# 2004 MATE Center/MTS ROV Committee ROV Competition for High School & College Students

www.marinetech.org/rov_competition/index.php

## *Competition Challenges and Design & Building Specifications*

The 2004 ROV competition focuses on the excitement and challenges of sanctuary science and exploration. We invite you and your teammates to take part in this program of technical innovation and discovery. This is the third annual competition and promises to be one of the most technically challenging to date.

## Competition Challenges

There are two competition classes in which teams can compete – ***Explorer*** and ***Ranger***. Your challenge is to build an ROV to accomplish **one** of the two following missions:

### Explorer Class

*Explore Mystery Reef and perform a multi-faceted set of scientific measurement and recovery mission tasks within 30 minutes.*

### Ranger Class

*Explore Mystery Reef and perform a set of 7 scientific and recovery mission tasks within 25 minutes.*

**Which competition class is appropriate for your team?**

The ***Explorer* class** is suitable for those who are willing to design and construct an advanced, multi-functional ROV with a sophisticated control and payload system. ***Explorer* class** vehicles have a higher power limit, and are usually more costly to build.

The ***Ranger* class** is suitable for those who have limited budgets and/or prefer to work with "hardware store" technology. This class is by far the most popular with high school students – but don't be fooled. The ***Ranger* class** mission tasks are equally as challenging.

Look over both missions and decide which one you would like to tackle. **Your team can only compete in one competition class.**

**Regional Ranger Competitions:**

Teams in the New England, Houston, Texas, Southern California, and Northern California areas interested in competing in the ***Ranger class*** are asked to participate in the regional event in their area before moving on to the national competition. The top two winners from each regional will move on the national event. Teams outside of these areas interested in competing in the ***Ranger* class** can register directly with the national competition.

See the **General Information** document for details about the regional events or, for information about the ***Ranger*** regional contest near you, contact:

**New England**
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# Scoring

While the focus of the competition is on the science and exploration mission, it would be unfair to judge the merits of team's efforts solely their performance in the water. Each team will put a tremendous effort into the process of designing, constructing, and testing its ROV. This undertaking should be rewarded.

To that end, the scoring for the competition is divided into two categories:

- **Mission** score – **100** points (max)
- **Engineering & Communication** score – **120** points (max)

The Engineering & Communication score is divided into two categories:

- Engineering – **80** points
- Communication – **40** points

Communication is subdivided into two categories:

- Technical Report – **25** points
- Poster – **15** points

**Total possible score = 220**

## Mission Logbook

A three-ringed logbook will be given to each team at the competition venue. **This will be the most valuable piece of information that you will receive at the competition.** You will need this logout throughout the event. It will be your responsibility to maintain it and have it on hand at all times. Bring it with you to all competition events.

The mission logbook will contain score sheets for:

- Technical report
- Poster display
- Engineering presentation
- Mission challenge

Other items that are relevant to the competition event may also be included, such as:

- The scheduled times and locations where your team is to compete
- Venue meetings and lectures
- A list of competing teams and team rosters
- Names of the judges officiating at each specific event
- A list of other officials
- Where to get lunch

The main purpose of the mission logbook is to provide teams with instant feedback on their performances. At each competition activity, your team will remove the appropriate score sheet from your logbook and hand it to the group of judges evaluating that particular portion of the competition. After they have completed their evaluation and filled in the score, the judges will initial the score sheet. This is called **confirmation**. The team captain will also initialize the score sheet as confirmation that the team has witnessed the score. (**NOTE:** the judges will also record this score onto the master score sheet.) The judges will then hand the score sheet back to your team to place into your mission logbook. **Only the engineering presentation score sheet will not be returned to your team immediately.** The judges will keep this score sheet until all of the scores are entered and the final scores are tallied. It will be returned to you at the awards banquet.

Your team must be able to produce this logbook for any judge or official who requests it. While the judges will keep a master score sheet, this logbook will contain the only available detailed record of your performance. If there is a question about your team's score or a comment on which you want clarification from a judge, you will need your team's logbook to present your case. Keep it available and keep it safe.

# *Ranger* Class Mission

*"Discovery consists of seeing what others have seen and thinking what they have not."*
*– unknown*

## *Mission Objective*

***Explore Mystery Reef and complete a set of 7 scientific and recovery mission tasks within 25 minutes.***

This competition scenario and mission tasks will test your engineering skills. You will need to design and construct an ROV to explore Mystery Reef, an imaginary underwater reef located in the Straits of Florida near NOAA's Florida Keys National Marine Sanctuary. Mystery Reef is made up of features that could be found on one or more of the many different types of reefs found within our national marine sanctuaries.
The NOAA exploration expedition described in the scenario has just completed preliminary side scan sonar, sub-bottom profiler, and drop camera surveys of Mystery Reef. The expedition team found that there is a wreck resting on a ledge, but could not identify the wreck since it is deteriorated and covered in marine growth. The survey data also indicated there might be caverns within the reef. Most exciting of all are the methane seeps that energize the unique ecosystems clustered around them.

You have the exciting and challenging job of collecting specimens, identifying the wreck, finding the source of the methane gas, and exploring the caverns. For an added test of your resourcefulness and tenacity, you have to recover that *very expensive* towfish that Nancy and Leah lost on the survey track that led to the discovery of this reef.

This is an exploration mission. Exploration means discovery of the new – and the unexpected. This competition will push your imagination and technical skills. Enter the event with the spirit of the men and women explorers who have set out into the unknown. Take on the challenges with gusto, enthusiasm, and excitement. Design your ROV to be robust, reliable, and multi-functional so that it can perform the varied mission tasks. Do your research, document your work, pay attention to detail, and learn from your mistakes.

