

2026 MATE ROV COMPETITION:

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

NAVIGATOR 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-002N)
- 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.

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

2.0 SAFETY

Safety is the competition's primary concern and guiding principle. Any system that is 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!!!

MATE ROV Competition safety inspectors will be reinforcing the competition's emphasis on safety and good workmanship. Wiring discipline/workmanship (ELEC-011N) and strain relief at both ends of the tether (ELEC-012N) will be areas of particular emphasis. **Not only is your vehicle required to meet all of the safety requirements, but it should also be a reflection your company's workmanship and attention to detail. Your vehicle's wiring, strain relief, and electronics must be safe and should also look professional.** Additional examples of wiring workmanship will be included in the [MATE ROV Competition Safety Inspection Tutorial](#).

See the [Onsite Safety Inspection Score Sheet](#) for specific information. 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](#)

Not all areas of the MATE Expected Work Practices may apply to your vehicle, but make sure to follow the guidance of those that do.

Examples of safety violations from previous ROV competitions include:

- Companies used equipment that did not participate in and/or pass safety inspection.
- No SID was provided at the safety check
- The electrical SID did not show a main fuse.
- The ROV did not have a main fuse.
- The ROV used pneumatics, but a pneumatics diagram or pneumatic specifications.
- The ROV used pneumatics, but the company had not passed the fluid power quiz.
- Sharp items, or potentially sharp items (glass) were included on the vehicle.
- Motors/propellers were not shrouded to IP-20 standards

Examples of workmanship violations from previous ROV competition include:

- 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

2.1 Safety Pre-Inspection

NEW for 2026!!!

NAVIGATOR class companies may or may not be required to submit documentation for a Safety Pre-Inspection. Contact [your regional coordinator or visit your regional contest's website](#) to determine which, if any, of the required documents must be submitted, as well as the date and proper format for submission.

If required, a safety pre-inspection will be completed before competition day. Safety pre-inspection document submissions may 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

See 2.1.1 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.

2.1.1 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 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.
- The SID must include a FUSE SYMBOL using an ANSI, NEMA or IEC symbol.

- 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 Fukien Secondary School Over-Defined SID](#) – RANGER class (shared as example only)

Another example of a SID (switchbox with 3 switches).

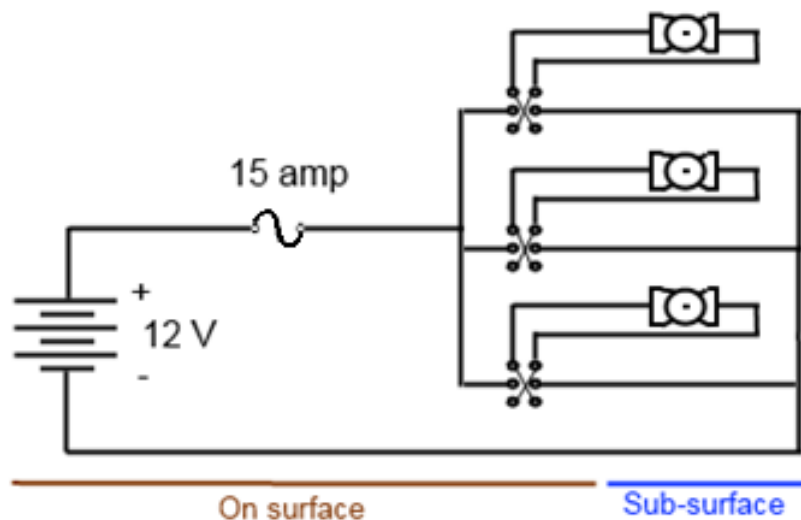


Diagram: An example of an acceptable SID.

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

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 a 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 document: Companies will be required to submit a written and photographic description of their non-ROV device. This document is limited to 2 pages in length. This non-ROV device design document must contain:

- Information on the type of float designed (independent, autonomous, or manual) and whether the device uses a buoyancy engine or does not use a buoyancy engine.
- If the float uses a buoyancy engine, companies must describe how their buoyancy engine operates
- A photo or diagram of the non-ROV device.
- A photo of the fuse(s) used on the ROV.

