

RANGER & EXPLORER Class Safety Inspection Tutorial

This tutorial goes through the safety practices required by the MATE ROV Competition. It covers:

- Initial Safety Inspection
 - Company safety review
 - Non-ROV device specifications and documentation
 - Initial safety inspection scoring
- Onsite Safety Inspection
- Examples and photographs of what will and will not pass safety inspection

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Company Safety Review

All EXPLORER and RANGER companies advancing to the world championship competition must submit a company safety review that demonstrates compliance with the following specifications:

- Anderson Powerpole connectors are the main point of connection to the MATE supply (ELEC-010R) or (ELEC-010E).
- A properly sized fuse is within 30 cm of the main point of connection. The company must use a ruler to show this distance (ELEC-008R) or (ELEC-008E).
- EXPLORER class must use a Littlefuse (ELEC-001).
- Fuse calculations (ELEC-008R) or (ELEC-008E) should be included and a properly sized fuse used.
- The inside of the control box is does not have exposed wiring (ELEC-017R) or (ELEC-017E),, the control box is neatly laid out with attention to workmanship (ELEC-022R) or (ELEC-022E), a separation and identification of 120VAC wiring from DC and control voltages (ELEC-023R) or (ELEC-023E). If AC wiring is not used in the control box, include a statement saying no AC is used.

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Company Safety Review (cont.)

- All wires entering and leaving the ROV have proper strain relief (ELEC-024R) or (ELEC-024E).
- If hydraulics / pneumatics are used that the company has passed the Fluid Power Quiz (FLUID-014). If fluid power is not used on the vehicle, include a statement saying no fluid power is used.
- Hydraulic / pneumatic systems include a pressure release valve and regulator in the system (FLUID-007, FLUID-011), and that any pressurized cylinder, pressure storage device meets the MATE specifications (FLUID-012, FLUID-013).
- Any watertight housing on the vehicle can withstand pressure at 4 meters (MECH-001).
- All propellers are shrouded and guarded to IP-20 standards (MECH-006). The guard / shroud must completely enclose the thruster so no object of 12.5 mm can reach the propeller.
- Any Non-ROV Device (the micro-ROV in 2019) is detailed for safety.
- The ROV has no sharp edges or elements of the ROV that could cause damage (MECH-006, ELEC-017R or ELEC-017E).

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Company Safety Review (cont.)

The **Company Safety Review** should include an explanation of how the system meets the safety specifications and **photographs** of the relevant system for review by the MATE Center staff.

Each item on the lists should be accompanied by photographs and text explanations showing how each specification is satisfied.

Upon reading this document, it should be clear to the safety inspector how the ROV meets all the required safety items.

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The **Company Safety Review** should include an explanation of how the system meets the safety specifications and photographs of the relevant system for review by the MATE Center staff.

Companies advancing the world championship competition must submit their Company Safety Review to the MATE Center by **May 20th, 2021**, along with (but as a **separate** document from) their technical documentation.

Companies that do not submit a Company Safety Review by the required date will be **DISQUALIFIED** from advancing to the world championship competition.

World championship competition safety inspectors will review companies' documentation for an **initial safety inspection** worth 20 points. Safety inspectors will also compile a list of the safety violations and publish them to the competition web site. This is not done to "call out" or embarrass companies in any way. It is to emphasize the fact that **EVERYONE** is responsible and accountable for ensuring a safe, successful event. It also allows the company to correct the safety violations before arriving at the world championship competition.

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Job Site Safety Analysis (JSA)

Job Safety and Environmental Analysis (JSEA)

A JSA or JSEA is a checklist of the steps required to do a task, identifying the potential hazards for each task and what measures are taken to eliminate or remove the hazards involved.

Companies choosing to submit a JSA must focus on the product demonstrations. The JSA should be specific for the product demonstration run (operating the ROV in the water). Deck side setup, operations, and breakdown of the system should be considered in any JSA.

For each specific step of ROV set up, operations, and breakdown, potential hazards should be identified, measures taken to mitigate risk should be listed, and person(s) responsible for hazard mitigation should be listed.