## *Mission Overview*

The event takes place in a swimming pool. The water may be up to 5 meters (m) deep, but most likely will be no more than 2.5m of depth. A mock-up of Mystery Reef will be on the bottom of the pool; a launching station area called the **control shack** will be just above the mock-up. Here teams will set up to fly their ROV into the mock-up and perform the mission tasks. ***(See Control Shack below.)***

This is a timed event. Your team has 5 minutes to move your gear to the competition control shack and set up your ROV system, conduct a systems check, fine tune the ballast, and ensure that all safety protocols are completed by the judges, which include having the judges' multi-meter connected to measure your system's voltage and amperage. The judges will use the following safety checklist:

- AC power supplies, power bars, and extension cords are secured and clear of any water or potential areas where water might collect on the deck.

- Fuses are present and operational.
- Auxiliary power sources are secure and safe to use. For example, compressed air cylinders are securely supported in an upright or prone position (i.e., laying flat on the deck); the cylinders have had recent hydro and VIP inspections; hoses and valves are in good repair; the high pressure connection from the cylinder to delivery device is rated to operate at the designated line pressure for that part of the system; etc.
- DC voltage and amperage does not exceed 13.5 volts and 25 amps.
- Warning labels are on potentially hazardous devices.
- No danger of hazardous gases or chemicals leaking onto the pool deck, in the water, or into the atmosphere.
- Any other safety concern the judges may have about your ROV system and its operation.

At the end of the 5-minute set up period, your ROV should be in the water alongside the control shack pool deck and ready to dive.

At the "go" signal from the judges, the timer will be started and your team's mission performance period begins. You will have 25 minutes to dive the ROV to the mock-up of the reef and complete the 7 mission tasks. Your ROV can surface and return to the reef as many times as you need to in the 25-minute time frame. Your team's mission performance period ends when the 25-minute period is up, or when you have successfully completed all 7 of the mission tasks faster. At the end of the mission, you must have your ROV alongside the control shack with a team member touching it (it is not necessary to remove it from the water).

If your ROV is not alongside the control shack at the end of the 25-minute mission performance period, your team will lose 1 time point for every minute you are late. No points are awarded for any samples brought back to the deck after the mission clock has stopped.

You will then have a 5-minute period in which you must demobilize your gear and clear the control shack for the next team. Make sure that the judges have recorded your score on the master score sheet and that both the judges and your team's captain have confirmed that all your tasks completed (i.e., initialized your mission score sheet). Be sure that you take your initialized score sheet and place it back into your logbook. Divers will take any recovered samples from the deck and place them back into the mock-up for the next team.

***We ask teams who have completed their missions not to disclose their knowledge of the reef to the other competing teams.***

***The judges may ask the divers to randomly reposition objects related to the mission tasks to other locations on the wreck for the next competing team.***

## *Mission Tasks and Score*

The mission score is determined by tasks worth 70 points and time points worth 30 points. The tasks can be performed in any order.

**Task 1: Find and recover the lost towfish.**
The side scan sonar (aka "towfish") was lost on the reef during the initial survey. This is an *expensive* instrument. You must find and recover the tow fish. Your team will be given a 63mm (1/4") polypropylene 3-strand line with an eye spliced into one end. The line is long enough to reach any part of the reef. Your ROV must take the spliced end of this line and attach it to the ring on the tow fish. Your team can then pull the towfish back to surface **by hand** and bring it onto the deck at the control shack.

The towfish will be made out of 2" black ABS plastic plumbing pipe and weigh no more than 9.8 Newtons (N) in air. It will be approximately 1m long **(*see TOWFISH illustration*)**. You can supply any type of hook, clip, or shackle to attach to the towfish ring as long as it can be attached to the line's eye splice. The eye splice will be no smaller than 25mm in diameter and no longer than 76mm **(*see EYE SPLICE illustration*)**. The towfish's location on the reef may change between competing teams. However, it will never be placed inside the reef, nor will be obstructed in any way (i.e., your ROV will not need to remove debris in order to access and free it). In the event that the towfish does become obstructed, divers will intervene and clear the obstruction.

If you drop the towfish on the way to the surface, you can reattach the hook to the towfish in the place where it has landed and attempt to pull it back up to the surface. The divers will not reposition a dropped towfish. Make sure that the judges confirm that you have completed this task by initializing your mission score sheet.

**NOTE: The ring on the towfish will be upright and oriented vertically. It will not be angled or laying against the bottom.**

**Task 1 scoring – 10 points**
Attach the hook to the towfish – 5 points
Bring the towfish to the surface and onto the deck at the control shack – 5 points

**Task 2: Find and identify the U-boat captain's bell.**
The name of the U-boat is inscribed on this bell. You must find the bell and, using your video camera, read the inscription. You must demonstrate this to the judges by showing them the image of the bell on your video monitor. Write the inscription on the appropriate page in your logbook and ask the judges to confirm your find and inscription by initializing your mission score sheet

**Note: The bell will be in an upright, vertical position. A short, floating loop of line will be attached to the top of the bell.**

**Task 2 scoring – 10 points**
Find the bell – 5 points
Reading and correctly recording the inscription – 5 points

**Task 3: Patch the hole in the leaking barrel.**
With mysterious red liquid leaking out of one of the barrels, the U-boat poses a potential environmental problem. You must find the hole in the leaking barrel and place a

temporary patch on it – a future expedition will deal with the ecological hazard by pumping the barrels dry **(*see BARREL illustration*)**.

The competition officials will provide your team with this patch. The patch is a circular plate with a diameter of 10 centimeters (cm). There is a protruding dowel attached to the center of the patch faceplate. A small loop of line is also attached to the patch as alternative way to grip the patch. The bottom of the circular patch plate is covered with Velcro (loops). The leaking barrel will have a 3cm circular piece of black Velcro (hooks) on it to represent the "hole." A 15 cm diameter white circle will mark the area around this "hole". The Velcro "hole" (hooks) will be located at the center of this white area.