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 required for the non-ROV device design document (i.e. DOC-004 can be a total of 3 pages, 2 pages for a description, one page for a SID). The SID must include:

- A fuse using a standard fuse symbol
- Full load amps fuse measurements

Companies that design an independent float that uses onboard batteries must also include information on:

- The type of batteries used.
- A photo of all battery packs.
- Fuse determination showing the full load amps measurements for both waiting mode (motors off) and buoyancy change mode (motors on).
- A description of how the battery pack was designed to safely fulfill the full load amps needs and the voltage requirements of the float device.

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, 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 Geneseas Non-ROV device document 2025

Note that these are **RANGER** Non-ROV Device documents are used as example only and include additional information not required for NAVIGATOR Non-ROV device documents.

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

- Anderson powerpole connectors are the main point of connection to the MATE supply (ELEC-006).
- A properly sized fuse is within 30 cm of the main point of connection to 12-volt power. The company must use a ruler to show this distance (ELEC-004).
- Full load amps value and fuse size selected (ELEC-004).
- The inside of the control box does not have exposed wiring (ELEC-013), the control box is neatly laid out with attention to workmanship (ELEC-018), a separation and identification of 120VAC wiring from DC and control voltages (ELEC-019). 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-020).
- The tether leading to the ROV has adequate strain relief (ELEC-020).
- 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 4 meters (MECH-001).
- All propellers are shrouded and have propeller guards (MECH-005).
- The ROV has no sharp edges or elements of the ROV that could cause damage (MECH-006, ELEC-013).

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

- Anderson powerpole connector within 30 cm of the fuse (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 Company Safety Reviews from RANGER class companies:

- [Labrador Straits Shark Tech Company Safety Review 2025](#)
This company includes all components in their company safety review
- [Po Leung Kuk Ngan Po Ling Aquamarine Company Safety Review 2025](#)
This company does not use fluid power and clearly states 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.
- Fuse calculations were used instead of full load amps values.
- 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.

2.2 Onsite Safety Inspection

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

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.

What follows is the safety inspection protocol used at the World Championship. For regional events, consult [your regional coordinator or visit your regional contest's website](#) for more information about the safety inspection process used.

2.3 Safety Inspection Protocol

Safety Inspection Protocol

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

2.3.1 Safety Inspection Completed

Companies will receive 10 points when they pass their safety inspection. Companies will also receive their Blue PASSED safety card which will allow their vehicle into the water.

3.0 SPECIFICATIONS

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

3.1 Operational

3.1.1 Multiple Vehicles

OPER-001: MULTIPLE VEHICLES ARE NOT PERMITTED. Companies are required to design and build ONE ROV that can complete the necessary product demonstration tasks. All ROV components, including cameras and payload tools, must be connected to the ROV.

3.1.2 Environmental

OPER-002: The ROV System must be able to function in fresh, chlorinated water with temperatures between 15°C and 30°C. The water should be considered conductive of electrical currents.

OPER-003: Visibility in the pool is unlimited. The pool will not be covered or purposefully darkened in any way. However, wind, divers, or ROVs may create ripples on the surface that affect visibility. Companies should plan accordingly.

OPER-004: There will be no water currents intentionally created. However, depending on the venue, pressurized pool filtration system outlets may cause unexpected currents.

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

3.1.3 Service Requirements

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

3.1.4 Maintenance and Calibration Requirement

OPER-006: All work and system maintenance during operations shall be conducted by company personnel. Work of any kind must NOT be done by mentors or advisors.

All measurement devices shall be calibrated according to manufacturer recommended calibration procedures and performed by company members only. Company mentors or advisors are not

permitted to perform calibration procedures. More information about mentor restrictions is provided in the COMPETITION RULES.

3.2 Mechanical/Physical

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

3.2.1 Materials

MECH-001N: Any electronics housings on the ROV shall be capable of operating to depths of 4 meters.

3.2.2 Size

MECH-002N: ROVs are not limited to a maximum size, but companies must be able to personally transport the vehicle and associated equipment to the product demonstration station and to the engineering presentation room. ROV systems must be capable of being safely hand launched.

