2026 MATE ROV COMPETITION:

Pushing Performance: Science, Technology, & Discovery in Harsh Environments

EXPLORER CLASS COMPETITION MANUAL

PART 2: VEHICLE DESIGN & BUILDING SPECIFICATIONS

1.0 GENERAL

IMPORTANT NOTE: Questions about the competition, including the production demonstrations and design and building specifications, should be posted to the MATE ROV Competition Forum Board. Questions will be answered by MATE ROV Competition staff so that all companies can see the questions and answers. This will also help to avoid duplicate questions. That said, please make sure that your question(s) has not already been asked – and answered – before posting. It is up to you and your company to read, comprehend, and comply with ALL rulings posted on the site. All pertinent rulings will be posted to the 2026 Official Rulings thread, which will be pinned to the top of the forum board.

When emailing their question, companies should reference:

- Any specific specification or rule (e.g. ELEC-002E)
- Competition class

Conventions: All values contained in this document are threshold values unless specifically stated otherwise. All water depths are given in meters (m). All dimensions and measurements utilize SI units.

EXPLORER class companies competing at a regional event should contact their regional coordinator or visit their regional contest's website to find out any specific requirements for your regional.

2.0 SAFETY

Safety is the competition's primary concern and guiding principle. Any system that is deemed unsafe by competition officials will not be permitted to compete. If a safety concern is identified during the initial inspection, companies are permitted to modify their system and have it re-inspected. Companies are permitted to have their vehicle re-inspected twice. If a company fails to pass its third and final safety inspection, it is disqualified from the underwater competition portion of the event. There are NO APPEALS once an ROV has been disqualified.

NEW for 2026!!!

This year the MATE ROV Competition will reinforce the competition's emphasis on safety *and* workmanship. This year vehicle inspections will include both a safety *and* a workmanship inspection. **Companies that do not meet the safety standards will not be permitted to compete in the in-water events until issues are corrected. Companies that do meet workmanship standards will have points deducted from their workmanship score sheet but can still compete in the product demonstration.** Safety and workmanship examples will be included in the MATE ROV Competition Safety Inspection Tutorial.

See the Onsite Safety Inspection Score Sheet and the Onsite Workmanship Sheet for specific information. The Technical Bulletin – MATE Expected Work Practices has additional information on workmanship and minimum industry standards. `

Examples of safety violations from previous ROV competitions include:

- Companies used equipment that did not participate in and/or pass safety inspection.
- Companies did not have the required Anderson SBS50BLU or Littelfuse.
- The electrical SID included in the technical documentation did not show a main fuse.
- The ROV used pneumatics, but the technical documentation did not include a pneumatics diagram or pneumatic specifications.
- The ROV used pneumatics, but the company had not passed the fluid power quiz.
- Motors were not shrouded to IP-20 standards

Examples of workmanship violations from previous ROV competition include:

- Circuit boards and components were not securely fastened.
- There was insufficient strain relief topside or ROV-side.
- Wiring in the control box is messy; a "rat's nest."
- Wires in the control box were not properly labeled
- Wires in the control system have improper termination
- Jumper pins were used to make connections in final control box

2.1 Jobsite Safety and Environment Analysis

Each member of the company is encouraged to read Oceaneering Americas Region HSE Employee Handbook, with emphasis placed on the following chapters.

Chapter 1 - Housekeeping
Chapter 9 - Hand Safety
Chapter 11 - Lifting and back safety
Chapter 12 - PPE
Chapter 17 - Tool Safety
Chapter 24 - Electrical Safety
Chapter 29 - Employee Observation Program
Chapter 33 - JSEA
Chapter 37 - Working at Other sights

Jobsite Safety and Environment Analysis (JSEAs)

Note for 2026!!!

Companies advancing to the World Championship are required to create a JSEA and submit it along with (but as a separate document from) the Technical Documentation. Companies are also required to bring their JSEA to the onsite safety inspection; companies will not pass their inspection without this document. Companies must also bring a copy of their JSEA with them to the mission station and present it to the mission station judges prior to setting up for each of the product demonstration attempts. Companies will receive 5 points on their product demonstration score sheet for presenting the product demonstration judges with their JSEA prior to setup. **Companies without a JSEA will not be allowed to compete in the product demonstration run.**

JSEAs may or may not be required for EXPLORER class companies attending a regional. Contact your regional coordinator or visit their regional contest's website to find out whether a JSEA is required for an EXPLORER regional competition.

A **JSEA** describes job tasks in step-by-step fashion, identifies associated hazards at each step, and outlines proper hazard controls that minimize the risk of injury or illness to the individual(s) performing that task. JSEAs are used extensively by the offshore industry.

The JSEA process follows a structured approach that comprises three (3) processes

In addition to these three processes, JSEAs should include the following information:

- The scope of the work.

- Space for specific names to be entered as responsible for implementing safeguards.
- Names and positions of all members involved in the JSEA discussion or Toolbox Talk.

- Describe Job Steps
  - Breakdown the task into basic steps. Each step should briefly describe what is done and in what order. Avoid making the breakdown so detailed that it has too many steps or making the job breakdown so general that basic steps are omitted.
- Identify the Hazards
  - Examine each step for hazards – either caused by the task to be conducted or by the work environment – or for any situation that might deviate from expected circumstances. The main activity in the JSEA procedure is to determine the hazards or potential hazardous exposures at each step of the task. Companies should strive to recognize all potential risks and plan to eliminate or reduce the hazards identified.
- Implement and Assign Safeguards
  - Safeguards must be implemented to defend against the identified hazards. Remember that Oceaneering maintains the following Safeguard Hierarchy for implementation:
    - **Eliminate** the risk by avoiding it altogether, eliminating the source of risk, or substituting the source of risk with something that poses no risk or a much lesser risk.
    - **Engineer** solutions that reduce the risk or eliminate exposure to it.
    - Provide necessary Personal Protective Equipment (**PPE**) to protect from residual risk.
  - Assign responsibility for safeguards

    For safeguard implementation, it is extremely important to assign direct responsibility for each safeguard developed during the JSEA process. For example, if a task requires the replacement of a hydraulic pump, a safeguard would be to isolate the energy source feeding the pump's drive motor. The ideal method to describe this safeguard implementation on the JSEA would be: "*Tech II Bob* will apply lock-out /tag-out to *the energy source.*"

    These responsibilities should be communicated to the appropriate personnel when the JSEA is reviewed by the company.

For more information and examples, companies can visit the following web sites:

- Shops and Trades | Office of Environment, Health & Safety (berkeley.edu) https://ehs.berkeley.edu/shops-and-trades
- SafetyWorks!: Job Hazard Analysis (safetyworksmaine.gov) https://www.safetyworksmaine.gov/safe_workplace/safety_management/hazard_analysis.shtml

POTENTIAL HAZARDS

DESCRIBE JOB STEP (List the natural steps of the job. Do not make the steps too broad or too fine)	POTENTIAL HAZARDS (What are the potential hazards identified at this part of the job steps)	RECOMMEND RISK CONTROL MEASURES (describe how the identified hazards can be eliminated or reduced)	RESPONSIBLE PERSON (S) (Implementing control)	INITIAL (Of the responsible person/s)
Toolbox Talk	Miscommunication	**ANYONE can call ALL STOP at any point if an unsafe condition /act is perceived/observed.** **Cell phone use is PROHIBITED in test area while testing!** Ensure all participants are aware of procedures and roles within the procedure and sign JSEA acknowledging thusly. Ensure that all participants are wearing correct PPE (safety glasses, safety shoes, gloves, and hard hats if crane ops are being performed) Ensure participants/witnesses are wearing adequate clothing for weather conditions and to take breaks whenever necessary.		
Hydraulic Function Testing	Stored/Trapped Energy: Up to **12,000 PSI** Environmental Discharge Tubing/Hose Failure Line of Fire	Ensure all functions have pressure/flow reduced to 0 PSI when not being actively function tested. Ensure each circuit is setup correctly before increasing pressure. Ensure Vent hoses are properly connected to fluid containment reservoir. Ensure all hoses are whip checked before coming up on pressure. Ensure valves and actuators are in proper configuration before testing. Ensure relief valves are set to relieve at the proper setting.		

Example JSEA task items courtesy of Oceaneering International

NOTE for 2026!!!

