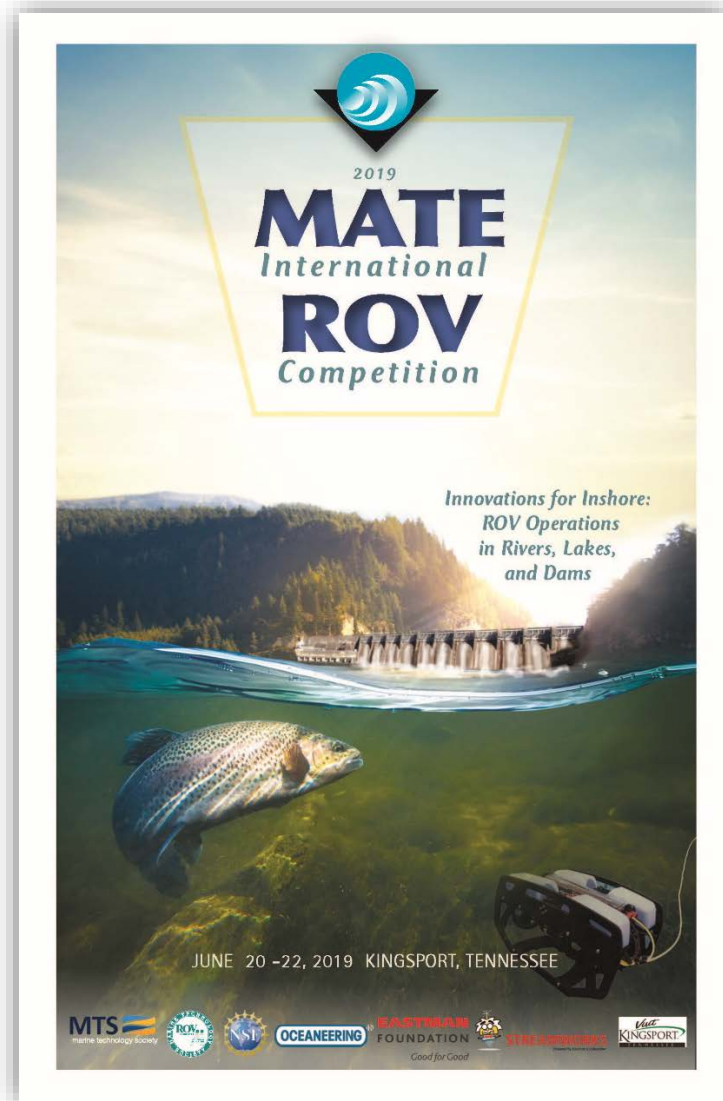


## 2019 MATE ROV COMPETITION: PRODUCT DEMONSTRATION AND SPECS BRIEFING



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## 2019 MATE ROV COMPETITION: PRODUCT DEMONSTRATION AND SPECS BRIEFING

### *MATE Competition Philosophy*

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

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

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

### ***Innovations for Inshore: ROV Operations in Rivers, Lakes, and Dams***

#### **CONTEXT**

Eastern Tennessee, USA, is probably best known for the Great Smoky Mountains (including the national park that bears their name), the cities of Gatlinburg (gateway to the park) and Pigeon Forge (home of Dollywood), and the University of Tennessee (go Volunteers!). Just northeast of these landmarks and attractions lies the city of Kingsport. Less than 5 miles from the Virginia border, Kingsport is home to Bays Mountain Park and Planetarium, the annual summer Fun Fest, and the Exchange Place Living History Farm, where, before it became a plantation and stagecoach horse “exchange” station, Daniel Boone, traveling along the Wilderness Trail, killed a bear and recorded the incident on a beech tree.



*D. Boone killed a bear on this tree 1775.*

In addition to hiking miles of mountain trails with picturesque views, Kingsport residents and visitors can walk, run, or bike along the South Fork Holston River. Like the Exchange Place, the river also has a place in history. On December 13, 1864, the Civil War Battle of Kingsport took place on its banks. Three hundred Confederate soldiers held off a much larger force of 5,500 Union soldiers for two days before surrendering.