Your ROV must be able to grip the patch, carry it down to the leaking barrel, and place it over the hole. The patch must completely cover the black Velcro on the barrel. Demonstrate to the judges that you have patched the hole by showing the image on your video monitor; the judges must confirm this by initializing your mission score sheet. Only ask the judges to confirm that the patch is in place when you satisfied that you have placed it correctly. Your ROV can set and remove the patch any number of times before you ask the judges to confirm that it is in place. However, once you have asked the judges to confirm and initialize your logbook you cannot remove the patch and try again even if you have time after completing the other mission tasks. Your ROV can access the hole from outside the U-boat; this task does not require you to enter the wreck mock-up.

**Note: The barrel will be oriented vertically. It will not be angled or laying on its side. The hole will be located on the upright, flat end of the barrel.**

**Task 3 scoring – 10 point**
Find the barrel and deliver the patch to it – 5 points
Place the patch completely over the hole – 5 points

**Task 4: Find and collect a specific species of fish.**
Footage from the drop camera survey showed **several** unique species of fish that are found only at methane seeps. These fish are black or white with geometric patterns that are unique to each species **(*see FISH illustration*)**. The judges will ask your team to find **one** particular species of fish, collect **one** of them, and place it in a sample collection basket located on the bottom of the pool directly below the control shack. For example, you may be asked to find the species with two vertical black stripes on a white body. You must search the reef inside and out – including the U-boat – to find and collect the one white fish with two vertical black stripes. Before you collect it, demonstrate to the judges that you have found your particular species by showing them the image on your video monitor.

The sample collection basket has a line attached to it so that your team can pull it to the surface and bring it onto the deck at the control shack **by hand**. Alternatively, you may elect not to use the sampling basket and recover the fish by another means (i.e., by bringing them directly to the surface using your ROV). The judges must confirm that you have found and collected the correct species by initializing your mission score sheet.

The location of the fish will change since, being fish, they do swim around. In other words, the judges will instruct the divers to randomly reposition the fish **between** competing teams.

**Note: The fish will be slightly negatively buoyant and oriented vertically. The total, collective, submerged weight of five fish will be 3N or less.**

**Task 4 scoring – 10 points**
Find the correct fish species – 5 points
Collect one fish and bring it to the control shack deck – 5 points
**NOTE:** Teams will receive 1 point for each additional fish (of the correct species) that they collect and bring to the control shack deck.

**Task 5: Find the source of the methane and tag the tubeworm cluster next to it.**
At Mystery Reef, there is a source of seeping methane. In this case liquid methane, as it reaches the ocean floor after being buried by layers of sediment and the pressure on it lessens, turns to gas – hence the bubbles that Leah and Nancy saw on their camera survey. Your team must find the source of the methane bubbles and tag the cluster of tubeworms next to this source. Your ROV may have to transit through the methane bubbles to accomplish this.

The competition officials will provide your team with this tag **(*see TUBEWORM TAG illustration*)**. Your ROV must be able to grip the tag, carry it down to the source of the methane bubbles, and attach it to the tubeworm cluster **(*see METHANE SEEP and TUBEWORM illustration*)**. You must demonstrate to the judges that you have completed this task by showing them the images of the methane source and tagged tubeworm cluster on your video monitor. The judges must confirm that you have found the source and attached the tag to the tubeworm cluster by initializing your mission score sheet.

**Task 5 scoring – 10 points**
Find the source of the methane bubbles – 5 points
Tag the tubeworm cluster – 5 points

**Task 6: Find and tag the mussel bed.**
You must explore inside the caverns to find and place a tag on a bed of this unique mussel species. The competition officials will provide your team with this tag **(*see MUSSEL TAG illustration*)**. Your ROV must be able to grip the tag, carry it through the caverns, and place it on the mussel bed. You must demonstrate to the judges that you have completed this task by showing them the images of the tagged mussel bed on your video monitor. The judges must confirm that you have found the mussel bed and placed the tag on it by initialing your score sheet.

**Task 6 scoring – 10 points**
Find the mussel bed – 5 points
Tag the mussel bed – 5 points

**Task 7: Find the authigenic carbonate formation and bring back one sample.**

Leah and Nancy's survey found evidence of authigenic carbonate formations derived from bacterial activity within the caverns of Mystery Reef. You must search the reef to find and collect one small carbonate sample. The samples are represented by small pieces of lava rock. Lava rock is small, lightweight, porous, and irregularly shaped (***see CARBONATE illustration***). Once you find a sample, place it in the sample collection basket (the same basket that was used to collect the fish species) and bring it to the deck of the control shack. Alternatively, you may elect not to use the sampling basket and recover the sample by another means (i.e., by bringing them directly to the surface using your ROV). Once on deck, show the judges that you have collected one piece. The judges must confirm that you have found and collected the carbonate samples by initializing your mission score sheet.

**Task 7 scoring – 10 points**
Find an authigenic carbonate piece – 5 points
Collect a sample and bring it back to the deck of the control shack – 5 points
**Note:** Teams will receive 1 point for each additional (up to 4) piece of carbonate that they collect and bring to the deck of the control shack.

## Mission Time Points:

Your team will be awarded bonus points if you successfully complete all 7 tasks in less than 25 minutes. The time bonus is calculated by subtracting the time it takes your team to complete the mission tasks from 30. For example, if your team took 15 minutes to complete the mission, then a bonus of 30 minutes – 15 minutes = 15 points will be awarded. Fractions of a minute will also be calculated. For example, if it took your team 12 minutes and 15 seconds to complete the mission tasks, then a bonus of 30 minutes – 12.25 minutes = 17.75 points will be awarded. Teams' mission times will be subtracted from 30 so that each team receives at least a 5-point time bonus for getting in the water and attempting the mission regardless of whether or not it accomplishes the mission tasks. A 5-point time bonus will not be issued if a team is disqualified from the mission.

**Reminder – Judge's Confirmation:**
For many of the mission tasks, the judges must observe the task as it is being executed via your ROV's video monitor. Upon successful completion of the task(s), the judge will assign a score(s) and record and initialize the entry on your mission task score sheet to confirm your results.