Companies **MUST** focus their JSEA on their deck/dive operations only. **Shop safety and tool safety for building the ROV is extremely important but does not belong in this JSEA**. The submitted JSEA should focus information on potential hazards and recommended risk control measures of a company's pool side operations. This JSEA should cover topics such as:

Deck Ops/Launch and Recovery:

- Entering/exiting the pool deck area
- System set up
- Power up checks
- Pool side operations
- System breakdown

Examples of JSEAs:

- **2025 Overflow Robotics**
- **2025 Alcona RAFT Robotics**

2.2 Safety Pre-Inspection

A safety pre-inspection will be completed before competition day. Companies will submit the following documentation to the MATE ROV Competition. EXPLORER teams competing at a regional event should submit their required documentation to their regional coordinator. Regionals may not require all of these documents. Contact your regional coordinator or visit your regional contest's website to determine the required documents as well as the date and proper format for submission. Safety pre-inspection document submissions will include the following:

- Technical documentation
- Company spec sheet
- SID [Electrical, Pneumatic & Hydraulic as utilized]
- Non-ROV device design document (if used)
- Non-ROV device SID (if used)
- Company safety review
- JSEA

See 2.2.1 Safety documentation requirements below for more information.

Once received, safety inspectors will conduct an initial safety inspection to identify potential safety and workmanship violations. This inspection will be worth 20 points. Companies with violations will be notified via email. Once notified, companies must:

1. Respond acknowledging receipt
2. Layout a plan to address this violation
3. Submit new documentation if required

Onsite safety inspectors will also be informed of any potential safety violations identified during the initial safety inspection. This will allow safety inspectors to verify that any issues have been resolved.

2.2.1 Safety documentation requirements

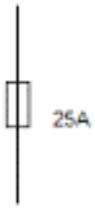
Unless stated otherwise, each document MUST be submitted separately. In addition to the SID included in the technical documentation, an individual SID must be submitted for the initial safety inspection. The company safety review should NOT refer to systems shown in a submission video or detailed in the technical documentation.

DOC-001: SID Electrical: This must be an electrical diagram for all ROV systems. One section should focus on the systems above the waterline, and one section should focus on systems on the ROV (below the waterline). The SID:

- Should not exceed one 8.5" x 11" page in length (both above and below water sections, as well as any other information, should be on one page). Printed documents must be sized to fit on one side of the printed paper.
- Must be drawn with a CAD (computer assisted drawing) program. Hand drawn figures are not permitted.
- All symbols used should be standard symbols as specified by ANSI, NEMA or IEC.

- The SID must include a FUSE SYMBOL using an ANSI, NEMA or IEC symbol.
- ***Note for 2026!!!***: The SID does not require fuse calculations; instead, companies must determine their full load amps (FLA) in water value and include that on the SID (see 3.3.3 Current for more information).
- The SID must not be component level schematics, but a higher-level interconnection block type diagram. Do not include individual pins on a board; the SID is a higher-level diagram.

The following ANSI and IEC fuse symbols are all acceptable for MATE documentation:

Item	ANSI	IEC
FUSE		

An example of an acceptable SID can be found here:

- **2025 Jesuit High School Rovotics SID**

DOC-002: SID Fluid Power: Companies using fluid power **MUST** include a fluid power diagram using industry standard symbols, showing all items, including regulators, and control valves. The diagram must document the components on the surface and the components located onboard the ROV. Fluid power diagrams must use ANSI, NEMA or IEC symbols. The fluid power diagram must also be drawn with a CAD program and should be a one 8.5" x 11" page diagram. The fluid power diagram may be included on the main electrical SID or as a separate one-page document.

DOC-003: SID Non-ROV Device: Companies utilizing an independent sensor or other electrically powered, non-ROV device to complete a product demonstration task must submit a SID for this device. The *MATE Floats!* vertical profiling float, if designed and used at the competition, is considered a non-ROV device. This diagram must be completed to the specifications listed in DOC-001. The non-ROV device SID may be included on the main electrical SID or as a separate one 8.5" x 11" page document. Two (or more) separate pages may be used for two (or more) different non-ROV devices. Companies must include the full load amps in water value and the selected fuse size on their non-ROV device SID. Companies not designing and building a vertical profiling float or powered release container should state so in their Company Safety Review.

DOC-004: Non-ROV device design: Companies will be required to submit a written and photographic description of their non-ROV device. For 2026, this only includes Task 4's vertical profiling float. This document is limited to 2 pages in length. Companies must measure the full load current of the float and select their fuse size from their full load amps value. This non-ROV device design document must contain:

- A photo or diagram of the non-ROV device.
- The type of battery used.
- A photo of the battery pack.

- A photo of the fuse(s) used on the non-ROV device.
- A table of the measurements showing full load current.
- A description of the buoyancy engine used to complete vertical profiles.
- A description of how the float communicates with the shore side receiver. If any commands are given to the float after deployment, those communications must be described too.
- A description of how the battery pack was designed to safely fulfill the full load current needs and the voltage requirements of the float device.

A SID of the non-ROV device document must be included with the non-ROV device design document. This SID must be one page in length and is in addition to the 2 pages for the non-ROV device design document (i.e. DOC-004 can be a total of 3 pages, 2 pages for a description, 1 page for a SID). The SID must include:

- A fuse using a standard fuse symbol.
- Full load amps in water value and fuse size selected.

NOTE for 2026!!!

Any electrical or fluid powered device on the ROV MUST be documented on a SID. Depending on the type of device, it may be on the main ROV SID, an independent sensor SID, a Non-ROV device SID, or a Fluid SID. Any such device not represented on a SID cannot be used in the competition.

Examples of Non-ROV device documents:

Coral Crusaders Non-ROV device document 2025

St. Francis Genesea Non-ROV device document 2025

Additional Non-ROV device documents can be found in the 2025 Archives under the Technical Reports, Spec Sheets, Float Documentation tab.

DOC-005: Company safety review: EXPLORER companies submitting a company safety review MUST show compliance with the following specifications:

- SBS50 Anderson powerpole connectors are the main point of connection to the MATE supply (ELEC-011E).
- A properly sized Littelfuse is within 30 cm of the main point of connection to 48-volt power. The company must use a ruler to show this distance (ELEC-010E).
- Full load amps value and fuse size selected (ELEC-009E).
- The inside of the control box does not have exposed wiring (ELEC-018E), the control box is neatly laid out with attention to workmanship (ELEC-023E), a separation and identification of 120VAC wiring from DC and control voltages (ELEC-024E). If AC wiring is not used in the control box, include a statement saying no AC is used. Note: Companies using a computer or laptop should state that they are using a laptop and include the type of controller (Joystick, Xbox controller, etc.).
- The tether leading to control system has adequate strain relief (ELEC-025E).
- The tether leading to the ROV has adequate strain relief (ELEC-025E).
- If used, hydraulic / pneumatic systems include a pressure release valve, shut-off valve and regulator in the system (FLUID-004, FLUID-008), and that any pressurized cylinder, pressure

storage device meets the MATE specifications (FLUID-003, FLUID-004, FLUID-007, FLUID-008).

- ***Note for 2026!!!*** If used, the specifications and details of the hydraulic / pneumatic components, including pressure ratings of hoses and components.
- Any watertight housing on the vehicle can withstand pressure at 5 meters (MECH-001).
- All propellers are shrouded and have propeller guards (MECH-006).
- The ROV has no sharp edges or elements of the ROV that could cause damage (MECH-006, MECH-007, ELEC-018E).

The following photos **MUST** be included within the company safety review:

- SBS50 Anderson powerpole within 30 cm of the Littelfuse (show fuse, ruler and connectors).
- Inside of the control box with wires labeled or control system (and controller) for those using a computer or laptop.
- Strain relief where the tether connects to the control system.
- Strain relief where the tether connects to ROV.
- Compressor or pump (if pneumatics/hydraulics are used) including release valve, shut-off valve and regulator.
- Propeller shrouds (front and back of one propeller).
- The entire vehicle

The company safety review should include an explanation of how each system meets the safety specifications and include photographs of the relevant systems for review by the MATE ROV Competition officials.