Recreational opportunities as well as community events also abound at nearby Boone Lake, a reservoir formed by the impoundment of the South Fork Holston River behind Boone Dam. Swimming, boating, water skiing, and fishing are popular activities on the lake. Each year the Boone Lake Association, one of

the oldest environmental groups in the state of Tennessee, organizes the Boone Lake Clean-Up, where the local community helps to rid the lake of trash and debris, including old tires, tree limbs, and lumber.

Boone Dam has also gotten its share of community attention. Owned and operated by the Tennessee Valley Authority (TVA), this hydroelectric dam was built in the early 1950s as part of greater efforts to control flooding in the Tennessee River watershed. In October 2014, a sinkhole was discovered near the base of the embankment, and water and sediment were found seeping from the riverbank below. While sinkholes are not uncommon in Eastern Tennessee, the locations of the sinkhole and the muddy discharge were indicators of potential issues with the safety of the dam. The TVA immediately began an inspection of the dam and continues to work on repairs and remediation to this day, with regular updates on the “Boone Dam Project” going out to the community.

Along with plenty of opportunities to enjoy the outdoors, discover (or rediscover) American history, and become involved in the community, Kingsport can lay claim to the corporate headquarters of a world-renowned Fortune 300 company. Eastman is a global specialty chemical company that produces a broad range of advanced materials, additives and functional products, specialty chemicals, and fibers that are found in products people use every day. As a world leader in the diverse markets it serves, Eastman is focused on delivering innovative and technology-based solutions while maintaining its commitment to safety and sustainability.

Eastman believes a truly sustainable company is one that creates significantly more value in the world than the resources it uses. Whether it's through developing more efficient products and bringing innovative solutions to customers, collaborating with world-class scientific institutions to help solve significant global challenges, or working with community partners to have a positive impact, Eastman is committed to enhancing the quality of life in a material way.

## **NEED**

This year, Eastman is collaborating with the MATE ROV Competition and looking to its competitors to assist the company in doing “Good for Good.” Eastman has issued a request for proposals (RFP) for a remotely operated vehicle (ROV) and crew that can operate in the freshwater environments of Boone Lake, Boone Dam, and the South Fork of the Holston River. The specific tasks for the ROV and operators include:

- 1) Ensuring Public Safety – inspecting and making repairs to a hydroelectric dam. Eastman’s stake in the safety and security of Boone Dam extends beyond its company doors to the communities, cities, and state in which it makes its home.
- 2) Maintaining Healthy Waterways – monitoring water quality, determining habitat diversity, and restoring fish habitat. Eastman commissions studies of the South Fork Holston River on a regular basis to ensure the health of both the water and the species that live there.
- 3) Preserving History – recovering a Civil War era cannon and marking the location of unexploded cannon shells. Eastman recognizes the rich heritage of the area and the important of preserving historical artifacts for generations to come.

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.

## REFERENCES

### Kingsport

- <https://youtu.be/eGp3-k0Eccw>
- [www.exchangeplace.info](http://www.exchangeplace.info)
- <http://danielboonetrail.com/>
- [www.eastman.com](http://www.eastman.com)
- [www.eastman.com/Company/Sustainability/Pages/Introduction.aspx](http://www.eastman.com/Company/Sustainability/Pages/Introduction.aspx)

### Ensuring Public Safety – Dam Inspection and Repair

- [https://en.wikipedia.org/wiki/Boone\\_Dam](https://en.wikipedia.org/wiki/Boone_Dam)
- [www.tva.com/Newsroom/Boone-Dam-Project](http://www.tva.com/Newsroom/Boone-Dam-Project)
- [www.youtube.com/watch?v=Fu8cJT-nEmc](https://www.youtube.com/watch?v=Fu8cJT-nEmc)
- [www.deeptrekker.com/clearing-trash-racks](http://www.deeptrekker.com/clearing-trash-racks)
- <https://epd.georgia.gov/safe-dams-program-faq-owner-inspections>

