 15 to 20 minutes before their scheduled product demonstration run. Regional competitions may not require size measurements or may change the size measurement process. Contact [your regional coordinator or visit your regional contest's website](#) for more information on the size process and scoring.
- 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 four students.** The demo team is defined as the team of students who operate the vehicle and its associated equipment during the product demonstration. The product demonstration is held at a "product demonstration station." Only four 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. If a regional offers two product demonstration attempts, **companies may alternate students on the demo team for the two product demonstrations. See below for additional information about the number of attempts.** (All members of the company should participate in the engineering and communication components; see [ENGINEERING & COMMUNICATION](#) for more information.)
- 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 following 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 following 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.
- 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.
- Companies will compete in ONE product demonstration that consists of three distinct tasks. Companies may get up to **TWO** attempts to complete each product demonstrations. If that is the case, 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**.

Note: Regional contests may or may NOT offer companies two attempts at the product demonstration tasks. In addition, the product demonstration time frames for set-up, performance period, and demobilization may be different at your regional contest. Contact [your regional coordinator or visit your regional contest's website](#) for more information.

- 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.
- If your vehicle is completely disabled and/or its tether tangled and unable to free itself from the underwater environment, SCUBA divers can be called in to assist. However, the product demonstration time will NOT stop and **5** points will be deducted from the final product demonstration score.

Diver assistance may not be available at your regional competition. Contact [your regional coordinator or visit your regional contest's website](#) to determine if diver assistance will be available at your regional competition.

- 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. 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 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.

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 [VEHICLE DESIGN & BUILDING SPECIFICATIONS](#) for additional information.
- **ROV MOTORS MUST BE WATERPROOFED!** No exceptions. You may use already waterproofed motors (bilge pump motors, etc.) or you may choose to waterproof small electrical motors.
- Propellers must be enclosed inside the frame of the ROV or shrouded. **Companies that have propellers protruding outside of their frame will not pass the safety inspection and will not be allowed to compete.**
- 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.

- Safety must also be a priority when operating your ROV poolside. Keep an eye out for tripping hazards. Make sure that your connections to the battery or power supply are not lying in pools of water on the deck. During your product demonstration, be sure to secure any equipment so that it does not fall, 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.

- **Closed-toed shoes are required on the pool deck and anytime you are working on your ROV.** Safety glasses or goggles should be worn when working on your ROV.
- Personal flotation devices (PFDs) may be required when launching and recovering your vehicles. Contact [your regional coordinator or visit your regional contest's website](#) to determine whether this is a requirement at your regional event. If PFDs are required, they will be provided by the regional coordinator.

PART 5: ENGINEERING & COMMUNICATION

NOTE for 2021!!!

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 four engineering and communication components:

- Company spec sheet
- Technical (written) documentation (Examples of spec sheets and technical documentation from previous competitions can be found at <http://www.materovcompetition.org/archiveshome>.)
- Engineering (oral) presentation (Examples of engineering presentations can be found on [MATE's Vimeo channel](#).)
- Marketing display

NOTE: Regional contests may not require all four of the Engineering & Communications components. Contact [your regional coordinator or visit your regional contest's website](#) for more information.

See the [TIPS FOR EFFECTIVE WRITTEN AND ORAL COMMUNICATION](#) for additional information.

NOTE for 2021!!!

Your company should refer directly to the scoring rubrics posted under [Scoring](#) for details on what is required for your technical documentation, engineering presentation, and marketing display. 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, innovations (“hacks, tips, and tricks”), and include a profile of your company and staff. You should consider this document a reference for both judges and future team members (part of the company’s institutional knowledge).

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

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, 2021. In the meantime, companies may refer to the previous year's rubrics posted [here](#) 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 their team. The presentation should be delivered as a "technical brief." The presentation is the opportunity your company has to 1) communicate directly and in person your critical thinking, creativity, and engineering reasoning and 2) demonstrate your individual and collaborative contributions to the creation of the vehicle.

During the competition, your company will have 10 to 15 minutes deliver your presentation to a panel of working professionals – individuals who represent science, exploration, government, and industry. After the presentation, the judges will take 10-15 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 (50 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 the presentation and 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 able to answer a specific question, the others may pass 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, 2021. In the meantime, companies may refer to the previous year's rubrics posted [here](#) 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.
- Encourage each member of your company to keep a project notebook. Before the competition, set up a time where you compare notebooks. One member might have written more information about your ROV's electrical system, while another might have included details about buoyancy that others forgot. This exercise will help to refresh everyone's memory about the design and building process. If your company submitted technical documentation, make sure that all company members have read it and are familiar with it. 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 5-10 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 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.

Each company will have a space approximately 3-feet x 3-feet for its display. Depending on your regional, tables may or may not be provided. Contact [your regional coordinator or visit your regional contest's website](#) for more information.

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, 2021. In the meantime, companies may refer to the previous year's rubrics posted [here](#) for a general idea of the categories and points.

Creating an effective marketing display:

- Address the theme and make real-world connections.
- 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 10 points for "corporate responsibility."

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

- **Mentoring** 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.
- **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 districts board of directors are other examples.
- **Media outreach** consists of:
 - o Developing a list local media contacts
 - o Writing a press release about your participation in the MATE ROV competition
 - o Distributing it to your media contacts
 - o Following up with your media contacts to see if they're interested in your company and its ROV
 - o Compiling a summary of results

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.

- **Raising awareness of environmental, social, and governance (ESG) issues. Just look at this year's theme and product demonstration tasks for ideas – from removing plastic pollution from our oceans to assessing the health of ecosystems impacted by climate change and creating habitats to promote species diversity.**
- Corporate responsibility efforts will be reviewed by competition coordinators and awarded 0 to 10 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. mentoring, exhibiting at a community event, raising awareness)
- 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
- 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.

TIPS FOR EFFECTIVE WRITTEN AND ORAL COMMUNICATION

Communicating ideas about how to solve a problem and evaluating those ideas against alternative ideas 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 have a say in 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 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 information 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 important 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 in a concise way, which helps give readers 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 design and building 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 process did you use to evaluate different design solutions?
- What were the most important design decisions you made and why?
- How did you arrive at your final power budget? What trade-offs, 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 major troubleshooting experience? Any problem or procedure that takes more than 20 minutes to figure out is worth understanding and writing down.

PART 6: DOCUMENTATION

Companies are required to submit a system interconnection diagram (SID) of their vehicle control system. Your regional may also require you to submit technical documentation and a company spec sheet.

Contact [your regional coordinator or visit your regional contest's website](#) to determine what documentation must be submitted for your regional and the date it is due.

DOC-001: Technical documentation: A technical document or engineering notebook about your vehicle that will be reviewed by a panel of judges. See the [technical documentation](#) section for more information on the contents required for the technical documentation.

DOC-002: Company spec sheet: A one page document that provides a snapshot of your company and ROV. See the [company spec sheet](#) section for more information on the requirement for the company spec sheet.

DOC-003: SID Electrical: Companies must provide a [system interconnection diagram \(SID\)](#) of their vehicle control system during their safety inspection.

DOC-004: Fluid power SID: Companies using fluid power (hydraulics or pneumatics) must provide a fluid power diagram. The diagram should separate and show what systems are on the surface and what systems are on the vehicle. A fluid power SID for simple syringe hydraulics would consist of a syringe box on the surface connecting to a syringe box on the vehicle.

The fluid power SID can be incorporated into the Electrical SID or can be a separate, one page document.

DOC-005: Documents may be due before the competition or the day of the competition. Regardless, companies MUST bring a SID of their ROV systems in order to pass the safety inspection!

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