# Engineering & Communication Score:

### *Engineering Score – 80 points*

This is one of the most critical scores in the competition. It measures your team's theoretical and technical knowledge about your ROV.

The engineering evaluation (aka "design and construction interview") will take place the day before the mission portion of the competition event. Unlike previous competitions where teams were visited by roving groups of judges, this year teams give a formal, 15-minute presentation in front of a judges panel. After your presentation, the panel will ask your team members questions about your ROV, including its design, operation, and safety features.

**Only the members, instructors, mentors, family members, and non-competing friends of the team being evaluated are permitted to attend this interview.** We do understand and appreciate the value of sharing ideas and learning from other teams. However, our goal is to keep the competition as fair as possible. Teams being interviewed "first" won't know what questions to expect from the judges; if we allow other teams to attend the interviews, they will know what to expect, giving them an unfair advantage. We appreciate your understanding.

**While they are permitted to attend, instructors and mentors are not allowed to participate in the interview process.** If there is a critical question or issue that requires clarification and the student team members are unable to address it, the judges may decide to invite a mentor or instructor to answer.

**Who presents?**
All student members of your team must participate in this presentation. You can choose to delegate one team member to give the complete 15-minute talk or divide topics up amongst one, two, or all of your teammates. Audio visual aids, such as slide projectors, computer projection screens, white boards, etc. may or may not be available. We will update you on this once the venue for the competition is confirmed. You will be required to have your ROV in the room. A table will be on hand for you to set up your vehicle. During the question period, all team members must be present and prepared to answer any question a judge asks them to answer.

Each judge on the panel (there could be as many as seven) will award an engineering score based out of 80. These scores will then be averaged out to obtain your team's final engineering score. Engineering scores will be kept confidential until the concluding awards ceremony. At that time, the judges' engineering scores and comments will be returned to you.

**Engineering evaluation:**
In order to evaluate and score your team's engineering presentation, the judges' panel will focus on certain features of your ROV's design and the process that went into building it. Here are some examples of questions that the judges may ask. (**NOTE: These are only examples and may not be the actual questions asked.)**

**Structure**
- How did you decide on the shape of the vehicle and the materials used to build it?
- What is the depth rating of your ROV? How did you test this?
- Did you use any pressure cans in your design? Explain how you designed and built these.
- What are o-rings and how do they work?
- How much did it cost to build your vehicle?
- How much does your ROV weigh?

**Control system**
- What type of control scheme have you used? Why?
- How does your control system work?
- How many conductors are in the tether?

- What devices/functions does your system control?
- Is there some unique feature of your control system that you would like to tell us about?
- How did you waterproof your underwater electrical connections?

**Propulsion**
- How many thrusters does your vehicle have? Why?
- How much thrust does each produce?
- How many watts does one thruster use at full rpm?
- How many amps does one thruster draw under full load?
- Explain how you measured thrust.
- How is power (watts) used by one thruster related to the thrust it produces?
- Do you know the forward speed of your ROV? How did you measure this?

**Ballast System**
- How does your ROV ballast system work?
- Explain what stability is.
- Why is it important to consider stability in the design of ROVs?

**Sensors**
- What type of camera did you choose? How did you waterproof it?
- What is a CCD camera? Briefly explain how one works.
- What do your sensors measure or detect?
- What unique features are incorporated into your sensors?
- What additional sensors (other than a camera) have you put on your ROV? Why?

**Payload Tools**
- What kind of payload tool(s) did you design to accomplish the mission tasks? Why?
- Explain how this tool(s) works.

**Resources**
- Did the project meet the budget?
- What equipment/building supplies were donated, built, or bought?
- Did you economize yet produce a functional and robust vehicle?

**System Design**
- Can the vehicle accomplish the mission tasks?
- What are the strengths of the design?
- What are the weaknesses?
- Do the safety systems work?

**Originality**
- Does the design of the vehicle and its sub-systems exhibit unique and/or original concepts?
- Are there any innovations or modifications that resulted in higher functionality and reduced costs?

**Workmanship**

- What is the overall quality of the workmanship?
- Are the electrical systems neatly run and wired?
- Is it easy to access components for maintenance?
- Are warning labels and guards posted on potentially hazardous components?
- Is the tether neatly bundled and protected?
- Does the vehicle look aesthetically pleasing yet have practical functionality?

Your team must be prepared to answer questions other than those examples listed above. The judges will ask for more details.

**Preparing for your engineering presentation and evaluation:**
Standing in front of a group of judges and convincing them that your team has a worthy vehicle can be very stressful. It is difficult to predict exactly what questions the judges will ask. The scout motto "be prepared" is your team's best strategy for reducing the stress and meeting this challenge successfully.

Here are some suggestions for how to "be prepared:"

- Make sure that every member of your team has a good, general working knowledge of your vehicle, even though they may have specialized in one specific aspect of its design and construction.
- Every member should have a project notebook. Project notebooks or journals are a requirement in all scientific and technical work. They are the daily, detailed notes that you keep when developing and building your project. They are also useful as the primary reference and source of information when creating your team's technical project report (***see Technical Report below***). Write relevant technical and procedural issues down throughout your design and building process.
- Research the specifications of the components that you use in your vehicle. For example, look up the specs of your ROV's CCD camera and be familiar with such numbers as the amount of propulsive force the thrusters produce, the weight of your ROV, etc.
- Freely share information amongst your team members.
- Produce clear, simplified diagrams that you might be able to use in your presentation.
- Make sure that your vehicle is in complete and in working condition when you present.
- Write a concise technical report and make sure all the members of your team have contributed to it. Ask every member of the team to read it over to catch any errors, omissions, or typos. This will help to familiarize all team members with all aspects of the project.
- Practice your presentation. Each team member should practice what he/she is going to say. You'll be surprised how fast 15 minutes will pass. Generally, you will have more to say about your ROV than can be presented in fifteen minutes. That is why it is critical to organize your material and practice communicating it. Ask your instructors or mentors to give you feedback. Practice your presentation more than once so that you become comfortable speaking in front of other people in a coherent and organized way.