### Maintaining Healthy Waterways

- [www.eastman.com/Company/Sustainability/features/Environment/Pages/River\\_Studies.aspx](http://www.eastman.com/Company/Sustainability/features/Environment/Pages/River_Studies.aspx)
- <https://boonelakeassociation.org>
- [www.youtube.com/watch?v=AIQXPPJFbDI](https://www.youtube.com/watch?v=AIQXPPJFbDI), [www.youtube.com/watch?v=10rAjQT7uMM](https://www.youtube.com/watch?v=10rAjQT7uMM)
- [www.timesnews.net/Local/2016/02/03/Raw-sewage-flows-into-Bluff-City-family-s-yard-possibly-Boone-Lake](http://www.timesnews.net/Local/2016/02/03/Raw-sewage-flows-into-Bluff-City-family-s-yard-possibly-Boone-Lake)

### Preserving History

- [www.waymarking.com/waymarks/WMKWW2\\_Civil\\_War\\_Battle\\_of\\_Kingsport\\_Tennessee](http://www.waymarking.com/waymarks/WMKWW2_Civil_War_Battle_of_Kingsport_Tennessee)
- [https://en.wikipedia.org/wiki/Field\\_artillery\\_in\\_the\\_American\\_Civil\\_War](https://en.wikipedia.org/wiki/Field_artillery_in_the_American_Civil_War)
- [www.civilwarartillery.com](http://www.civilwarartillery.com)

## DESIGN BRIEF

Below is a summary of the product demonstrations organized by competition class. All three product demonstration tasks will be attempted in one product demonstration run.

## EXPLORER

### ***Ensuring Public Safety – Dam Inspection and Repair***

- Inspect the foundation of the dam
  - Identify and count the number cracks
  - Gather information about the size of the cracks
  - Map the location of the cracks
- Deploy a secondary, micro-ROV from the primary ROV to inspect the inside of a drain pipe for indicators of possible dam failure
  - Identify areas of muddy water flow
- Insert grout into voids underneath the dam
- Inspect and repair trash rack
  - Remove the damaged screen of the trash rack
  - Install a new screen

### ***Maintaining Healthy Waterways***

- Monitor water quality
  - Measure the water temperature
  - Measure the pH of a water sample
- Determine habitat diversity
  - Lift a rock from the bottom
  - Examine the benthic species underneath rock
  - Use a handbook to determine the number and type of benthic species
- Record the date, time, temperature, pH, and species diversity on a data sheet
- Transport and release trout fry
- Restore fish habitat
  - Remove degraded rubber tire(s)
  - Install new fish/reef ball(s)

### ***Preserving History***

- Recover the Civil War era cannon
  - Prior to the competition:
    - Determine the lift capability of your ROV
  - At the competition:
    - Calculate the amount of force needed to lift the cannon
      - Calculate the volume of the cannon
      - Determine the composition (specific gravity) of the cannon
        - Use the cannon's casting mark to identify the build location and build date
        - Consult a handbook to determine the composition
    - Determine if the ROV has enough thrust to lift the cannon
  - Return the cannon to the surface, side of pool \*
- Mark the location of metal cannon shells
  - Identify the location of metal cannon shells
  - Place markers at the cannon shell locations

\*Companies may return the cannon to the surface, side of the pool by any means they wish, with the exception of lifting and recovering the cannon manually. No team member can physically lift or pull the cannon to the surface.

