



2006 MATE Center/MTS ROV Committee ROV Competition For High School & College Students

www.marinetech.org/rov_competition/index.php

*Challenging Teams to Design & Build Vehicles for the Next Generation of
Ocean Observing Systems*



Design & Building Specifications and Competition Rules



Competition Classes:

The MATE Center's ROV competition is divided into two classes – **EXPLORER** and **RANGER**.

EXPLORER class ROVs operate at a maximum of 51 volts DC, 40 amps.

RANGER class ROVs operate at a maximum of 13 volts DC, 25 amps.

Teams must choose to enter **one** competition class. Two teams per instructor will be considered as long as one team represents a high school or home school and the other a college or university. Institutions/instructors interested in entering one team per competition class will be considered on a case-by-case basis.

Design & Building Specifications:

Note: Teams ARE permitted to design, build, and operate more than one ROV. However, the combined power of these vehicles CANNOT exceed the maximum power limits listed below. The power limits in each class are not per vehicle, but for all vehicles combined. In other words, the sum of the power requirements for each vehicle must be within the class-specific power limits.

All vehicles must be documented in the technical report. A vehicle is considered documented in the tech report if 1) there is a picture of the vehicle; 2) the vehicle's systems are described in detail; and 3) there is an electrical schematic provided for the vehicle.

EXPLORER

Power: Maximum surface supplied power – 51 volts, 40 amps.
Maximum onboard power – 13 volts, 25 amps.

Your ROV must operate on DC voltages. Only low-voltage (i.e., 24 volts or less) AC control signals are allowed through the tether. The total electrical power allowed to travel down the tether is limited to a maximum of 51 volts and 40 amps. All power traveling down the tether must go through a single fuse that does not exceed 40 amps and is readily accessible to competition officials.

Onboard power is permitted but is limited to a maximum of 13 volts DC and 25 amps. Onboard power must be electrically isolated from surface-supplied power and use a power source that is safe for the event venue (e.g., gel cell batteries, non-liquid type batteries, generators, etc.). All onboard power systems must be connected in series to a single fuse that does not exceed 25 amps and is readily accessible to competition officials.

Onboard dive lights that contain their own DC batteries and use 9 volts or less are permitted and do not “count” towards onboard power limits. These lights must be self-contained; no other systems may be powered from onboard dive lights.

Other sources of “stored,” non-electrical power (hydraulic or inert compressed gas) are permitted, provided that they meet the following safety guidelines:

- hydraulic, such as oil or other liquids up to 150psi
- pneumatic, such as compressed, inert gases up to 60psi

These non-electrical sources of power can be:

- run by hand or foot (e.g., manual bicycle tire pump)
- run by DC. Note that DC systems must be fused
- run by 110 volts, GFI-protected AC (e.g., AC-powered air compressor)
- generated from approved, tested, and inspected pre-pressurized containers. These containers must have a safety relief device. Please see safety rules on SCUBA and other compressed air containers in the **Safety & Power** section below.

EXPLORER class teams will be provided with a GFI-protected 110/120-volt, 15-amp AC power source. This AC power can be used to run topside computers, additional video devices, repair tools, etc. This AC power source cannot be used to power your vehicle or any onboard payload tools.

Monitors: Three.

MATE will provide one video monitor and one 6-outlet power strip at the control shack. This monitor will be powered by the GFI-protected 110/120-volt, 15-amp AC power source mentioned above. This monitor will have both RCA and RF inputs. Your team must supply any additional monitors (including monitors for practice sessions), video recorders, etc.

Depth Rating: Up to 13 meters (~40 feet).

Your vehicle must be able to operate at a water depth of up to 13 meters (~40 feet).

Tether Length:

Depth will be 13 meters maximum. All underwater missions will take place within 10 meters from the side of the pool. The control shack will be no more than 2 meters from the side of the pool. Tether length should be calculated accordingly.

Operating Environment: Chlorinated freshwater.

Your vehicle must be able to function in a pool environment. The pool contains fresh, chlorinated water and should be considered conductive of electrical currents. All electrical components must be waterproofed against the elements. ROVs that cannot demonstrate basic waterproofing will not pass the safety check.

Size Restrictions:

The mission team must be able to personally transport the vehicle and associated equipment to the control shack. The vehicle must be launched and recovered manually; no powered winches or portable cranes can be used. Hand powered lifts and levers may be used to launch and recover the vehicle. The vehicle and any associated equipment must not damage any part of the pool or pool deck.

RANGER

Power: Maximum surface power – 13 volts, 25 amps. No onboard power is permitted.