- When your team is prepared and knows the material well, you will all be more comfortable and confident. This will come across favorably to the judges.

### *Communication Score – 40 points*

This component of the competition is a great way to earn up to 40 points towards your team's total score before you even show up at the event!

Your team is required to submit a **Technical Report** and create a **Poster Display** that describes your ROV and your design and building process. Up to 20 points will be awarded for having a clear, concise, and informative technical report; up to 10 points will be awarded for having a poster display that provides a good, overall visual presentation of your vehicle and the work that went into creating it.

## Technical Report – 25 points:

The technical report is essentially an extension of your engineering score. As such, your team should make an effort to do a good job on this report and not relegate it to the back burner. If your team has been keeping a project notebook(s), then writing this report should be relatively easy. Your team's project notebook(s) will provide you with content and reference information, as well as help you to organize your report.

**The technical report must be submitted to the competition coordinator 2 weeks prior to the competition date** in order for the judges to evaluate the technical merits of the team's ROV design and construction and address any safety issues that may need to be resolved before the competition. Any changes or additions that you make to ROV system that differ from the information the project report that you submit can be presented to the judges as part of your poster display and/or during your team's engineering presentation. **The judges will not review and rescore revised versions of your project report at the competition venue.**

**THE REPORT SHOULD BE SENT ELECTRONICALLY AS A PDF FILE ATTACHED TO AN E-MAIL OR AS A PDF FILE SAVED ON A CD-ROM OR DISC AND SNAIL-MAILED TO THE COMPETITION COORDINATOR.**

Examples of technical reports from previous years' competitions are posted on the competition web site at www.mpcfaculty.net/jill_zande/report_examples.htm. The guidelines and required components for the report are:

- **Length is less than 20 pages**
- **All measurements are in SI units (metric)**
- **Title page** that includes:
  - Your project/ROV name
  - School/club name
  - Team name (if applicable)
  - List of team members (you can also include degree/area of study and expected graduation date)
  - Names of your instructor(s) and/or mentor(s)
- **Abstract (250 words or less)** that is concise and clearly summarizes the project.
- **Photograph(s) of your completed ROV**

You are permitted to make modifications that may change the look of your vehicle between the time you submit your report and the competition, however this must be a photo(s) of your completed, intact vehicle, not a photo of individual systems and/or payload.

- **Budget/expense sheet**
  Keep an accounting of your monies and expenditures. In addition to funds, list any items (building materials, equipment, etc.) that were donated, the organization that made the donation, and an estimate of the item's value. A sample expense/budget sheet will be provided shortly as an example of how you can organize and report this information.
- **Electrical schematic**
  Make sure to highlight safety features such as circuit breakers and fuses. This schematic may be NEATLY drawn by hand or created using a CAD software program (e.g., OroCAD).
- **Design rationale** presented in a clear and logical manner.
- **Description of at least one challenge** that your team faced and what methods were used to overcome it. These can include both technical and those challenges related to working as a team, such as team dynamics and dealing with individual personalities.
- **Explanation of troubleshooting technique(s)** used to overcome technical problems.
- **Description of at least one lesson learned or skill gained** during the design and building process.
- **Discussion of future improvements**
- **How ROVs are currently being used to explore and understand our national marine sanctuaries (500 words or less).** You can focus on one sanctuary or include information about ROV missions in a number of different sanctuaries. These missions can be related to science, exploration, conservation, or policy issues. Reference at least 3 sources for your information, and include photographs and/or graphics where appropriate.
- **Acknowledgements**
  Please recognize the companies, organizations, professionals from industry, and/or mentors who helped to support your team by donating funds, building supplies, equipment, site visits to facilities, time, and/or technical expertise.

The score sheet for your technical report will be returned to your team after your engineering presentation for you to place into your mission logbook. Please keep this score sheet available at all times. The judges may ask to see it at anytime during the competition. An electronic as well as a hard copy of your team's technical report will be on hand at the competition in case there is a question, concern, or issue requires the judges to view the actual document.

## Poster Display – 15 points:

Creating an informative, clear, and concise visual presentation that effectively explains how your vehicle systems function and why you constructed them the way you did will go a long way in helping you to sell your "product" to the "client" – in this case, the competition judges.

Your team's poster will be evaluated and scored by a group of judges during the competition. The score sheet for your poster display will be returned to you once the judges have evaluated all of the posters and recorded the scores onto the master score sheet. Your team may not receive your poster score sheet until after your mission performance period, but it will be returned to you before the awards banquet. You should place it into your mission logbook. The score sheet must be available at all times; the judges may ask to see it at anytime during the competition.

Competition officials will provide each team with one 3-panel, freestanding presentation display board (although you may bring your own). Each display board is:

- Made out of black, corrugated cardboard
- Free-standing; no easels or stands are required
- 36" tall with a total width of 48"
- Comprised of three panels
    - One 24" wide by 36" tall center panel
    - Two 12" wide by 36" tall side panels

For more details about the display board, including a photo, visit www.staples.com and search for project display board item #922528. Competition officials will also provide scissors, tape, glue sticks, adhesives (e.g., Velcro), and other means of attaching display items to the presentation board, although you are also welcome to bring your own.