3.2.3 Tether Length

MECH-003N: ROVs must be capable of operating in a maximum pool depth of 4 meters (13 feet). All underwater product demonstrations will take place within 6 meters (20 feet) from the side of the pool. Tether lengths should be calculated accordingly.

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

3.2.4 Vehicle Deployment and Recovery

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

3.2.5 Propellers

MECH-005N: All thrusters must be shrouded. ROVs that have propellers exposed without shrouds 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. Shrouds 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 should meet this standard. If your finger can touch the propeller, then it is not properly shrouded.

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

An example of a shroud

[MATE Compatible ROV Kort Nozzle for Bilge Pump Thruster](#) – CAD

[MATE Compatible ROV Kort Nozzle for Bilge Pump Thruster](#) – Photo

3.2.6 Sharp Edges and Pinch Points

New for 2026!!!

MECH-006: 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-007: 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-001N: 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.

ELEC-002N: The ROV system must be capable of operating off the power provided by a MATE supply with a nominal voltage of 12 VDC. This voltage may be as high as 14.8 volts. At regional competitions, power may be provided by isolated power supplies or batteries. [Contact your regional coordinator or visit your regional contest’s web site](#) if you have questions about the type of power source being used. Your system should be designed to work with the maximum specified voltage of 14.8 VDC.

ELEC-003N: ROV systems may use any voltage desired up to 12 volts. Voltage may never be increased above the nominal 12 volts anywhere in the ROV system.

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

The vertical profiling float qualifies as a non-ROV device in 2026.

ELEC-NRD-001: The vertical profiling float can be powered from the surface or from 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).

Companies powering their float device from the surface are required to plug into a MATE power supply. The connection requires red/black Anderson powerpole connectors. If plugging into the surface power supply, the onboard battery rules presented in ELEC-NRD-003 do not apply.

Companies using onboard batteries **MUST** follow the battery pack specifications outlined in ELEC-NRD-003.

ELEC-NRD-002: The vertical profiling float non-ROV device may not include any cameras.

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 being 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. Battery packs are multiple smaller batteries linked together, often wrapped in plastic. **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. **Hi discharge LiPo batteries are not allowed.**
- Batteries are mounted in a manner that they are not loose inside the container. Use battery holders to securely mount your batteries or battery pack.

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

Battery Type	Maximum Fuse Size
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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.

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. The above table was derived from the general mAH from the types of batteries in question.

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

For floats using surface power:

- 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 30 cm of the battery positive terminal.

For floats using onboard batteries:

- 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 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!!!** NAVIGATOR devices are limited to one battery pack. All onboard devices must be powered from a single battery pack.

ELEC-NRD-005: Full Load Amps Value. Companies MUST measure the full load amps (FLA) of their device in water during waiting mode (motors off) AND during buoyancy change mode (motors on). For floats using onboard batteries, the type of battery pack allowed for their system can be determined using the full load amps measurement (See ELEC-004N) in the competition manual for more information).

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

New for 2026!!!

ELEC-NRD-006: If using onboard batteries, 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 Current

ELEC-004N: ROVs will be limited to 15 amps at 12 volts.

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

Note for 2026!!!

Companies **MUST** use ATO type blade fuses or MINI blade 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.

COMPANIES WITHOUT A PROPER BLADE FUSE WILL NOT PASS SAFETY INSPECTION!

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.

12V Full Load Amps	Fuse Size	Fuse Color
< 3.5 A	3 Amp	Violet
3.5 A – 4.5 A	4 Amp	Pink
4.5 A – 5.5 A	5 Amp	Tan
5.5 A – 8 A	7.5 Amp	Brown
< 10.5 A	10 A	Red
10.6 A to 15.5 A	15 A	Blue

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.

New 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 an internal 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-005N: ROV systems are allowed one replacement fuse during the product demonstration. In the event that the ROV 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 and 25 amps. Additional standard fuse sizes are 1, 3, 7.5, and 10 amps.

Note for 2026!!!