MATE will provide a 12-volt DC power source capable of 25+ amps to operate your ROV. Your ROV must operate on DC voltages. Connections to this power supply will be via standard banana plugs. Your ROV must have male banana plugs 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.)

All ROV systems (cameras, motors, manipulators, control systems) must operate off of this 12-volt power source and are limited to a total current draw of 25 amps. ROV cameras **MUST** operate off the 12-volt power supply, not AC power.

Onboard power is **NOT** permitted for RANGER class vehicles, with one exception. Onboard dive lights that contain their own DC batteries and use 9 volts or less are permitted. These lights must be self-contained; no other systems may be powered from onboard dive lights.

Other sources of “stored,” non-electrical power (hydraulic or inert compressed gas) are permitted, provided that they meet the following safety guidelines:

- hydraulic, such as oil or other liquids up to 150psi
- pneumatic, such as compressed, inert gases up to 60psi

These non-electrical sources of power can be:

- run by hand or foot (e.g., manual bicycle tire pump)
- run by DC. Note that DC systems must be fused
- run by 110 volts, GFI-protected AC (e.g., AC-powered air compressor)
- generated from approved, tested, and inspected pre-pressurized containers. These containers must have a safety relief device. Please see safety rules on SCUBA and other compressed air containers in the **Safety & Power** section below.

RANGER class teams will be provided with a GFI-protected 110/120-volt, 15-amp AC power source. This AC power can be used to run topside computers, additional video devices, repair tools, etc. This AC power source cannot be used to power your vehicle or any onboard payload tools.

Monitors: Three.

MATE will provide one video monitor at each control shack. This monitor will be powered by a separate GFI-protected 110/120-volt, 15-amp AC power source. This monitor will have both RCA and RF inputs. Your team must supply any additional monitors (including monitors for practice sessions), video recorders, etc. These additional video devices and/or any repair tools (repair tools **NOT** payload tools) can be powered by AC. MATE will provide a single 6-outlet power strip at each control shack. Only video monitors, video recording devices, and repair tools can use this AC power. All other systems must run off the 12-volt DC power supply.

Depth Rating: Up to 5 meters (~16 feet).

Your vehicle must be able to operate at a water depth of up to 5 meters (~16 feet).

Tether Length:

Depth will be 5 meters maximum. All underwater missions will take place within 8 meters from the side of the pool. The control shack will be no more than 2 meters from the side of the pool. Tether length should be calculated accordingly.

Operating Environment: Chlorinated freshwater.

Your vehicle must be able to function in a pool environment. The pool contains fresh, chlorinated water and should be considered conductive of electrical currents. All electrical components must be waterproofed against the elements. ROVs that cannot demonstrate basic waterproofing will not pass the safety check.

Size Restrictions:

The mission team must be able to personally transport the vehicle and associated equipment to the control shack. The vehicle must be launched and recovered manually;

no winches or portable cranes can be used. The vehicle and any associated equipment must not damage any part of the pool or pool deck.

Competition Rules:

General:

- All members of the team and their supporters must follow the safety regulations of the ROV competition, pool facility, and event venue.
- All team 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 teams will lead to penalty points or disqualification.
- Sabotaging, stealing, or pilfering equipment of other teams will lead to disqualification. Teams found cheating will also be disqualified.
- The MATE ROV competition is, at its core, designed to be an educational and inspirational event for STUDENTS. Therefore, it is expected that all adults involved in the competition (e.g. teachers, mentors, parents) limit their input to educational and inspirational roles. Actual construction of the ROV (particularly in the complex electrical and software areas) should be completed by the student team members. Adults may work closely with students in design and construction. Throughout the process adults are encouraged to focus on benefits to the student form the process not simply “winning” the competition. If during the engineering judging or mission execution it becomes apparent that adults exercised more than an advisory role, judges reserve the right to deduct points or, in extreme cases, disqualify teams.

Upon arriving at the ROV competition, ALL work done on the vehicle must be conducted by team members. Teachers, mentors, parents, and non-competing students will not be allowed 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 student team members. Judges who observe unauthorized work by non-team members will deduct engineering or mission points or disqualify teams, depending upon the severity of the infraction. If teams choose to take their ROVs off the competition grounds for maintenance and repair, they are expected to observe this rule in the interests of the spirit of the competition.