## **RANGER**

### ***Ensuring Public Safety – Dam Inspection and Repair***

- Inspect the foundation of the dam
  - Identify and count the number cracks
  - Gather information about the size of the cracks
  - Map the location of the cracks
- Deploy a secondary, micro-ROV from the primary ROV to inspect the inside of a drain pipe for indicators of possible dam failure
  - Identify areas of muddy water flow
- Insert grout into voids underneath the dam
- Inspect and repair trash rack
  - Remove the damaged screen of the trash rack
  - Install a new screen

### ***Maintaining Healthy Waterways***

- Monitor water quality
  - Measure the water temperature
  - Collect a water sample from the bottom
  - Use a water monitoring kit\* to
    - Measure the pH of the water sample
    - Measure the phosphate levels of a water sample
- Determine habitat diversity
  - Lift a rock from the bottom
  - Examine the benthic species underneath rock
  - Use a handbook to determine the number and type of benthic species
- Record the date, time, temperature, pH, phosphate, and species diversity on a data sheet
- Transport and release trout fry
- Restore fish habitat
  - Remove degraded rubber tire(s)
  - Install new fish/reef ball(s)

### ***Preserving History***

- Recover the Civil War era cannon
  - Prior to the competition:
    - Determine the lift capability of your ROV
  - At the competition:
    - Calculate the amount of force needed to lift the cannon
      - Calculate the volume of the cannon
      - Determine the composition (specific gravity) of the cannon

- Use the cannon's casting mark to identify the build location and build date
  - Consult a handbook to determine the composition
  - Determine if the ROV has enough thrust to lift the cannon
  - Return the cannon to the surface, side of pool \*\*
- Mark the location of metal cannon shells
  - Identify the location of metal cannon shells
  - Place markers at the cannon shell locations

\*MATE will provide this kit.

\*\*Companies may return the cannon to the surface, side of the pool by any means they wish, with the exception of lifting and recovering the cannon manually. No team member can physically lift or pull the cannon to the surface.

## NAVIGATOR

### ***Ensuring Public Safety – Dam Inspection and Repair***

- Inspect drains for indicators of possible dam failure
  - Identify areas of muddy water flow
  - Identify and determine the number of cracks
- Insert grout into voids underneath the dam
- Inspect and repair trash rack
  - Remove debris over trash rack
  - Remove the damaged screen of the trash rack
  - Install a new screen

### ***Maintaining Healthy Waterways***

- Monitor water quality
  - Measure the water temperature
  - Collect a water sample from the bottom
  - Use a water monitoring kit\* to
    - Measure the pH of the water sample
    - Measure the phosphate levels of the water sample
- Determine habitat diversity
  - Lift a rock from the bottom
  - Examine the benthic species underneath rock
  - Use a handbook to determine the number and type of benthic species
- Record the date, time, temperature, pH, phosphate, and species diversity on a data sheet
- Transport and release trout fry
- Restore fish habitat
  - Remove degraded rubber tire(s)
  - Install new fish/reef ball(s)

\*MATE will provide this kit.

### ***Preserving History***

- Recover the Civil War era cannon
  - Calculate the amount of force needed to lift the cannon
    - Calculate the volume of the cannon
    - Determine the composition (specific gravity) of the cannon
      - Use the cannon's casting mark to identify the build location and build date
      - Consult a handbook to determine the composition
  - Attach a lift bag to the cannon and inflate
  - Return the cannon to side of pool
- Identify the location of metal cannon shells
  - Mark the cannon shell locations on a grid map
  - Place markers at the cannon shell locations

## **SCOUT**

### ***Ensuring Public Safety – Dam Inspection and Repair***

- Remove debris covering the trash rack
- Remove the damaged screen of the trash rack
- Install a new screen
- Insert grout into voids underneath the dam

### ***Maintaining Healthy Waterways***

- Monitor water quality
  - Measure the water temperature
  - Collect a water sample from the bottom
  - Use a water monitoring kit\* to
    - Measure the pH of the water sample
    - Measure the phosphate levels of the water sample
- Determine habitat diversity
  - Lift a rock from the bottom
  - Return the benthic species to surface
  - Use a handbook to determine number and type of benthic species
- Record the date, time, temperature, pH, phosphate, and species diversity on a data sheet
- Transport and release trout fry
- Restore fish habitat
  - Remove degraded rubber tire(s)
  - Install new fish/reef ball(s)

\*MATE will provide this kit.