Examples of EXPLORER Company Safety Reviews:

- **Memorial University Eastern Edge Company Safety Review_2025**
  This company includes all components in their company safety review
- **East Tennessee State University Company Safety Review_2025**
  This company does not use fluid power or a non-ROV device and clearly state that fact in the company safety review.

Initial Safety and Documentation Review points

Penalty points will be deducted from the initial safety and documentation review if:

- Companies do NOT submit ALL the required documentation by the given date. See KEY DEADLINES.
- Submissions are not within the given file size or page limit, submissions do not use the proper naming convention, or documents are not submitted as PDFs. See DOCUMENTATION for more information.
- The SID does not show a fuse, or the fuse does not use an ANSI, NEMA or IEC symbol.
- Full load amps value and fuse selected are not shown on the SID.
- The vehicle uses fluid power, but a fluid power diagram is not included.
- A non-ROV device is used but is not shown on any SID.

- A non-ROV device is used but not properly documented (including all required photos and descriptions).
- Companies not using fluid power or not attempting a task requiring a non-ROV device, do not state this fact in the company safety review.
- The company safety review does not show compliance with all of the specifications.

The initial safety and documentation review rubric can be found here.

Documentation notes: The MATE ROV Competition recommends that companies keep a folder with specification sheets for all commercially purchased components, as well as testing procedures and results for any home-made components. This can be a physical copy in an actual folder, a digital copy in an electronic folder, or both. If a safety inspector has a question about a specific component, companies will then have all the necessary documentation on hand. For example, if a company is using a Blue Robotics T200 thruster, companies should print out the Technical Details - Specification section and include these specifications in their folder along with any software limitations they have incorporated to maintain the proper current restrictions of the MATE ROV Competition.

2.3 Onsite Safety Inspection

Companies must complete their onsite safety inspection before their vehicle enters the water.

Companies advancing to the World Championship must complete their first onsite safety inspection immediately after checking in. A sign-up form with specific dates and time frames will be circulated in advance of the World Championship. Companies should review this form carefully and select the date and time frame that aligns with their travel plans. Companies that ship their ROV should also consider the expected delivery date and time when making their selection; without a vehicle present, the company will fail their first onsite safety inspection. Companies are required to check in and undergo their first safety inspection on Tuesday, June 23rd or Wednesday, June 24th, prior to the MATE World Championship competition. Accommodations will be made for companies that experience travel delays beyond their control (i.e., a cancelled flight or flight delay), but these will be the exceptions and not the norm.

NOTE for 2026!!! All items used on the ROV MUST participate in and pass safety inspection. Companies that use a device that did not participate in and pass the safety inspection will be disqualified. Companies should prepare for their safety inspection as if they are headed to a product demonstration run. All equipment being used for a run should be available for inspection. A power supply will be available; companies may be required to power up their control system and vehicle during the safety inspection. The inspector(s) will reference the list of violations as he/she conducts the safety inspection of the vehicle using the onsite safety inspection and workmanship rubrics.

At the World Championship, companies MUST pass their safety inspection by the end of the first day of the competition. Companies that do not pass their safety inspection by the end of the first day will be disqualified from the underwater product demonstration component.

What follows is the safety inspection protocol used at the World Championship. For EXPLORER class teams competing at a regional event, consult your regional coordinator or visit your regional contest's website for more information about the safety inspection process used at your regional.

2.4 Safety Inspection Protocol

New for 2026!!!

The inspection will be divided into two parts, safety and workmanship.

Safety Inspection Protocol

1. Before entering the water for practice or a product demonstration run, the ROV system must go through a safety inspection. Once a company successfully passes inspection, they will turn in their safety inspection sheet to the safety inspector and receive a Blue PASSED Card with their company number on it. Companies must present the Blue PASSED Card to the pool practice/product demonstration coordinator before their vehicles are permitted to enter the water.
2. Competition staff will conduct a safety inspection of the vehicle using the safety inspection rubric.
3. If the safety inspector(s) identify a safety violation, companies will have the opportunity to address it. The pool practice or product demonstration run schedule will NOT change to allow companies more time.
4. If during the second safety review the
    a. violation has not been properly addressed or
    b. another violation is revealed

   companies will have ONE additional opportunity to address the issue.
5. If during the third safety inspection a violation still exists, safety inspectors will request that the Chief Judge(s) review the violation. If the Chief Judge(s) confirms the violation, companies will not be permitted to participate in the underwater product demonstration component of the competition. However, companies can still participate in the engineering and communication (technical documentation, engineering presentation, and marketing display) component.
6. Reminder: All companies must present the Blue PASSED Card to the pool practice or product demonstration judge before placing their vehicles in the water. In addition, product demonstration station judges and competition officials can pause or stop a product demonstration run at any time if they feel that there is a potential safety concern.

Workmanship Inspection Protocol

1. Competition staff will conduct a workmanship inspection of the vehicle using the workmanship inspection rubric.

2. If the safety inspector(s) identify a workmanship violation, points will be deducted from the workmanship inspection rubric.
3. Companies that have a workmanship issue will still receive their blue PASSED safety card and can compete in the product demonstration.

2.5 Safety Inspection Points

The safety inspection is worth 30 points. Each time a company fails its safety inspection it loses 10 points. After a company fails its second inspection, it must meet with the chief safety inspector to discuss a plan of action prior to returning to its workstation. THREE STRIKES and a company

a. Receives 0 points for the safety inspections and
b. Is disqualified from the underwater product demonstration component

The workmanship inspection is worth 20 points total. Companies that do not meet the workmanship requirements will lose 5 points per issue identified.

Additional information on workmanship can be found in the MATE ROV Competition Tech Bulletin - MATE Expected Work Practices Updated.pdf.

Note for 2026!!!
MATE highly recommends using transparent, see-through electronic enclosures onboard the ROV and float. Safety inspectors MUST be able to see the contents inside any enclosure. Companies not using transparent enclosures will be REQUIRED to open the enclosure and display the contents for the safety inspectors.

3.0 SPECIFICATIONS

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

3.1 Operational

3.1.1 Multiple Vehicles

OPER-001: EXPLORER class companies are required to design and build ONE ROV that can complete the necessary product demonstration tasks. "Floating eyeballs" or other vehicles that are not hard connected to the frame of the main vehicle are NOT permitted. Cameras designed to provide a "birds-eye view" are permitted provided that these cameras are hard connected to the frame of the main vehicle. "Hard connection" does not include the wiring between the camera and the ROV.

3.1.2 Environmental

OPER-002: The ROV system must be able to function in fresh, chlorinated water with temperatures between -2°C and 30°C. The water should be considered conductive of electrical currents.

At the World Championship, companies will operate in an ice tank. The tank is water mixed with an EGADS (Ethylene Glycol/Aliphatic Detergent/Sugar) at a 0.39% concentration. The ice tank operates at 0°C to 0.5°C during testing, but companies should assume a temperature as low as -2°C. The specific gravity of the EGADS ice tank is approximately 1.025.

OPER-003: The pool will not be covered or purposefully darkened in any way, although the specific product demonstration tasks may require that your ROV operates in low-light. Surface ice or waves may cause low light conditions.

OPER-004: Depending on the venue, pressurized pool filtration system outlets may cause unexpected currents. At the World Championship, companies will be operating in a flume tank with a current.

OPER-005: The pool venues at the World Championship have a flat, smooth bottom.

OPER-006: At the World Championship, the water level may be up to 30 cm below the level of the deck. Companies may need to lift their ROV or float over a rail 30 cm high to reach the tank. Companies should plan accordingly.

Note: EXPLORER companies attending regional competitions should note that regional events may be held in pool venues with different environmental conditions than those listed here. If you are unfamiliar with the regional pool, contact the regional coordinator or visit your regional contest's website for additional information.

3.1.3 Service Requirements

OPER-007: Companies shall provide a crew of at least 3 but not more than 6 people on the pool deck to operate the ROV System. Companies can send a larger crew complement, but no more than six can be on the deck at any time. More information about this "product demonstration team" is provided in the COMPETITION RULES.

3.1.4 Maintenance and Calibration Requirement

OPER-008: All measurement devices shall be calibrated according to manufacturer recommended calibration procedure and performed by company members only. Company mentors or advisors are not permitted to perform calibration procedures. More information about mentor restrictions is provided in the COMPETITION RULES.