The guidelines and required components for the poster display are:

- **Font size that is clearly legible from a distance of 1.5 m**
- **All measurements are in SI units (metric)**
- **Your school/club and team name (if applicable)**
- **Images AND captions**
    - Team photo
    - Photo of your ROV
    - Photo(s) of any special features of your vehicle and building photo(s)
- **Description of your vehicle and why you built it the way that you did**
- **Answers to the following questions:**
    - What was the most rewarding part of this experience?
    - If you were to do this again, what would you do differently?
- **How ROVs are currently being used in national marine sanctuaries**
  Use the information that you included in your technical report (***see Technical Report above***) to create a brief summary paragraph of ROV missions taking place in sanctuaries. Include a photograph or other graphic.
- **Acknowledgements**
  Please recognize any companies, organizations, professionals from industry, and/or mentors who helped to support your team by donating funds, building supplies, equipment, site visits to facilities, time, and/or technical expertise.
- **Other items that you may use in your poster or have on display include:**
    - Diagrams or sketches (CAD drawings, for example)
    - Photo journals
    - Copies of your team's technical report
    - Resumes of individual team members

**Note:** This year we are planning to circulate the resumes of students nearing graduation and/or interested in applying for a MATE Center Technical Internship to competition sponsors and other potential employers (think JOBS!). More information about this process, as well as guides to resume writing, will be set out to teams in January 2004. There is no obligation to participate.

**Recommendations for your poster display:**
We recommend using Microsoft PowerPoint or Publisher slide presentation program to create your team's poster presentation. PowerPoint will allow you to include both text and photos, which should make creating your presentation relatively easy. Once you've created your slide presentation in PowerPoint, you can print out each individual slide and tile the slides along the presentation board. For example, the two side panels will hold four 8 ½" x 11" pieces of paper; the center panel has room for eight. You may want to use 24-lbs. or higher stock, such as cardstock, paper for text and photographic paper for images to ensure presentation quality display materials.

**Your team will be required to submit a copy of your team's poster presentation materials, so please bring two sets – one to display on the presentation board and one to turn in to competition officials. Please place the materials in a folder with your school/team name.**

# Awards

A complete list of the award categories will be posted to the competition web site shortly. The award categories will be similar to those from last year. For last year's competition awards and the teams who won them, visit www.mpcfaculty.net/jill_zande/2003_winners.htm.

# Competition Arena

## *The Reef Mock-Up*

The 7 tasks that make up the *Ranger* class mission will require your team to fly your ROV outside and inside of the reef structure. The exact location of these mission tasks is not known. Be prepared to fly your vehicle through simulated methane seeps (air bubbles), dash through twisting passages inside the reef, search the U-boat for the leaking barrel and bell, explore the reef for collecting/tagging tasks, and search for the lost towfish. You should have a minimum of 12m of tether from the control box to your ROV.

### Structure of Reef

The Mystery Reef mock-up is a 3m long x 3m wide x 2m high structure. The frame is constructed of ¾" schedule 40 PVC pipe and fittings with a black landscaping cloth covering the framework. It will be placed in a minimum of 2.5m of water, but it may be deeper depending on the venue pool. It will be located directly below and somewhat in front of the edge of the pool below the control shack (***see Control shack below***).

### U-Boat structure

The mock-up of the U-boat will be located outside and on top of the reef. The U-boat will be approximately 2m long x 1m in diameter, with a conning tower about 1m high.

(**NOTE:** The U-boat dimensions may change slightly from those stated above; however, you can consider these its minimum size dimensions). The U-boat mock-up will be divided internally with bulkhead compartments (***see U-BOAT illustration***).

**Caverns**
The reconnaissance survey showed that the reef has a cavern system with a number of entrances, the exact number of which is unknown. The minimum size of any entrance (which may be circular or square in shape) will be no less than 60cm in diameter. The inside passages of the caverns can be likened to a maze with blind alleys, twists, and turns. Any transit inside of the reef from a cavern entrance to an endpoint will be 4m or less. The exact layout of the maze system is unknown; your team will have to explore it. Light levels inside the caverns will be reduced but not be completely dark.

**Methane Seep**
The methane seep will be simulated by air bubbles. An air compressor located on the pool deck will create the bubbles. An airline will run from the deck into the reef mock-up. A bubble diffuser or air stone like those used in aquaria will be located at the end of the air line in order to break the bubbles into a fine stream. To accomplish some of the mission tasks, your ROV may have to pass through or fly in the bubble stream, so design accordingly. The bubble stream will not be so strong as to create water currents that affect the operation of your *Ranger* class ROV. However, the exact volume of bubbles that you will need to transit is unknown. Rest easy; the simulated methane bubbles are not explosive.

***We apologize for the artificial look of the reef (i.e., plumbing pipe and landscaping cloth). You will have to use your imagination to see the reef's complex diversity and beauty, and the unique place that reefs have in our ocean ecosystems.***

### *Control shack*
There will be one or more areas marked, roped off, and designated as the *Ranger* class control shack along the edge of the pool. The set up at the control shack will include:

- A tent-like structure with four walls that extend to the pool deck. Your team will set up inside this structure. The team member handling the tether will be positioned outside of the structure, but will not be able to look into the water to direct the pilot as to the position of your ROV.
- A 110/120-volt AC, 15-amp, 3-pronged GFI protected power receptacle for you to use for repair tools, video monitors, and recorders. This will be located at least 3m away from the edge of the pool but might be further. Make sure you're your extension cords are at least 10m long so that they can reach a plug-in point.
- A table located within 2m of the pool edge for you to use to set up your ROV system.
- Three chairs for your team members.
- A small table for the judges close to and in view of the ROV control shack.
- A mock-up of *Mystery Reef* at the bottom of the pool and immediately below the control shack.

## Competition Rules

***We have tried to develop these rules so that they are fair for each and every team. However, nothing human is ever perfect. If you have any concerns or questions regarding these rules, please let us know in advance of the competition and we will do our best to address them. During the competition, any dispute regarding the awarding of points, intent of the rules, omissions, inconsistencies, human error, etc., will be addressed by the chief judge and deliberated in consultation with the other judges, participants, and competition officials.***

***It is very important to review the following safety regulations and make sure that they are followed. Most of these safety rules will impact the way that your team will design, build, and operate your ROV.***

## *General Safety*

- All members of a competing team and their supporters are expected to conduct themselves in a professional and responsible manner throughout the duration of the competition.

- All members of a team and their supporters must agree to follow the safety regulations of the pool facility.

- All members of the team and their supporters must agree to follow the posted safety regulations of the ROV competition.