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Job Site Safety Analysis (JSA)

Job Safety and Environmental Analysis (JSEA)

JSA links:

[Oceaneering International HSE Employee Handbook](#). See chapter 33 on JSEAs. The Oceaneering International handbook, including additional suggested reading, can also be found here: https://www.marinetech.org/oceaneering_safety/

MATE safety inspectors from Oceaneering International found the following JSAs submitted to the MATE ROV Competition to be especially good:

2017 JSA from [Halifax Robotics Nova Underwater Technologies](#)

https://www.marinetech.org/files/marine/files/ROV%20Competition/2019%20competition/Safety/Halifax%20Robotics_Nova%20Underwater%20Technologies_JSA_2017.pdf

2018 JSA from [NTNU Vortex](#)

https://www.marinetech.org/files/marine/files/ROV%20Competition/2019%20competition/Safety/NTNU_Vortex_NTNU_JSA_2018.pdf

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Powering a Non-ROV-Device

- Only the powered Seabin connector and the pipe inspection device are considered non-ROV-device for 2021.
- Power may be supplied from the surface, from the primary ROV or by on-board batteries. Power is limited to 12V and 6 amps.
 - If powered from the surface, the micro-ROV must have a 7.5 amp fuse (or less) within 30 cm of battery. If powered from on-board batteries or from the primary ROV, the micro-ROV must have a 7.5 amp (or less) fuse at the point of connection.
 - Onboard power must be AAA, AA, A, A23, C, D or 9-volt alkaline batteries only.
 - Onboard batteries should be mounted, not loose, in the container.
 - The battery container must be designed so it will open or release if pressure inside becomes greater than the external pressure.
 - One end of container pops off
 - **EXPLORER ONLY:** Both a 3 psi pressure release valve AND a Schrader valve

A SID is required for any powered Non-ROV Device. This SID must be submitted separately from, and in addition to, any SID included in the technical manual.

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Documentation of powered Non-ROV Device

- Companies must provide a written explanation of their non-ROV devices. This should include information on how the device(s) is powered, as well as information on the systems on the device (cameras, movement/thrusters, water-tight housings, etc.).

Failure to provide the necessary documentation or SID means companies will not be allowed to use their device during the product demonstration.

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Initial Safety Inspection Penalty points

Penalty points will be deducted from the initial safety inspection if:

- Companies do NOT submit the documentation by the specified date ([May 20th, 2021](#) for the world championship competition).
- Documents are not submitted with the proper naming format.
- The SID does not show a fuse or a fuse that does not use an ANSI, NEMA or IEC symbol.
- Fuse calculations are not shown on the SID.
- The vehicle uses fluid power, but a fluid power diagram is not included.
- The Company Safety Review does contain the necessary information.
- The non-ROV device specifications are not documented. If companies are not using non-ROV devices and not attempting the specified tasks, inform the MATE ROV safety team that these tasks are not being attempted.

RANGER & EXPLORER Class Safety Inspection Protocol

ONSITE SAFETY INSPECTION

Before entering the water for practice or for a product demonstration run, the ROV system must successfully complete a safety inspection.

Once the company successfully passes their safety inspection, the safety inspector will keep their onsite safety inspection score sheet and the company will receive is **Blue PASSED card**.

Companies must present their Blue PASSED card to the pool practice coordinator and/or product demonstration judges before their vehicles are permitted to enter the water. Each company's card will be uniquely identified with company name and number, as well as allowed features of their ROV (fluid power use, laser use, etc.).

RANGER & EXPLORER Class Safety Inspection Protocol

ONSITE SAFETY INSPECTION

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

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.

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.

RANGER & EXPLORER Class Safety Inspection Protocol

ONSITE SAFETY INSPECTION

If during the third safety review a violation still exists, 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, product presentation, and marketing display) component.

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.

Note: Companies do not need to present their **Blue PASSED card** to the judges during their product presentation.