OPER-009: System maintenance during field operations shall be conducted by ROV personnel at their workstations. Work of any kind must not be done by company mentors or advisors. All maintenance parts and equipment necessary to meet the operational requirements shall be provided by the company. More information about these regulations is provided in the COMPETITION RULES.

3.2 Mechanical/Physical

This section of the document provides specifications for the mechanical properties of the ROV system.

3.2.1 Materials

MECH-001: At the World Championship, any electronics housings on the ROV shall be capable of operating to depths of 5 meters.

3.2.2 Size and Weight

MECH-002: ROVs are limited to a maximum weight, in air, of 35 kg. Vehicles over this weight will not be allowed to compete. Product demonstration tasks will limit the size of the vehicle. Companies must be able to personally transport the vehicle and associated equipment to the product demonstration station and to the engineering presentation room. ROV systems must be capable of being safely hand launched. Additional points will be given to lighter vehicles (see WEIGHT RESTRICTIONS).

Note for 2026!!!

Companies should not rely on carts to transport their equipment to and from the station. Carts will not be able to reach all mission station areas.

3.2.3 Tether Length

Note for 2026!!!

MECH-003E: At the World Championship, ROVs must be capable of operating in a maximum pool depth of 4 meters (13.2 feet). All underwater product demonstrations will take place within 10 meters from the side of the pool. The product demonstration station will be no more than 3 meters from the side of the pool. Tether length should be calculated accordingly. EXPLORER companies attending regional competitions should note that regionals may be held in pool venues with different maximum depths than those listed here. If you are unfamiliar with the regional pool, contact your regional coordinator or visit your regional contest's website.

3.2.4 Vehicle Deployment and Recovery

MECH-004: The ROV system 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.

MECH-005: Any hand-powered lift or levers that are used as a launch and recovery system (LARS) must be detailed in the technical documentation and must be part of the safety inspection procedure. Any LARS equipment that is deemed unsafe at the safety inspection will not be allowed. Ladders, tripods, or other bracing equipment are not permitted as part of a LARS.

3.2.5 Propellers

MECH-006: Propellers must be shrouded and have thruster guards. ROVs that have propellers exposed without thruster guards will not pass the safety inspection and will not be allowed to compete. A shroud must completely encircle the propeller and extend at least 2 mm in front of and behind the propeller. Thruster guards must completely cover any openings on the thruster and should have a mesh size that meets IP-20 standards (solid particulate protection level 2). This IP code equates to a mesh size <12.5 mm. To pass safety inspection, the shroud and propeller guard should meet this standard. If your finger can touch the propeller, then it is not properly guarded.

Teams may construct thruster guards, 3D print thruster guards, or may purchase commercially available thruster guards. All motors on the ROV must be protected with shrouds and thruster guards on all sides.

See https://www.thingiverse.com/thing:1498338 for an example of an acceptable thruster guard.

New for 2026!!!

3.2.6 Sharp Edges and Pinch Points

MECH-007: No "sharps" are allowed on the ROV or other related systems. "Sharps" are defined as sharp edges or points that could cause harm to people or the environment. This includes cable ties cut leaving sharp edges, glass, cutting blades of any type, and the like. No glass will be allowed on the pool deck; glass can break and create sharp edges. The no glass rule includes video monitors with glass faceplates. Monitors with glass faceplates may not be used. For cable ties, MATE recommends using flush cutters with wire catcher to snip off the remaining tie leaving a smooth edge.

If a mission task requires a sharp device, that device should be marked with cautionary colors, such as yellow/black caution tape. This sharp device should be noted in the technical documentation, the engineering presentation, to the safety inspectors, and to the product demonstration judges, with the safety precautions taken by the company noted to those judges.

MECH-008: Any gear assemblies must be fully shrouded. Turning gears create pinch points that can cause injury. Geared systems are allowed, but the gears should be shrouded and protected to IP-20 standards (solid particulate protection level 2). This IP code equates to a mesh size <12.5 mm, but companies may use a solid covering as well. If a finger can touch the gear assembly, then it is not properly shrouded.

3.3 Electrical

ELEC-001E: All power provided to the ROV system through an external connection for any purpose during the competition must be obtained from the MATE competition power supply. This includes dedicated lines for cameras, manipulators, and any other devices. This is a singular point of connection; all power to the ROV must pass through the MATE-provided fuse AND the single in-line fuse as specified in this section.

NOTE for 2026!!!

Companies **MUST** use one of the following inline fuse(s) that are rated for the voltages used on EXPLORER class ROVs. Circuit breakers are not allowed as the primary circuit protection on the ROV system, but they could be used "downstream" of the primary fuse.

30-amp fuse or 30-amp fuse
25-amp fuse
20-amp fuse or 20-amp fuse
Fuse holder

COMPANIES ARE REQUIRED TO USE ONE OF THE LITTELFUSES AND THE LITTELFUSE HOLDER LINKED TO ABOVE.

These specific components are required. Companies without these components will not pass any of the following:

- video qualification
- initial safety inspection
- onsite safety inspection

If companies cannot purchase these components from the above sources, companies may purchase fuses and fuse holders from the SeaMATE Store. The SeaMATE store will ship these components anywhere in the world (Contact Us – SeaMATE).

ELEC-002E: The ROV system must be capable of operating off the power provided by a MATE supply with a nominal voltage of 48 VDC. Power supplies will be a fixed output voltage and will not be "turned down" to accommodate other than the specified voltage for the class. All references to 48 VDC in this document are the nominal voltage of 48 VDC.

ELEC-003E: The ROV system must deliver the supply voltage to the ROV as provided and without modification. No conversion of this voltage is allowed prior to it arriving at the ROV system bus. Methods on the surface such as DC/DC converters, voltage drop resistors, and Pulse Width Modulation (PWM) are not allowed to be used between the ROV and the power source. ESCs and H-bridges are not allowed on the surface. Power supplies and conversion devices are not allowed on the surface if they operate the ROV.

MATE strongly urges companies to refrain from sending reduced voltage signals from the ROV back up the tether to power devices on the surface. This is not done by ROVs in industry and therefore discouraged by the MATE ROV Competition.

ELEC-004E: Power over Ethernet (PoE) types 1 through 4 are permitted on 48V vehicles. Note that PoE is intended for low-current/low-power applications. Companies using PoE should evaluate, document, and be able to explain the justification for using PoE in their specific application.

ELEC-005E: ROV systems may use any voltage desired up to 48 Volts, but any conversion to a lower

voltage must be made on board the ROV. Companies will not be permitted to operate an ROV that reduces the voltage on the shore-side/top-side end of the ROV tether.

ELEC-006E: Voltage may not be increased above the nominal 48 volts anywhere in the ROV system.

ELEC-007E: Sonar or other systems that may have DC/DC conversion resulting in voltages above 48V nominal are not permitted.

ELEC-008E: Voltages in excess of the class parameters set forth in this specification are not allowed on the ROV system at any time other than any inductive spikes that are caused by the switching on/off of motors, solenoids and other inductive devices. Companies should design their systems to handle these voltage spikes but will not be penalized for the presence of these in a system. For additional information on this, companies can research back electromotive forces (back EMF), collapsing magnetic motor fields, and transient suppression.

3.3.1 Non-ROV Device Power Specifications

NOTE for 2026!!!

Systems that qualify as a non-ROV device in 2026:

- vertical profiling float

No other devices qualify as non-ROV devices.

ELEC-NRD-001: The vertical profiling float cannot be powered from the surface. If the float is powered, it must use onboard batteries. Voltage is limited to **12 VDC maximum**; amperage is limited to **5 amps maximum**. All power for the non-ROV device must go through a single fuse (see ELEC-NRD-005).

ELEC-NRD-002: The vertical profiling float non-ROV device may not utilize thrusters nor include any cameras. Vertical profiling floats cannot use a camera onboard to take images or video of sensor data and transmit those images/videos to the surface station.

NEW for 2026!!! New battery limitations are in place. Read the following information carefully!

ELEC-NRD-003: Onboard power is allowed for non-ROV devices. If onboard batteries are used, the following specifications must be met.