- Your ROV vehicle system (this includes carts, tool boxes, tools, and any other items used to operate or maintain your ROV) must not damage any part of the pool deck or bottom tiles. Make sure that any sharp hard (metallic) edges on the vehicle structure are protected with some sort of soft covering, such as rubber or plastic, to ensure the pool tiles are not damaged during set-up, launch, mission operations, recovery to the deck, and moving your ROV around the pool deck for repairs, practice, or transport.

- Make sure that any power cords are not lying in pools of water on the deck.

- Secure any equipment so that it does not fall off the table, damage the deck, or cause in jury.

- Keep an eye out for tripping hazards in the control shack and in your team's workspace.

- Your ROV can be constructed out of materials of your team's choice as long as they meet the listed competition rules and safety regulations.

- Hazardous and/or non-biodegradable materials (i.e., hydraulic oil) may not be intentionally released into the competition waters or the atmosphere.

- Officials may stop the competition at any time that they feel there is a safety issue.

- All teams must pass the safety check in order to compete in the mission. The safety check will take place at the control shack during the 5-minute set up period. Your team must pass each item on the checklist in order to compete. However, no points will be given or taken away during the safety check.

- The judges will always keep the safe operation of your vehicle system in mind throughout the event. They may ask you to explain and/or demonstrate some aspect of your vehicle that they feel is unsafe. Your team must comply with any such requests and address any concerns to the satisfaction of the judges.

- The competition organizers (MATE, the MTS ROV Committee, and NOAA's National Marine Sanctuary) and venue operators are not liable for any injury or damage caused by any ROV system participating in the event.

### *Electrical Safety*

- Teams will be supplied with a DC power source that will supply 12 to 13.5 volts and 25 amps. There is no need to bring batteries to the competition to power your ROV system.

- Some teams may opt to bring their own their own 12-volt DC power source. This is allowed as long as the competition officials are ensured that the supply is safe (fused) and gives no advantage over the other teams that are using 12-volt DC source supplied by the competition. If you plan to use your own power source, you must submit your intention in advance of the competition; include it with your documentation portfolio.

- Lead-acid storage batteries with liquid electrolyte MUST be carried and kept in a leak proof container to prevent accidental spillage.

- Teams will be provided with a 110/120- volt AC, 15-amp, 3-pronged, GFI protected power receptacle to power AC devices such as tools, video monitors, and recorders. Your team must bring your own extension cords and power bars. These will not be provided.

- Competition officials must be able to place a multi-meter in-line in order to monitor the voltage and amperage during your vehicle's competition run.

- You must have male banana plugs on the end of your 12-volt DC power cord in order to connect to the 12-volt DC power source, typically a 12-volt car battery, provided.

- Your team must demonstrate the presence of short circuit protection (i.e., fuse) in your vehicle circuitry to competition officials.

- Only DC voltages are allowed to travel from the control box and through the tether to your vehicle.

- Maximum DC voltage is 13.5 volts.

- Maximum DC amperage is 25 amps.

- Any AC to DC power supplies (transformers) must be located at least 3 m from the pool's edge. They must be elevated off the pool deck to prevent standing water from creating an electrical hazard.

## *Penalty Points or Disqualification*

***Disqualification and imposition of penalty points requires a consensus of the judging group that is officiating for the team.***

***Grievances will be heard by competition officials and judges as the urgency of the circumstances dictate.***

Penalty points or disqualification may result:

- A team member goes in the water to recover the team's ROV. Only the arms of the team members can be in the water to recovering the ROV and any associated equipment or sample.
- A team member accidentally falls into the water during the team's mission performance period.
- A team's vehicle system does not meet the safety requirements or fails to operate (i.e., complete systems failure that results in your vehicle being unable to move or submerge during the mission performance period).
- Disrespectful behavior towards the judges, competition officials, pool staff, audience, or other teams.
- Sabotaging, stealing, or pilfering the equipment of other teams.
- Cheating in anyway.

## *Procedural Rules*

- Your team's technical report (***see Technical Report above***) should be submitted four weeks prior to the competition.

- Your ROV must be launched and recovered by hand and only by the members of your team.

- The vehicle and all associated equipment, including the tether, must be either hand-carried or stowed on a wheeled cart to transport it to the pool practice and competition launch area. Your team must supply this cart.

- Teams are required to bring their own video monitors. There are no limits on the number of video monitors a team can use.

- Other sources of "stored" power (e.g., hydraulic, pneumatic, or compressed air) and auxiliary equipment that uses this stored power are permitted as long as the vehicle and any and all associated equipment can be hand-carried to the site and operated off of the 12 volts and within the 25 amp limit allotted.

- Inside the control shack, teams will be provided with a table located within 2m of the pool edge to set up their ROV system and associated equipment.

- The ROV's monitor and control panel will be set up to prevent the pilot and team members from looking at the ROV in or under the water except through the ROV monitor.

- The surface of the water near the control shack will be rippled to make it difficult to clearly see your vehicle or the reef below.

**Who goes first - volunteers?!**
This year we are asking for at least six teams to volunteer to go first. We recognize that this may put these teams at somewhat of a disadvantage as they will be the first to explore the reef and determine many of the unknowns of the mission tasks. Because underwater footage will be broadcast to big screens topside, the teams not competing at the time may be able to determine the layout of the reef and location of some of the mission tasks. However, as previously noted, divers will randomly reposition items related to the mission tasks between competing teams. In addition, ripples may be created by sprinkling water near the control shack, making it difficult for ALL of the teams, as well as the spectators, to get a good look at the reef below. These efforts will help to keep the playing field even, and ease any disadvantage/advantage a team might have. Once the first six teams have been assigned their competition time slot, the time slots for the remaining teams will be chosen by lottery.

**When you submit your technical report 2 weeks prior to the competition, please indicate if your team would volunteer to go first.**

## *Mission Team Rules*

- "Mission team" refers to the student members who will actually launch, pilot, and perform the competition mission. Instructors, mentors, and/or non-student members cannot participate as part of the mission team.