- To encourage student participation at all levels, MATE is discouraging the use of “off-the-shelf” technology. Much of engineering involves integrating existing technology into new systems. As such, students are encouraged to turn to commercially-available technology where available (and affordable). Individual

discrete “components” obtained commercially are acceptable. However, as this is an educational event, students are strongly discouraged from using commercially available “plug-and-play systems” within their ROVs. These devices violate the spirit of the competition in that they remove many of the technical challenges of electrical and software engineering. Thus, they eliminate much of the educational value of the event. An extreme example would be a team that focused its efforts on fundraising and simply purchased one of the low-cost ROVs available commercially. Such an entry would not be permitted.

Multiple commercial components are ENCOURAGED; systems designed to perform multiple, complex functions from one “black box” or a series of components designed to integrate with each other are DISCOURAGED. Examples of “components” versus “systems” are provided below. If teams are uncertain about the commercially-available items that they plan to use, they should contact the competition coordinator early in their design phase. All such questions, and answers, will be posted to the FAQs section of the MATE competition web site.

The engineering evaluation and technical report score sheets will reflect MATE’s effort to discourage the use of off-the-shelf systems. For example, both score sheets will contain sections devoted to control systems, as they have in previous competitions. However, teams that demonstrate control systems constructed from “scratch” versus complete control system purchased from a commercial vendor will be awarded higher scores. In addition, the originality of design and teamwork sections will be weighted more heavily than they have been in past competitions.

Examples of commercially-sourced components:

- Tethers
- Thrusters
- Radio control transmitters and/or receivers
- RC servos and/or motor controllers
- Pressure housings
- Watertight connectors
- Cameras with or without watertight housings
- Structural materials

Examples of commercially-sourced systems:

- “Black box” controllers that provide for multiple power and control signal interconnections and manipulations
- Thrusters, motor controllers, cabling, and control box designed and sold as a “system”

Procedural:

- Teams must compete during their assigned time slot. You are **NOT** permitted to switch time slots with another team. Failure to show at the control shack for your

scheduled mission performance run or at the room assigned for your team's engineering evaluation interview 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.

- The mission team is limited to six students. Only these six students will be allowed to launch, pilot, and perform the mission. Instructors, mentors, and/or non-student members cannot participate as part of the mission team. RANGER teams may alternate students on the mission team for the various heats.
- Only the mission team members and judges are allowed in the control shack during the mission period, which includes the set-up and demobilization periods. Other team members, instructors, mentors, audience members, and observers (press or special invited guests) must remain outside the control shack or in designated viewing areas.
- Video devices may be used to record the underwater activities. One or two mentors will also be allowed on the pool deck to video their team during the competition. Video is for entertainment and learning purposes only. Video will not be used as an instant replay to review judges' decisions or to challenge mission timing.
- Control shacks will be marked, roped off, and designated as the either RANGER or EXPLORER. Control shacks will contain 2-3 chairs and one 6-foot table long table for teams to use. This table will be within 2 meters of the pool edge. Control shacks 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 cameras.
- The mission consists of a 5-minute set-up period, the mission performance period, and a 5-minute demobilization period. Each RANGER mission performance period is 25 minutes; the EXPLORER mission performance period is 30 minutes. If the mission team and all of their equipment are not out of the control shack at the end of the 5-minute demobilization period, they will be penalized **1** point per each additional minute.
- RANGER class teams will get two separate attempts to complete their mission tasks. (Note that these heats will not be scheduled back-to-back.) The better of the two scores will be used to determine the winner of each event and to calculate the total, overall score for the competition. In the case of a tie, the second (lower) score will be used as the tiebreaker.
- EXPLORER class teams will get only one attempt at their mission. That score will be used to calculate the total, overall score for the competition.
- 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 mission score.

- Communication between mission team members poolside and those in the control shack will be limited. Only tether management issues (e.g., how much tether is out, how much is remaining on the pool deck, whether the tether is entangled) can be discussed. Those mission team members at poolside cannot give any directional or mission information to the pilot. Judges will issue one warning regarding illegal communication. Each future infraction will result in **5** points deducted from the final mission score.
- Pilots can only leave the control shack and move poolside to repair, adjust, or alter a vehicle if the ROV is surfaced and at the side of the pool.
- No 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. Teams will be disqualified or penalized depending on the severity of the infraction.

Safety & Power:

- All ROVs must be operated using DC voltages. Only low-voltage AC control signals are allowed through the tether.
- Maximum DC voltage for RANGER class teams is 13 volts.
Maximum DC voltage for EXPLORER class teams is 51 volts.
- Maximum DC amperage for RANGER class teams is 25 amps.
Maximum DC amperage for EXPLORER class teams is 40 amps.
- **All teams – RANGER and EXPLORER – must demonstrate the presence of a fuse within their vehicle’s electrical circuitry to competition officials in order to pass the safety inspection.** EXPLORER class teams using onboard power must also demonstrate the presence of a fuse within their vehicle’s onboard electrical circuitry. Other power control devices similar to a fuse, such as a breaker switch, will be considered on a case by case basis.