- NiMH (Nickel Metal Hydride) and AGM (Absorbed Glass-Mat) batteries only. **Alkaline batteries are not allowed**.
- NiMH battery packs consisting of 9-volt, AA, C or D cell batteries are allowed. See table below for maximum amperage allowed for each battery type.
- Larger NiMH and AGM (Absorbed Glass-Mat) 12-volt batteries are also allowed. This includes large (brick sized) batteries.
- No other size or chemical composition is allowed. 12-volt outdoor, re-chargeable batteries are not allowed. **High discharge LiPo batteries are not allowed**.
- Batteries are mounted in a manner that they are not loose inside the container.

All batteries are limited to the maximum allowed current shown in this table. Above this current, batteries will overheat.

Battery Type	Maximum Fuse Size
NiMH AA	2.0 A
NiMH C or D	5.0 A
NiMH 9-volt	200mA
NiMH* / AGM 12V	5.0 A

*The 5.0 amp maximum fuse size for NiMH 12 volt batteries refers only to the larger, brick sized batteries. 12-volt battery packs, consisting of multiple AA or 9-volt batteries, require the smaller fuse size for those batteries.

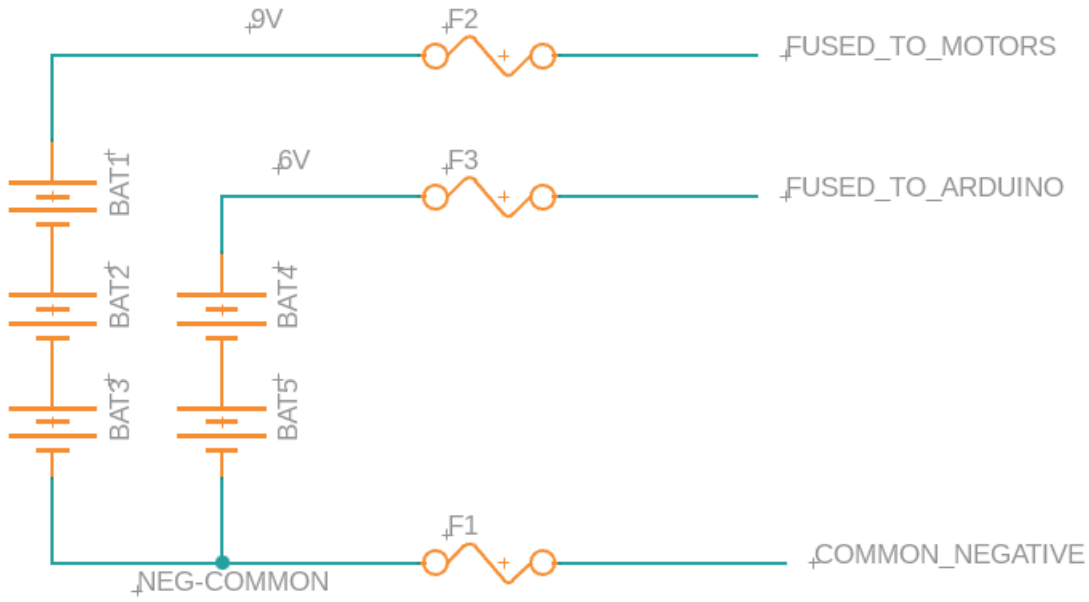
Technical note: To determine a NiMH battery's maximum fuse size, see the individual battery's mAH (milliamp hours) rating. Divide that number by 1000. For example, if a NiMH AA battery has a rating of 2300 mAH, its maximum current would be 2.3 amps, requiring a 2-amp fuse. If a NiMH battery has a rating of only 1900 mAH, its maximum current would be 1.9 amps, requiring a 1-amp fuse.

ELEC-NRD-004: Battery fusing for non-ROV devices is an important consideration and the following rules must be adhered to.

- A single fuse must be utilized that will shut down all power sources in the non-ROV device if the fuse blows.
- A fuse (5 amps max) must be installed within 5 cm of the battery positive terminal.
- All fuses, when installed, must be able to be visibly inspected for amperage through a clear housing or immediately after an opaque NRD device housing is removed without the need to uncover the fuse.
- ***Note for 2026!!!*** Cartridge, ATO type blade fuses or MINI blade fuses CAN be used for fusing NiMH and AGM batteries. The fuses to select from are 1A, 2A, 3A, 4A and 5A fuses. These fuses provide easy visual inspection for amperage using industry standard color codes.
  Fuse Reference: ATO fuse MINI fuse
  These fuses are all rated for 32VDC and are color coded for amperage.
- All blade fuses MUST correspond to the standardized color codes listed on the fuse links above. All cartridge fuses must be readily accessible and have the current stamped on the end of the fuse. Minimum DC voltage for the fuse must be 32 volts.
- The maximum distance from a battery pack to any fuse is 5 cm.
- Batteries in Series: No voltage over a nominal 12V is allowed. This means no more than eight 1.5V alkaline batteries in series.
- Batteries in Parallel: Batteries may be placed in parallel to increase the current available to the system within the following limits:
  - In no case shall the current from the pack exceed 5A.
  - The number of series strings in parallel is used as a multiplier to determine the fuse size. For example, using NiMH AA batteries, the maximum fuse size is 2.0 amps. If

two battery strings are placed in parallel, the maximum fuse size is 2 amps (2 * 2.0A = 4.0 Amps).

- ***Note for 2026!!!*** For systems with multiple battery packs, the battery packs should be connected to the negative terminals with the fuse (5 amps max) located off the common negative terminal connection. Each individual battery pack should also be fused with the properly sized fuse for that battery pack. Note that a single battery wired in parallel is considered a battery pack. For example, five NiMH 9-volt batteries wired in parallel, the maximum fuse size is 1 amp (5 * 0.2A = 1.0 A). Each 9-volt battery would need to be individually fused at 0.2A as well.



ELEC-NRD-005: Full Load Amps Value. Companies MUST measure the full load amps (FLA) of their device during waiting mode (motors off) AND during buoyancy change mode (motors on). The type of battery pack allowed for their system can be determined using the full load amps measurement (See ELEC-009E for more information).

Using the non-ROV device full load amps values, companies should select the standard fuse closest to their FLA.

ELEC-NRD-006: The enclosure housing must be designed so that it will open if the pressure inside the housing is greater than the outside pressure.

There are two allowable methods for pressure relief:

1. A pressure relief hole of a minimum of at least 2.5 cm in diameter. This hole can be plugged up with a rubber stopper but must be friction fit. Threads or other fastening methods are not allowed. Holes less than 2.5 cm in diameter will not pass safety inspection.

2. The enclosure is built in a manner that an end cap will pop off if under pressure. This can be an internal or external cap with O-rings to provide sealing. The sealing diameter of the end cap must be 2.5 cm in diameter or greater (this limits the smallest ID of an enclosure to 2.5 cm).

Additional notes:

- Under no condition should the housing be built with fasteners to hold the housing together. There must be at least one 2.5 cm or larger opening that serves as a pressure release.

Note for 2026!!!

- Utilization of pressure release valves are not acceptable as they cannot be tested at the competition site.
- Pop-off end caps that utilize a tightening mechanism (hose clamp, Twist-Tite) are not allowed.

ELEC-NRD-007: A SID must be submitted for any non-ROV device that uses electrical power

3.3.2 Independent Sensors

Certain product demonstration tasks may require a sensor that is independent of the vehicle. These electrically powered sensors will operate under the following independent sensor rules.

ELEC-IS-001: Independent sensors must be powered from the surface; no onboard batteries are allowed. Independent sensors are limited to 12 volts, 3 amps.

ELEC-IS-002: Companies may use USB to connect their sensors to a computer. Companies may also use surface battery packs (limited to 12 volts maximum) or the MATE supply to provide power for their independent sensor. A 12-volt MATE supply will be available at all EXPLORER stations for independent sensors to plug into via red/black Anderson powerpoles.

ELEC-IS-003: The independent sensor may only contain the intended sensor; thrusters, cameras, or other systems MAY NOT be attached unless specified in the PRODUCT DEMONSTRATION section.

ELEC-IS-004: Companies that use an independent sensor must provide a 3 amp (or less) fast blow fuse on the positive side of their connection. Companies using USB only to power an independent sensor may utilize the built-in current limiting of USB and do not need to add an additional fuse.

ELEC-IS-005: A SID must be submitted for any independent sensor that uses electrical power.

3.3.3 Current

ELEC-009E: ROVs will be limited to 30 amps at 48 volts.