The required ATO or mini fuse **MUST** be within 30 cm of the connection to the MATE 12-volt power supply. There should be no other components between the Anderson powerpole connections that connect to the MATE 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.**

3.3.3 Power Connections

ELEC-006N: Power supply connections will be red/black Anderson powerpole Connectors. Companies' ROV system power wires must have proper connectors to obtain power. The Anderson powerpole Connectors must be connected to the ROV power wires securely; use of a proper

mechanical crimper is required. Hand crimp tools do not have the force necessary to ensure proper and safe connections.

NOTE for 2026!!!

The red and black pole pieces must be attached. Loose powerpoles (those not attached) will not pass safety inspection.

[30 Amp Permanently Bonded Red/Black Anderson Powerpole Connectors | Powerwerx](#)

or

[30 Amp Unassembled Red/Black Anderson Powerpole Connectors | Powerwerx](#)

or

[ASMPP30-1X2-RK Anderson Power Products, Inc. | Connectors, Interconnects | DigiKey](#)

These are two-piece connectors as shown in the picture below.



ELEC-007N: 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.

3.3.4 Tether Voltages

The signals in the tether must meet the following specifications:

ELEC-008N: DC main-supply at a nominal voltage of 12 VDC as provided by the MATE power supply.

ELEC-009N: 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.

Note: Companies concerned about how voltage loss will affect their camera(s) should consider adding a separate line in the tether to supply the camera from the main power source. This dedicated line for cameras is permitted, provided it runs through the single fuse.

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

ELEC-011N: NTSC or PAL Video signals

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

3.3.5 Exposed Connections and Disposable Motors

ELEC-013N: 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-014N: “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-015N: 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-016N: For safety purposes, any ROV system that is disconnected from the surface supply must stop functioning in less than 5 seconds. This applies to electrical, pneumatic, and hydraulic power sources. Any filters, capacitors or accumulators must be sized accordingly to meet this specification.

3.6 Fluid Power

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.

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

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 or less.
3. Compressors with any sign of external rust will not be accepted.
4. The tank drain valve must open.
5. If more than 5 ml of water exits upon opening the drain valve, the compressor will not be accepted.
6. All wiring must be secure.
7. All guards must be in place.
8. Air compressors may run off of the 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.

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 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.

3.6.5 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.

3.6.6 Chemical Creation of Gases

The chemical creation of gases is not allowed.

3.6.7 Fluid Power Quiz

FLUID-013: NAVIGATOR 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-017N: NAVIGATOR companies are not limited to the type of control system they may use provided it complies with the other MATE design and safety specifications.

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

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. A

control system enclosed inside a box which is screwed shut (SeaMATE Angelfish, Pufferfish, Triggerfish, Barracuda) meets this guideline.

ELEC-019N: Surface control stations by nature may combine 120VAC and 12VDC 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-020N: Companies must use proper strain relief and abrasion protection where wires and the tether enter the vehicle. The ROV should be capable of being lifted by the tether without damaging the tether connection to the ROV. 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.

Cable glands are an acceptable strain relief if they are secured through the frame of the ROV and can hold the weight of the suspended ROV when wet. Note that many cable glands are more prone to slip when wet. MATE recommends tightening these over your tether cable and testing to verify the tether does not slip.

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**](#)

Not all areas of the MATE Expected Work Practices may apply to your vehicle, but make sure to follow the guidance of those that do.

3.8 Command, Control, & Communications (C3)

3.8.1 Power Provided

CCC-001N: 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-002N: 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-003N: 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-004N: 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 would then provide the power to the device from the MATE supply. USB cameras plugged directly into laptops are not allowed. Be sure to denote camera power on your SID.

3.8.3 Displays

CCC-005N: Companies are limited to ONE video display screen. This display screen may be powered by the MATE provided GFI-protected 115-Volt AC (60-cycle) and 15-amp AC power source described in CCC-001.

Capturing a still image of a video display on a cell phone or tablet for the purpose of completing a product demonstration task does not count as an additional display.

CCC-006N: 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. Companies are responsible for providing their own video monitor.

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).

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 must notify their [regional coordinator](#) 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](#) at least three weeks prior to their 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](#) at least three weeks prior to their 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 is 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](#)