### ***Preserving History***

- Recover the Civil War era cannon



- Calculate the volume of the cannon
- Attach a lift bag to the cannon and inflate
- Return the cannon to side of pool
- Identify the location of metal cannon shells
  - Mark the cannon shell locations on a grid map
  - Place markers at the cannon shell locations

## SPECS

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

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

## EXPLORER

- 48 volts, 30 amps DC. Conversion to lower voltages must be done on the ROV, not topside.
- Pneumatics and hydraulics are permitted provided that the company follows the specifications included within the competition manual.
- Lasers are permitted provided that the team follows the specifications included within the competition manual.
- Camera is required.
- Depth requirement at the international competition: 4 meters.
- Maximum size: 92 cm in diameter. Vehicles above this size will not be allowed to compete in the product demonstration. See below for additional details on size requirements.
- Maximum weight: 35 kg. See below for additional details on weight requirements.

## RANGER

- 12 volts, 25 amps DC. Conversion to lower voltages is permitted topside and on the ROV.
- Pneumatics and hydraulics are permitted provided that the company follows the specifications included within the competition manual.
- Lasers are permitted provided that the team follows the specifications included within the competition manual.
- Camera is required.
- Depth requirement at the international competition: 2.5 meters. Depth requirement may vary at regional competitions. Contact your regional coordinator or check your regional competition information document.
- Maximum size: 85 cm in diameter. Vehicles above this size will not be allowed to compete in the product demonstration. See below for additional details on size and weight requirements.
- Maximum weight: 25 kg. See below for additional details on weight requirements.

## NAVIGATOR *(only available at certain regionals)*

- 12 volts, 15 amps DC. Conversion to lower voltages is permitted topside and on the ROV. Any onboard electrical power source is not permitted.

- Manually-powered hydraulics and pneumatics are permitted. Pneumatic systems cannot exceed ambient pool pressure and must follow the fluid power specifications included within the competition manual.
- Lasers are NOT permitted.
- Camera is required.
- Depth requirement: Varies depending on the regional event. Contact your regional coordinator or check your regional competition information document.
- Anderson Powerpole connectors are required on all vehicles.
- Maximum size limit: None. See below for additional details on size requirements.

## SCOUT

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

## SIZE AND WEIGHT POINT VALUES

In light of some of the environments in which the ROVs will be operating, the Eastman Company has included an ROV size and weight requirement 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 and weight measurements will include the vehicle, all tools and components, and the tether. The following will NOT be included in the length or weight measurement:

- The topside control system and 1 meter of tether going into the control system
- EXPLORER and RANGER class cannon lift mechanisms (if removable from the ROV)
- NAVIGATOR and SCOUT class lift bag

To receive points for smaller sized vehicles, the two **largest** dimensions of the vehicle and tether must fit through a round hole of the following dimensions:

## EXPLORER

Size		Weight (in air)	
< 64 cm diameter	<b>+10 points</b>	< 20 kg	<b>+10 points</b>
64.1 to 75 cm diameter	<b>+5 points</b>	20.01 kg to 28 kg	<b>+5 points</b>
75.1 to 92 cm diameter	<b>+0 points</b>	28.01 kg to 35 kg	<b>+0 points</b>

Vehicles above 92 cm in diameter, or greater than 35 kg in weight, will not be allowed to compete in the product demonstration.

### RANGER

Size		Weight (in air)	
< 60 cm diameter	+10 points	< 15 kg	+10 points
60.1 cm to 75 cm	+5 points	15.01 kg to 20 kg	+5 points
75.1 cm to 85 cm	+0 points	20.01 kg to 25 kg	+0 points

Vehicles above 85 cm in diameter, or greater than 25 kg in weight, will not be allowed to compete in the product demonstration.

### NAVIGATOR and SCOUT

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

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

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

### RESOURCES

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

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

### TIME

The complete competition manual will be released by November 15, 2018; teams have from that date until the regional events in the spring of 2019 to construct their vehicles and prepare the engineering and communication components (technical documentation, engineering presentations, and marketing displays). Visit the MATE web site at [www.marinetech.org](http://www.marinetech.org) or request to be added to the MATE competition listserv to ensure a timely delivery.