EXPLORER SAFETY INSPECTION SHEET

Company Name: _____ Company Number: _____

2020 MATE ROV COMPETITION. Excite, Educate, Empower: Students Engineering Solutions to Global Problems

EXPLORER CLASS SAFETY INSPECTION CHECKLIST

Companies must bring this check list, the ROV, tether, surface controls, and any other item used in the deployment and operation of the ROV; they will all be inspected as part of the safety check. In addition, the SID, company safety review, technical documentation, and any additional documentation needed to verify compliance must be made available to the Safety Inspectors during the inspection process.

1.0 Initial Safety Inspection	4.0 Pneumatic / Hydraulic (if applicable)
Fluid power approved? Fluid power used? If yes to both, see Section 4.0 Pneumatics / Hydraulics	Passed fluid power quiz.
Laser approved? Laser used? If yes to both, see attached laser safety inspection sheet.	Pneumatic or hydraulic diagram (SID) present?
	Hydraulic fluid MSDS provided (if water is not used).
	Hydraulic fluid (other than water) has been approved by MATE ROV Competition Technical Manager.
2.0 ROV Physical	All pressure lines have a minimum pressure rating of 100 PSI (pneumatic) or 300 PSI (hydraulic) stamped on the line or verified with specifications.
All items attached to ROV are secure.	Valves meet the minimum pressure rating of 100 PSI (pneumatic) or 300 PSI (hydraulic)
Hazardous items are identified and protection provided.	Attachment to the pressure source is secure.
ALL propellers are completely shrouded to IP-20 standards. Mesh size is less than 12.5 mm.	Pressure is regulated to: 40 PSI max for pneumatics 150 PSI max for hydraulics
No sharp edges or elements of the ROV design that could cause injury to personnel or damage the pool surface.	Pressure vessels have a stamped pressure rating or verification by inspection.
	Pressure vessels have a current inspection sticker.
	Pressure vessels can be secured on the pool deck.
	Company fabricated pressure accumulator test results are provided (if used).
	No hydraulic fluids are leaking.
	Pneumatics utilize compressed air or inert gas.
3.0 ROV Electrical	
Tether has proper strain relief at the ROV.	
No power conversion before the ROV.	
No exposed motors.	
Brushless motors are considered exposed unless electrically sealed after purchase. Companies should provide proof of sealing or procedure.	
No exposed copper or bare wire.	
All wiring securely fastened and properly sealed.*	
Any splices in tether are properly sealed.*	
3.1 Surface Controls Electrical & Physical	
Single attachment point to the power source.	
Anderson powerpole attachment to power source.	
Properly sized (Littlefuse brand) fuse within 30 cm of power supply attachment point.	
The surface control station is built in a neat and workmanship like manner. No loose components or unsecured wires. All electrical components are covered inside an enclosure.	
No exposed copper or bare wire.	
120VAC wiring is separated from the DC wiring.	
120VAC wiring must be clearly identified from the DC and control voltages with signage and/or wire color schemes. If the color scheme is used, a key must be provided for identification.	
All wires entering and leaving the surface control station must have adequate strain relief and wire abrasion protection as the wires pass through the enclosure.	
All connectors utilized are properly rated for their application. AC only rated connectors cannot be used for DC.	
* Properly sealed means that the wires cannot be exposed to water. Tape only sealing will allow the conduction of electricity through water.	
At minimum, joints must be soldered, sealed with a proper waterproof sealant, and covered in tape or shrink wrap. For in water taping, silicone self-vulcanizing tape is preferred over thermoplastic tape. Cables with exposed male connections on both ends are not allowed.	

SAFETY INSPECTION #1	PASSED: 30 POINTS
Failed: Items to correct noted on rear of this sheet.	
SAFETY INSPECTION #2	PASSED: 20 POINTS
Failed: Items to correct noted on rear of this sheet.	
SAFETY INSPECTION #3	PASSED: 10 POINTS
Failed: Reason/ details are noted on rear of this sheet.	
Total Safety Points:	
On Site Inspection	
0 to 30 points	