- The names of the mission team members must be submitted to the judges the day before the mission portion of the competition begins.

- **The mission team is limited to six students.**

- The control shack will be clearly marked, roped off, and designated as the control shack.

- Only the mission team and judges are allowed at the control shack. Other team members, instructors, mentors, audience, and observers (i.e., press or special invited guests) must remain outside the control shack or in the designated viewing area during the mission period.

- Instructors, mentors, or other team members who are not part of the mission team are not allowed to pilot or assist in the setting up their ROV at the control shack.

However, they can assist in bringing the ROV equipment to the **entrance** of the control shack.

- Mission team members are allowed to communicate with each other at the control shack. Coaching from the sidelines is discouraged. However, loud and enthusiastic cheering is greatly appreciated.

- The team can pull on the tether to bring the vehicle back to the control shack.

- Any mission team member(s) can recover the towfish and/or sample basket.

- Only mission team members are allowed at the control shack during the 5-minute demobilization time. Follow any instructions from the judges or competition officials as to where to take your equipment after you leave the control shack in order to keep the area clear for the next competing team.

- The competition organizers (MATE, the MTS ROV Committee, and NOAA's National Marine Sanctuary) and venue operators are not liable for any injury or damage caused by any ROV system participating in the event.

## ROV Design and Operation Capabilities

Your ROV design and operation must have the following design and operation capabilities:

- Your ROV must be able to operate and withstand water pressure at a depth of 5m.

- The pool contains chlorinated, freshwater but should be considered conductive of electrical currents. Please waterproof your ROV components if possible.

- Your ROV should have at least 12m of tether in order to reach inside the mock-up from the control shack.

- Your team must be able to set up your ROV system at the control shack within the 5-minute set up period.

- Your team must be able to demobilize your ROV system and move it from the control shack within five minutes.

- Your ROV must be able to fit through a circular opening of 60cm in diameter and maneuver in a space 0.8m x 0.8m x 0.8m.

- Your ROV must be able to fly and operate in a bubble stream.

- The vehicle and all of its associated equipment, including the tether, must be either hand-carried or stowed on a wheeled cart (supplied by your team) and transported to the competition site.

- The vehicle must be launched and recovered by hand and only by the members of your team.

- The vehicle system (this includes carts and any other items used to operate or maintain the ROV) must not damage any part of the pool deck or bottom tiles.

- Your ROV must have a video camera.

- Your team may want to include a small light on your ROV. It will not be completely dark inside the mock-up, but light levels may be reduced.

- Your team should devise a payload tool(s) to perform all the mission tasks.

- Only DC voltages are allowed to travel through the tether to the ROV. The maximum DC voltage your ROV can use is 13.5 volts.

- The maximum DC amperage the ROV can draw is 25 amps.

- Your ROV's DC power system must be protected by a circuit breaker or a fuse(s).

- A 12 to 13.5 volt DC power source capable of 25 amps will be provided to operate your ROV during the competition and practice sessions.

- Connections to the 12-volt power source will be via standard banana plugs. Your ROV must have male banana plugs on the end of its DC power cord in order to make this connection. (**NOTE:** Banana plugs are available at your local Radio Shack or through electronics supply companies such as Digikey and Newark.)

- Your ROV's video monitor(s) and video recorder can be powered separately from a GFI-protected AC receptacle and is not considered part of the ROV maximum power requirements. This GFI-protected 110/120-volt AC 15-amp 3-pronged receptacle will be provided to you and located at least 3m away from the side of the pool.

- Your ROV system and all of its associated equipment, including auxiliary power sources, must meet all of the safety requirements stated in the competition rules.

## Funding and Budget

There is no limit to the amount of money, time, and technical expertise that can go into building your team's vehicle. However, keep in mind that a costlier vehicle does not necessarily mean that the vehicle will perform better or will be better able to successfully accomplish the mission tasks. In other words, spending more money does not always lead to competition victory!

This year the MATE Center will provide each team with $100 for building supplies and materials. This includes teams competing in the regional events as well as the national competition. Teams competing in regional events should contact the regional competition coordinator in their area in order to receive their ROV building supply and

material funds. In addition, regional coordinators may have plans for other types of support, including workshops and access to mentors.

In addition, the Center is working with a number of companies to encourage them to offer their products, materials, supplies, and/or access to equipment and facilities at no or reduced costs. For example, VideoRay (www.videoray.com) is creating a "MATE ROV Competition Store" that will be available to competition teams **only**. This on-line store will offer discounts on cameras, tethers, and, possibly, thrusters, among other items. (The URL for this on-line store will be posted to a "teams only" section of the ROV competition web site. The "teams only" section is currently under construction; its URL and password will be sent as soon as it's completed.) Likewise, Carrillo Underwater Systems is again offering a scholarship for free and/or discounted products. Visit www.carrillounderwater.com/mate/ for more information, including how to apply.

The MATE Center will also provide information on potential funding sources at both the national and regional level (e.g., local Rotary Clubs, American Association of University Women, etc.). This information will be posted to the "teams only" section of the competition web site.

The Center also encourages teams to organize their own fundraising activities, including approaching local businesses (e.g., Home Depot) for donations of funds, building materials, equipment, etc.

In addition to supply and material costs, the following funding issues may also challenge your budget:

- Travel costs for the team members to the competition venue. **NOTE**: The MATE Center will provide each team with a travel stipend of at least $1,500.
- Lodging and meal costs during the competition event. **NOTE:** The MATE Center will cover the cost of some housing and meals, the exact amount of which to be determined.
- Shipping your ROV system and tools to competition venue.
- Costs associated with fund raising or event presentations to community.
- Miscellaneous expenses for photocopying, phone calls, shipping costs associated with ordering ROV components, poster session materials, mailings, courier, etc.

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***National Marine Sanctuaries***

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