How to select the proper fuse size for your ROV

MATE is modifying its specifications on how fuse size is selected for the ROVs. Past methods allowed currents well beyond the class maximum fuse due to the time delay of the fuses. For 2026, companies must measure the full load amperage (FLA) of the ROV while in water and then select the next standard size fuse that is both above the FLA and equal to or below the class maximum fuse size. To measure the full load amperage, companies should:

- Submerge your ROV in water and apply full down and full forward on all motors (this should be your highest current draw)
- Measure the Full Load Amperage (FLA) with an ammeter
- Select the fuse size from the table below

Companies should not itemize individual device currents; only report the actual measurement of the FLA. Do not multiply by 150% as in past years.

48V Full Load Amps	Fuse Size	JCASE Color
< 20.5 A	20 A	Blue
20.6 A to 26.3 A	25 A	White
26.4 A to 33.2 A	30 A	Pink

If the ROV FLA exceeds the maximum current, companies should limit their ROV current to prevent blowing the fuse during the competition. An example of this would be limiting the maximum PWM applied to the thrusters.

Note for 2026!!!

Full load amps values must be included on any SID and in the Company Safety Review. Full load amps and fuse selection should be reported as follows:

ROV Full Load Amps (FLA) in water = _____

Fuse size selected based upon FLA = _____

SIDs without FLA values or without fuse size selections will have points deducted from their initial safety inspection. Also, SIDs without FLA values will not pass the safety inspection. All FLA values must be measured with the motors in water.

The MATE power supply will be protected by a 30-amp fuse; however, the ROV system must also have its own properly selected fuse.

Note for 2026!!!

The power supplies used by the MATE ROV Competition have integrated circuit protection. Under most conditions, this protection will activate before a company's fuse blows. If a company experiences a power supply circuit protection event during a product demonstration run, it will be assumed that there is an electrical fault within the ROV system. It will be at the discretion of the

lead safety inspector or their designate whether the company may continue the product demonstration, and whether the ROV will need to be reinspected by a safety inspector.

ELEC-010E: ROV systems are allowed one replacement fuse during the product demonstration. In the event that the RO system blows the second fuse during the demonstration, the demonstration will be over, and no additional points will be earned. Companies should have adequate replacement fuses on hand, MATE will not provide replacements. Standard sizes for fuses are 15, 20, 25 and 30 amps. Additional standard fuse sizes are 1, 3, 7.5, and 10 amps.

Note for 2026!!!
At the competition, companies will be connecting to the MATE 48-volt supply. The top end of the company's tether MUST have the SBS50BLU Anderson Powerpole connector and the Littelfuse within 30 cm. There should be no other components between the SBS50 Anderson Powerpole connection that connects to the MATE 48-volt power supply and the fuse. Companies choosing to use E-stops or control boxes must locate their fuse before any of these components. **Companies should consider using a power cable that is at least 2 meters long. This will allow companies to more easily connect to the MATE power supply.**

No substitute fuses or fuse holders are allowed. Companies MUST use one of the required fuse holders and fuses.

3.3.4 Power Connections

ELEC-011E: Power supply connections will be Anderson Power Connectors. Companies' ROV system power wires must have proper connectors to obtain power. The Anderson Power Connectors must be connected to the ROV power wires securely; use of proper (hydraulic) tooling is required. Hand crimp tools do not have the force necessary to ensure proper and safe connections. MATE will not provide companies with connectors or adapters at the 2026 World Championship.

NOTE for 2026!!!
COMPANIES ARE REQUIRED TO USE THE ANDERSON SBS50BLU LINKED TO BELOW.

This specific component is required. Companies without an Anderson SBS50BLU connector will not pass their video qualification, will not pass their initial safety inspection, nor will they pass their onsite safety inspection.
Housing: Anderson SBS50BLU-BK
DigiKey: SBS50BLU-BK Anderson Power Products, Inc. | Connectors, Interconnects | DigiKey
Mouser: SBS50BLU Anderson Power Products | Mouser
Newark: SBS50BLU-BK ANDERSON POWER PRODUCTS, Connector Housing, SBS50 Series, Plug, Receptacle, 2 Positions | Newark Electronics
RS: Anderson Power Products SBS50BLU-BK Power Connector Housing Blue SBS Connector SBS, SBS 50 Series
Grainger: ANDERSON POWER PRODUCTS, SBS 50, Blue, Housing - 820RD2|SBS50BLU - Grainger

Additional online sources for the Anderson SBS50BLU connector:
Blue SBS50 Standard Housings Up to 110 amps Bulk (andersonpower.com)

Pins: The proper pin for your tether conductors
12 or 10 AWG: Anderson 1339G3-BK
8 AWG: Anderson 1339G5-BK

http://leeselectronic.com

MATE strongly discourages the use of Anderson Powerpole "knock-offs." These connectors do not meet electrical specifications and have the potential to melt under load.

NOTE for 2026!!!
If companies cannot purchase an Anderson SBS50BLU from the above online sources, companies may purchase a kit with these connectors (and the proper Littelfuses/fuse holder) from the SeaMATE store. The SeaMATE store will ship anywhere in the world (Contact Us – SeaMATE).

ELEC-012E: The power supply may be located up to 1 meter from the station table and may be located on either side of the table. MATE recommends a power cable long enough to reach the power supply up to 3 meters from your control system.

3.3.5 Tether Voltages
The signals in the tether must meet the following specifications:

ELEC-013E: Low voltage, low current AC or DC control or sensor signals. Low voltage is defined as a voltage equal to or less than the maximum supply voltage per class specification. Low current is defined as being less than 500mA. Examples include video signals, control signals for electrically powered manipulators, sensor signals, etc.

ELEC-014E: DC main-supply at a nominal voltage of 48VDC as provided by the MATE power supply.

ELEC-015E: Ethernet, USB, or other ANSI or IEC accepted serial protocol signals.

ELEC-016E: NTSC or PAL Video signals

ELEC-017E: Fiber optic cabling of any type may be used.

NOTE for 2026!!!
At the World Championships, EXPLORER class companies should include a video splitter in their line at the surface control station so that their ROV camera view can be incorporated into the livestream. MATE ROV competition officials will connect to this splitter and broadcast the ROV camera view on the livestream. Optionally, companies may also provide a split view of their GUI and/or non-video displays to be broadcast over the livestream.

An HDMI connection box will be available at the product demonstration station. During the 5-minute setup, companies should connect their split video connector to this connection box. Companies should prepare their system to ensure that their video feed is not interrupted by splitting it out to the livestream feed.

MATE HDMI Connection Box:

The following are examples of video splitters. Companies may choose devices other than those provided below to split their video. Companies with analog or other non-HDMI cameras should consult with the livestream group prior to their mission runs. Contact the livestream coordinator if you have questions or require a converter to HDMI.

- OREI HDMI Splitter 1 input 2 output 1080p with EDID (HD-102)
- OREI 4K 1x2 HDMI Splitter: 1-in 2-out, EDID (HDS-102)
- Amazon Basics HDMI Splitter 1 In 2 Out
- GAOZHOU Capture Card with 4K Pass-Through, USB3.0 1080P 60FPS
- NZXT Signal HD60 Full HD USB Capture Card with Zero-Lag Passthrough
- Elgato HD60 X – Capture Card

3.3.6 Exposed Connections and Disposable Motors

ELEC-018E: ROVs with electrical connections that are exposed to water and not sealed are not permitted to enter the water. Taping a connection with electrical tape only does not constitute a sealed connection. The process of sealing electrical connections must include methodologies such as, but not limited to, Silicone RTV, hot melt glue, epoxy, self-vulcanizing tape, and enclosure of the connections in a housing.

ELEC-019E: "Disposable motors" are not permitted, these are exposed motors with no waterproofing.

Brushless motors must be properly waterproofed. Companies must show manufacturer documentation showing their brushless motors are waterproof, or companies must properly waterproof their motor and provide documentation showing their methodology. Non-sealed brushless motors will not pass safety inspection.

See the MATE Technical Bulletin for proper methods to waterproof a brushless motor.

3.4 Onboard Electrical Power

ELEC-020E: Onboard electrical power (i.e., power not provided by the tether) is not allowed on the primary ROV. See the Non-ROV Device Power Specifications regarding onboard power for other devices.