Inspection #1: Items to address Judge: _____

Inspection #2: Items to address Judge: _____

Inspection #3: Reason Judge: _____

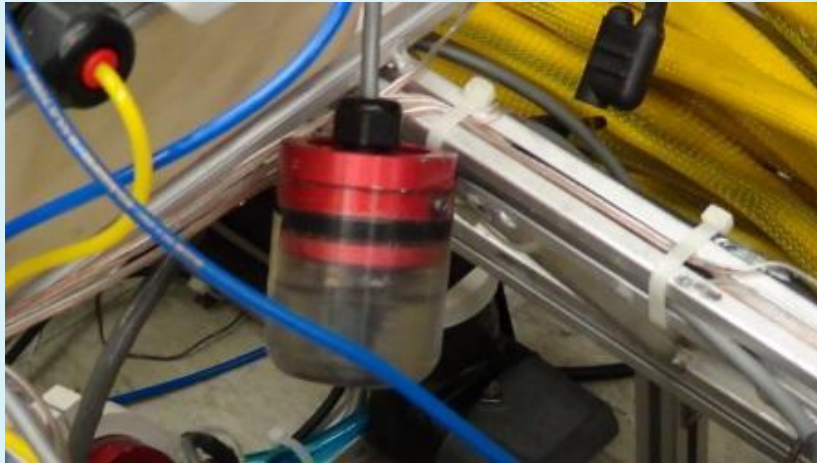
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2.0 Physical

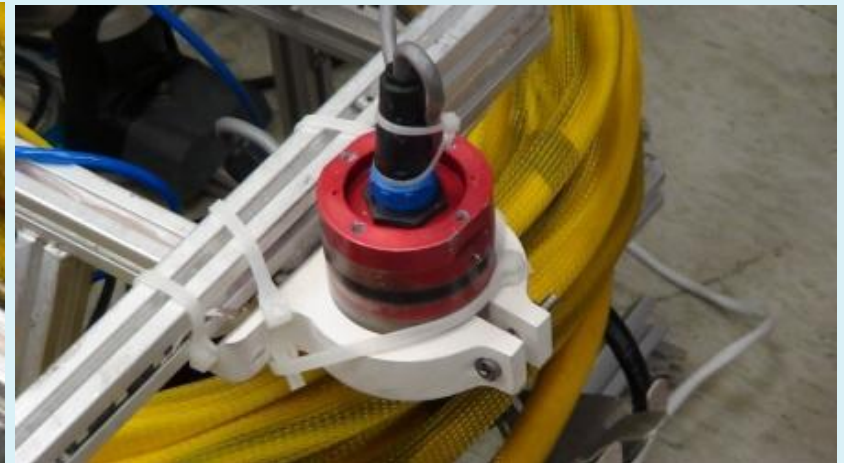
All items attached to ROV are secure and will not fall off.

Examples:

loose camera



securely attached camera



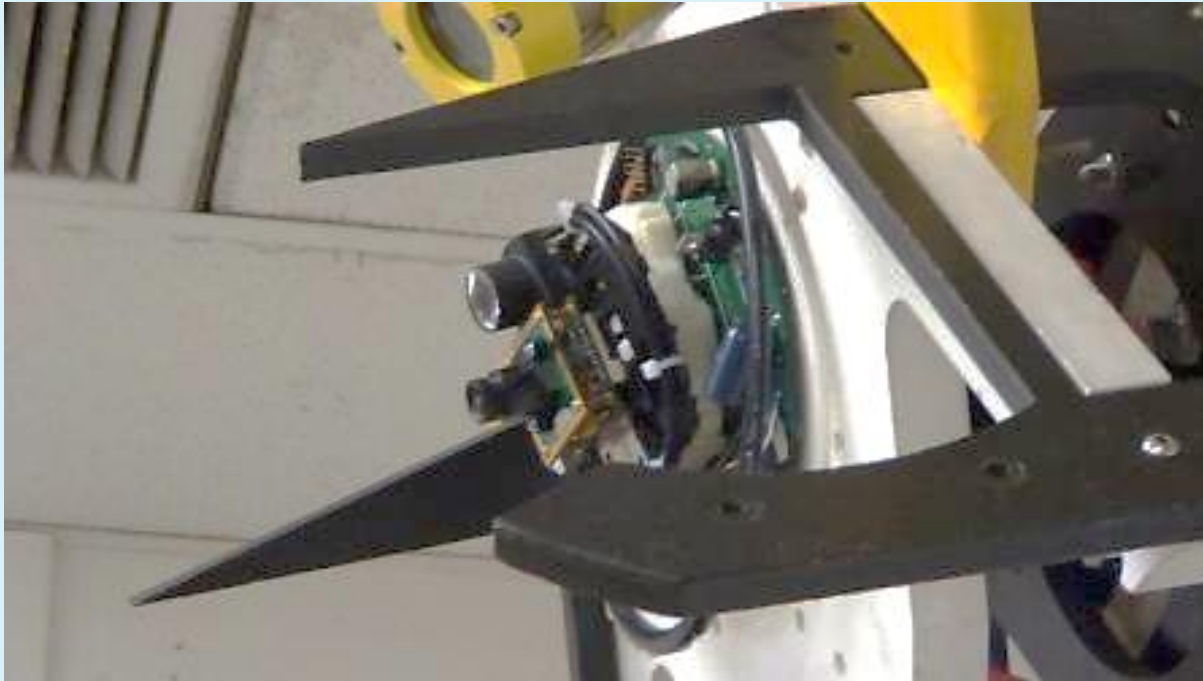
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2.0 Physical