The MATE battery provided at each RANGER class station does include an in-line fuse, but each team needs to protect their system with an additional fuse. If your vehicle is not protected with a fuse above and beyond the fuse provided on the MATE battery for the RANGER class, **YOU WILL NOT PASS THE SAFETY INSPECTION.**

- If a RANGER class team blows MATE’s in-line 25-amp fuse during a mission, they are allowed one replacement fuse. If the vehicle blows the second MATE fuse, their mission performance period is over. The team will receive points for

the mission tasks they have completed up to that point, but will not receive a time bonus score.

- If an EXPLORER class team blows their 40-amp fuse, their mission performance period is over. The team will receive points for the mission tasks they have completed up to that point, but will not receive a time bonus score.
- Hazardous and/or non-biodegradable materials may not be intentionally released into the competition waters or atmosphere.
- SCUBA tanks are permitted as a source of non-electrical power. However, please be aware of the following safety concerns:
 - Please handle the tanks carefully and with respect. The kinetic energy potential contained within an average SCUBA tank is 1.3 MILLION foot-pounds. This is enough energy to lift a 100-ton diesel locomotive off its tracks and into the air.
 - Safety needs to be stressed at all times. There have been cases of a tank being dropped, causing the valve to break off, with the resulting stream of air causing the tank to become a missile and propelling itself through solid concrete walls.
 - Never carry a tank over your shoulder. Losing your balance due to tripping or avoiding someone could cause the tank to fall on the valve. If the valve shears off, that tank instantly becomes a projectile. Always carry the tank in a manner to protect the valve.
 - If you hear air coming from the tank valve, do not put your ear near the valve. You don't want to risk damage to your hearing.
 - Never leave tanks standing up. Always lay them on their side, making sure to secure them from rolling.
 - Never leave tanks in a hot car or room.
 - Be sure to follow proper protocol for turning on the air – i.e., turn the valve completely on then turn back ¼ turn. The reasoning behind this is that if a valve is all the way open, someone might think that the valve is actually closed and try to open it more, which could possibly damage the valve.
 - Tanks are required to be visually inspected at least once a year. Make sure that the tanks that you are using have been inspected. Competition officials will be looking for a valid inspection sticker during the safety check.
- **Teams with questions about their planned power scheme should contact the competition coordinator AS SOON AS POSSIBLE. (It is better to clear up any concerns now rather than the day of the competition.)**

Design & Safety Considerations:

- **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.

Teams will be informed immediately if their ROVs do not meet safety requirements. Teams are permitted to correct any issues, although they will not be given additional time to do so. A final safety check will take place during the 5-minute set-up period. If the safety issue has not been corrected, the team will not be allowed to compete.

- Keep an eye out for tripping hazards in the control shack and at your team's work station. Make sure any power cords are not laying in pools of water on the deck.
- During your mission period, be sure to secure any equipment so that it does not fall off the control shack table, damage the deck, or cause injury. Make sure any power cords are not laying in pools of water on the deck.
- EXPLORER class teams using AC to DC power supplies (transformers) must be locate them at least 3 meters from the pool's edge. They must be elevated off the pool deck to prevent standing water from creating an electrical hazard.
- RANGER teams may use their own 12-volt DC power source. This is permitted as long as the competition officials are ensured that the supply is safe, fused, and gives no advantages over other teams using the power source supplied by MATE. **If you do plan to use your own power source, you must submit your intention in advance of the competition; include it along with your technical report.** You are encouraged to use standard banana plugs to connect to your own power source. That way, if there is a problem with your power source, the 12-volt power source that MATE provides can be used as a backup.
- RANGER class teams must have two individual male banana plugs (not a dual banana plug) on the end of your 12-volt DC power connections in order to connect to the 12-volt DC power source provided by MATE.
- Lead-acid storage batteries with liquid electrolyte **MUST** be carried and kept in a leak proof container to prevent accidental spillage of electrolyte if a battery is dropped.
- ROVs may be constructed out of materials of your team's choice, provided they meet the competition rules and safety regulations. Warning labels should be posted on potentially hazardous components of your ROV system.
- Light levels may be reduced and the surface of the water near the control shacks may be rippled to make it difficult to clearly see your vehicle or the pool bottom.

- All teams must wear close-toed shoes and safety goggles. **No one will be allowed into the work station area without closed toed shoes and safety goggles.** This includes team members, parents, mentors, and guests.