NOTE: Water leaking into a closed battery container can result in the generation of hydrogen gas. This gas can build up inside the pressure housing and create an unsafe situation. Any battery housing must be designed to open if the pressure inside the housing is greater than the outside pressure to meet the MATE safety standards. See the non-ROV device onboard battery rules (3.3.1 Non-ROV Device Power Specifications) for more information.

3.5 Power Shutdown

ELEC-021E: For safety purposes, any ROV system that is disconnected from the surface supply must stop functioning in less than 5 seconds. This applies to electrical, pneumatic, and hydraulic power sources. Any filters, capacitors or accumulators must be sized accordingly to meet this specification.

3.6 Fluid Power

Any vehicle using fluid power must provide a fluid power diagram. Fluid power is defined as hydraulic pumps (water) or pneumatic pumps (air) on the vehicle or on the surface.

3.6.1 Hydraulic Power

Note for 2026!!!

FLUID-001: Hydraulic fluid: Water only.

FLUID-002: Maximum Hydraulic pressure allowed: 10.33 bars (150 psig).

Note for 2026!!!

FLUID-003: Hydraulic system: All lines, fittings, and hydraulic devices must be rated for a minimum pressure of two (2) times the maximum supply pressure. Hydraulic component specifications must be included in the Company Safety Review.

FLUID-004: Hydraulic pumps must be part of the safety inspection.

1. They must have a pressure relief valve with a maximum setting of 300 psig or less installed before the pressure regulator.
2. The pump must have a regulator in place and set to 150 psig or less.
3. Pumps with any sign of external rust or deterioration will not be accepted.
4. All wiring must be secure.
5. All guards must be in place.
6. Hydraulic pumps may run off of the 15A 115VAC outlet provided for command and control as long as the hydraulic fluid is not being used to propel the ROV. The hydraulic fluid is to be used for grippers and actuators only.

Companies using hand/manually powered hydraulic systems do not need a pressure relief valve or regulator in their system. The hand/manually powered hydraulic system must be included on a SID.

3.6.2 Pneumatic Power

FLUID-005: Pneumatic fluid: Compressed air or inert gas only

FLUID-006: Maximum pressure allowed: 2.75 bars (40 psig)

Note for 2026!!!

FLUID-007: Pneumatic system: All lines, fittings, and pneumatic devices must be rated for a minimum pressure of two and a half (2.5) times the maximum supply pressure. For example, if an 83 bar (1200 psig) tank is regulated to 2 bars (30 psig), then all system components must have a minimum rating of 5.17 bars (75 psig). Pneumatic component specifications **MUST** be included in the Company Safety Review. Note: Aquarium tubing is not generally rated for the pressures associated with compressed gas systems and should not be used in a pressurized pneumatic system.

FLUID-008: Air compressors must be part of the safety inspection.

1. The company's system must have a pressure regulator, shut-off valve and manual pressure release. See Compressed Air at the MATE ROV Competition for more information.
2. The regulator must be set to 40 psig for less.
3. Compressors with any sign of external rust will not be accepted.
4. The tank drain valve must open.

5. If more than 5 ml of water exits upon opening the drain valve, the compressor will not be accepted.
6. All wiring must be secure.
7. All guards must be in place.
8. Air compressors may run off of the 15A 115VAC outlet provided for command and control as long as the air is not used for motor thrust. The air is to be used for buoyancy/ballast, grippers and actuators only.

At the World Championship competition, MATE ROV will provide compressed air at each station. Companies using compressed air MUST attach to the compressed air source provided by the MATE ROV Competition; companies may not use their own compressor. See 3.9 MATE Provided Equipment for more information.

3.6.3 Pressurized Cylinders

Note for 2026!!!

FLUID-009: Pressurized cylinders (SCUBA tanks) are not allowed.

Note for 2026!!!

FLUID-010: Electronic housings and other enclosures on the ROV must operate at surface pressures. Companies may not pressurize their electronics housing.

3.6.4 Pressure Operated Devices (PSO)

MATE will allow the use of soft-walled pressure operated devices in the competition provided they meet the following specifications:

- Device uses a pressure release valve of 12 psi maximum.
- Company provides specifications and factory cut sheets of the valve used and a description of the device to the Competition Technical Manager no later than May 15th, 2026 for review by MATE safety committee.

The intent of the exception to the pressure specifications is to allow the use of bladder type devices and flexible grippers that operate a few psi above ambient and would be destroyed if tested at full MATE pressure specifications. This exception does not apply to cylinders, pressure vessels or other pressure containment devices. If the device is tested to the 40 psi (pneumatic) or 150 psi (hydraulic) MATE specifications, a pressure release valve is not required.

3.6.5 Unpressurized Cylinders

FLUID-011: Companies may fill containers on the ROV with air provided those containers never exceed ambient pressure. Any such container is required to have at least one ¼-inch (6.35 mm) hole drilled into the bottom of the container to allow excess air to escape.

3.6.6 Pressure Storage Devices (Pressure Accumulators)

FLUID-012: Pressure storage devices are allowed on the ROV if they do not exceed 1.25L in total storage and do not store pressure higher than the allowed pressure for air or hydraulics. It is recognized that a company may not be able to purchase a pressure accumulator that has the proper rating and fits in the space needed. In that case, the company must show that their designed accumulator is capable of withstanding the specified pressures without rupture.

3.6.7 Chemical Creation of Gases

The chemical creation of gases is not allowed.

3.6.8 Fluid Power Quiz

FLUID-013: EXPLORER class companies planning to use hydraulics and/or pneumatics (i.e., fluid power) are required to take and pass an online quiz with a score of 100%. Companies ONLY using manual pumps and unpressurized containers are not required to take the Fluid Power Quiz but must still submit documentation regarding their fluid power system.

NOTE: The quiz was developed by MATE ROV Competition technical support staff and competition judges and is designed to ensure that companies understand basic information on these topics and can apply that knowledge to safe practices. The intention is not to add yet another "requirement," but rather to provide a safe and successful learning experience and competition environment.

The quiz should be completed by the STUDENT company members. Each member of the company does NOT have to take the quiz; students can work together and make it a group effort. **ONLY ONE TEST PER COMPANY.** The company's instructor or mentor can provide guidance and advice, but the questions should be answered by the students participating on the company. The quiz will be scored, and the results provided instantaneously. A score of 100% is considered a passing grade. Companies can take the quiz as many as 5 times to achieve this score.

The quiz must be completed with a passing grade by April 30th, 2026. NO EXCEPTIONS OR EXTENSIONS! Companies with regional competition prior to April 30th due date should plan to take the fluid power quiz at least 2 weeks prior to their competition. If registration for your regional competition opens after the fluid power closing date, you must still take the quiz before April 30th. Companies failing to complete this quiz within the given time frame will NOT be permitted to use fluid power during their competition event. **NO EXCEPTIONS OR EXTENSIONS! See KEY DEADLINES.**

To purchase and take the fluid power quiz, click here.

The following are sources of information on hydraulics and pneumatics. This is not intended to be an exhaustive list, but rather a starting point to encourage companies to seek out additional information and resources:

- Underwater Robotics: Science, Design, and Fabrication (Revised Edition – SeaMATE, published by the MATE Center and MATE Inspiration for Innovation

- What is Fluid Power? (nfpa.com)
- Full Guide to Air Compressor Safety | Quincy Compressor

3.7 Control Systems

ELEC-022E: EXPLORER class ROVs are expected to utilize computer- or electronic-based control methodologies and H-Bridge or BLDC controllers for the thrusters. Systems using surface switch box controllers are not permitted.

ELEC-023E: Surface control stations must be built in a neat and workmanship-like manner. Loose components and unsecured wires will not pass safety inspection.

New for 2026!!!
When the ROV is in use, all connections in the control box must be shielded or covered to **IP-30 standards**. IP-30 standards equate to <2.5 mm and should protect against tools, thick wires, and the like. Any guards / shields must be in place when the control system is connected to power.