No sharp edges or elements of ROV design that could cause injury to personnel or damage to pool surface.

Examples:

The points on the front of this ROV may look cool, but the inspector failed the company during safety inspection for putting something that could be a danger to the divers.



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2.0 Physical

Hazardous items are identified and protection provided.

Examples:

Sharp edges on the scoop are painted red; yellow and black safety warning colors are used elsewhere. The company successfully passed their safety inspection because potentially hazardous items that are needed to complete a task are identified and protected.



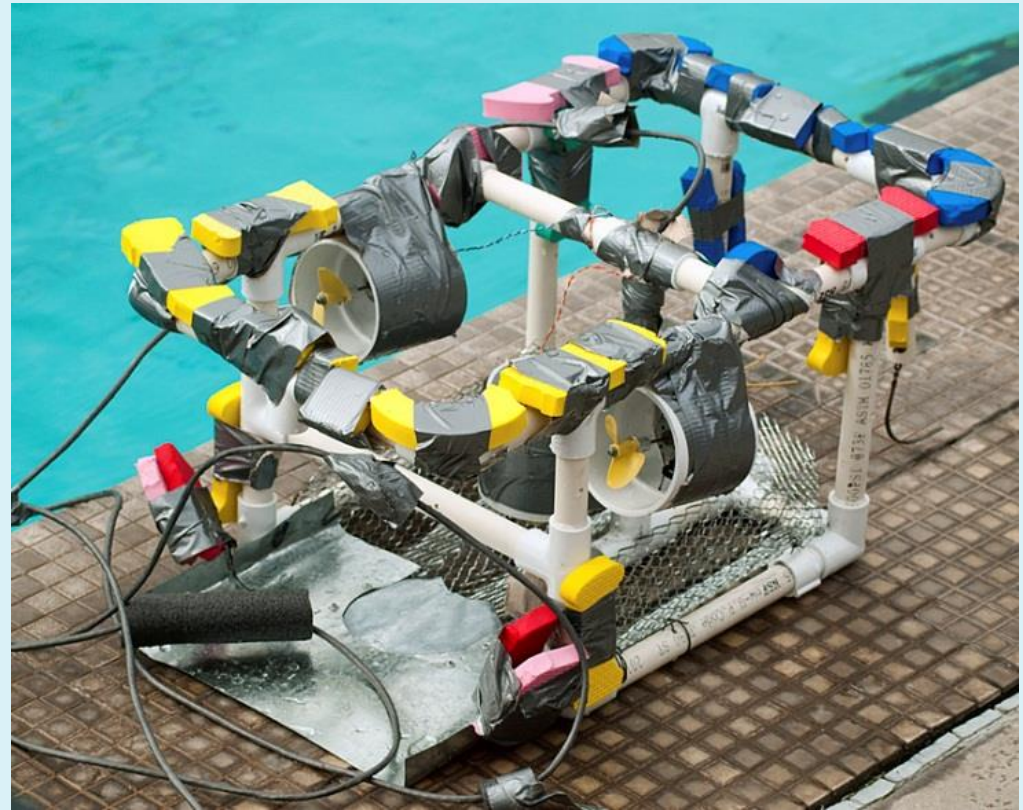
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2.0 Physical

ALL Propellers must be shrouded even if they are enclosed inside the frame of the ROV

Note that the shrouds shown do not meet IP-20 standards and are not acceptable shrouds/guards for propellers.