ELEC-024E: Surface control stations by nature may combine 120VAC and 48VDC wiring. The surface control stations must be wired in a manner such that the 120VAC wiring is physically separated from the DC wiring, the 120VAC wiring is clearly identified from the DC and control voltages, and every conductor is insulated in a manner that no conductor is exposed. Identification can be through signage and/or wire color schemes. All 120VAC wiring colors must use ANSI, NEMA or IEC standard wiring colors appropriate to each voltage. There must be a sign inside the surface control station indicating which wiring standard is being utilized. Companies that do not have adequate separation of AC wires and components and DC wires and components will NOT pass safety inspection. It is recommended that separation be designed into the control system to keep power systems separate. Wiring should be clear, neat and easy to follow by inspectors. Wiring "rat's nests" or "spaghetti wiring" will not pass safety inspection.

ELEC-025E: Companies must use proper strain relief and abrasion protection where wires and the tether enter the vehicle. The ROV should be capable of being lifted by the tether without damaging the tether connection to the ROV. Tape, glue, zip ties, and other quick methods of strain relief are not acceptable. The intent is to see the wires pass through a connector specifically designed to provide strain relief.

Companies must use proper strain relief at the surface where wires and the tether enter the control system. Pulling on the tether should not strain the wires entering the control system or computer/laptop.

Examples of some acceptable strain reliefs for the ROV side include:

Hubbell Strain Relief
Strain relief grip

Kellums strain relief cord grip

NOTE for 2026!!!

Additional information on expected and accepted practices for design and wiring of your system, including proper strain relief, can be found in the following MATE ROV Competition Tech Bulletin:

- **MATE ROV Competition Tech Bulletin – MATE Expected Work Practices**

ELEC-026E: Any connectors utilized in the surface control station and elsewhere in the ROV system must be properly type rated for their application. AC rated connectors must not be used for DC. The connectors must also be rated at or above the voltage and current used in their application

3.8 Command, Control, & Communications (C3)

3.8.1 Power Provided

CCC-001: Surface power: MATE will provide one GFI-protected outlet with a nominal 115 Volts AC (60 Hertz) and 15 amps maximum. This outlet is intended to provide power for pumps and other surface support equipment (e.g. video displays & control boxes). This AC power source CANNOT be used to directly or indirectly power the vehicle.

CCC-002: If hydraulic or pneumatic power is used for vehicle thrust, the power for the pump must come from the MATE supplied DC power supply.

CCC-003: In addition to electric pumps, hydraulic, and pneumatic systems can be powered by manual pumps (e.g. bicycle tire pump) or supplied from a pre-pressurized cylinder. Companies that are only using manual pumps must still comply with all hydraulic and pneumatic specifications, including the creation of a fluid power SID.

3.8.2 Cameras

NOTE for 2026!!!

CCC-004E: Cameras are required to pilot the ROV. ROV pilots will be penalized for looking into the pool when piloting their ROV.

All cameras, including USB cameras, must be powered by the MATE supply. Powering a USB camera from the MATE supply can be accomplished by using a USB repeater / extender that has a separate power input at the far (ROV) end. The ROV must convert the 48V to 12V or 5V as needed to power the device from the MATE 48-volt supply. This conversion must be done on the ROV. USB cameras plugged directly into laptops are not allowed. Be sure to denote camera power on your SID.

3.8.3 Displays

CCC-005E: Companies are not limited to the number of display screens used for video feeds or ROV status information. Display devices may be made up of any combination of TVs, monitors, laptops, and/or computer displays.

CCC-006E: These display devices may be powered by the MATE provided GFI-protected 115-Volt AC (60-cycle) and 15-amp AC power source described in CCC-001, Surface power.

CCC-007E: A company's C3 station may include devices like video recorders. All C3 devices must be able to run on the single AC power outlet provided or on its own internal battery power. Any device plugged into this AC power outlet can only provide C3 functions and cannot provide power to the ROV.

CCC-008E: A company's C3 station should have all items stable or secured to the station. Large monitors not secured to and stable in the product demonstration station are not permitted. Monitors and other C3 devices with glass faceplates are not permitted.

3.9 MATE Provided Equipment

MATE will **NOT** provide video monitors at the product demonstration stations.

In 2026, the MATE ROV Competition will supply compressed air at each station during the World Championship. Companies may connect to this compressed air via a standard ¼-inch NPT male fitting. See the Compressed Air Guidelines for more information on what MATE ROV provides and what companies are required to provide for their compressed air systems. For companies competing at an EXPLORER regional event, contact your regional coordinator or visit your regional contest's website as to whether compressed air will be provided at your regional competition.

3.9.1 Companies Sharing Equipment

Companies may share the following equipment during the competition event: monitors and joysticks/controllers.

Companies may NOT share the following equipment during the competition event: control systems and payload tools (e.g. grippers, manipulators).

For companies competing at an EXPLORER regional event, contact your regional coordinator or visit your regional contest's website to determine if equipment can be shared at your regional event.

Companies that plan to share equipment during the World Championship event must notify the Competition Technical Manager at least 4 weeks prior to the event so that this can be considered when creating the schedule. MATE will do its best to accommodate companies sharing equipment.

3.10 Laser Safety Rules

LASR-001: **Companies must forward the specifications of their laser to the Competition Technical Manager by May 15th, 2026. For EXPLORER class companies attending a regional, laser specifications should be forwarded at least three weeks prior to the regional competition.** Specifications **MUST** include a link to the laser being used. The link should include a photo of the laser and the laser specifications. A notification will be sent to the company when the laser is approved. Companies must also bring a copy of their laser specifications to their safety checks. If the laser is being used at a regional event or pool practice, notification will also be sent to the regional competition coordinator.

LASR-002: All lasers must operate in the visible range at either the 630-680 nm (red) or near the 532 nm (green) wavelength. All lasers must fall into the Class I, Class II, or Class IIIa category. Red lasers must operate at 5mW or less. Green lasers must operate at 1 mW or less.

LASR-003: Companies should include detailed specifications of their laser in their technical documentation as well as have that information ready and available during their safety inspection and engineering presentations.

LASR-004: Lasers must have an on/off switch. This switch must be on the surface controller.

LASR-005: All lasers must be powered by the MATE surface power supply. Batteries, including batteries for powering lasers, are not permitted on the vehicle.

LASR-006: Companies using lasers cannot increase the voltage or the current to increase the power of their lasers. Lasers must use the voltage and current set in their specifications.

LASR-007: When out of the water, the laser should have a shield or enclosed beam stop attachment within 30 cm of the laser. This means that the laser beam should not travel more than 30 cm before reaching the shield. This is a requirement at all times when the laser is out of the water. ***NOTE for 2026!!!*** The beam stop must be attached to the ROV at all times. Companies may not remove the beam stop by hand when the ROV enters the pool. The beam stop should be designed so it floats or moves out of the way of the beam when the ROV is in the water. The shield must be painted with FLAT BLACK paint.

LASR-008: At no time should the laser be focused or deviate from a collimated beam.

LASR-009: When testing the laser at a workstation, companies must display a sign telling others that a laser is being operated.

LASR-010: Operators working with the laser while the ROV is out of the water should wear appropriate laser safety glasses at all times. This requirement is for all laser types. Search online to find laser safety glasses appropriate for the wavelength being used.

Companies must forward the specifications of their laser safety glasses to the Competition Technical Manager by May 15th, 2026. For EXPLORER class companies attending a regional, glasses specifications should be forwarded at least three weeks prior to the regional competition. Specifications MUST include a link to the laser safety glasses being used. The link should include a photo of the laser glasses and the laser glasses specifications. A notification will be sent to the company when the laser safety glasses are approved. Companies must also bring a copy of their laser safety glasses specifications to their safety checks. If more than one brand of glasses are used, a copy of each specification sheet should be provided.

The following lasers are acceptable to use in the MATE ROV Competition, although companies may choose to use alternate lasers. NOTE: **ALL COMPANIES MUST FORWARD SPECIFICATIONS TO THE COMPETITION TECHNICAL MANAGER, EVEN IF ONE OF THE FOLLOWING ACCEPTABLE LASERS IS USED:**

- Amazon.com: HiLetgo 10pcs 5V 650nm 5mW Red Dot Laser Head Red Laser Diode Laser Tube with Leads Head Outer Diameter 6mm : Industrial & Scientific
- Amazon.com: Quluxe 650nm 5mw Laser Head Laser Tube Adjustable Focus 3~5V Red Laser Tube, Laser Head Industrial Laser (Pack of 3) : Industrial & Scientific