This will not pass safety inspection!



Insufficient shrouding

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3.0 Electrical (Ranger)

Single attachment point to power source.

Anderson powerpole connectors are required to connect to the MATE power source.

A single inline fuse (not shown) must be within 30cm of attachment point (power connectors). Fuses in each line are acceptable.

Ranger Class utilizes the RED & BLACK powerpole connectors. Looking at the end of the connectors, you will see a small A on the end of each. With the tip of the A pointing up, black should be on the left and red on the right



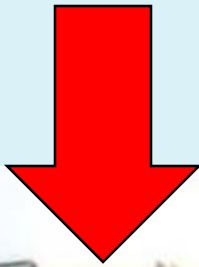
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3.0 Electrical (Ranger)

Problems with the Anderson powerpoles in Ranger class have developed when teams do NOT use the proper crimper for these connectors.

Standard Electricians Crimpers will NOT work!

The crimp must be a roll crimp not a “squish” crimp.



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3.0 Electrical (Explorer)

Single attachment point to power source.

Anderson power connectors are required to connect to MATE power source.

A single inline fuse within 30cm of attachment point (power connectors) is required. **This must be a Littlefuse!**

Explorer Class utilizes the Blue **SBS50BLU-BK (50 amp)** power connectors. Positive and Negative are marked on the connectors.



The terminals for these connectors must be crimped with a hydraulic or a ratcheting crimper designed for the terminals.

A 30A (or smaller) Littlefuse must be within 30cm of these terminals.



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3.0 Electrical (Ranger & Explorer)

Fuse Size Calculation

The team should have their fuse size calculation somewhere on their SID. It should also be included on the Company Safety Review. Review that calculation and verify that the attached fuse corresponds with their calculations.

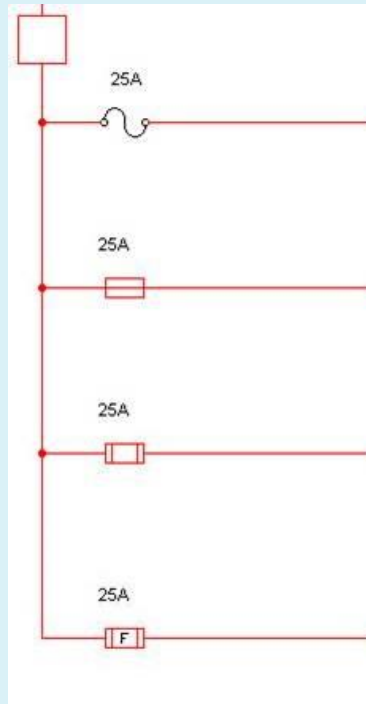
ELEC-008: The ROV system must have a fuse that is calculated based upon the maximum current draw of the ROV. This overcurrent protection must be calculated as follows: $\text{ROV Overcurrent Protection} = \text{ROV Full Load Current} * 150\%$. The overcurrent protection value may be rounded up to the next standard fuse. Companies must use a fuse that is rated for overcurrent protection. In no case can that value exceed the 30A maximum. The fuse must be installed in the positive power supply line within 30 cm of the power supply attachment point. The fuse may be a slow blow type. The SID and other electrical diagrams must show the fuse and include the amperage of the overcurrent protection. In addition, the SID must show the calculations used in determining the overcurrent protection value. SIDs without these calculations shown will have 5 points deducted from the initial safety inspection sheet. Also, SIDS without fuse calculations will not pass safety inspection.

Circuit breakers are not allowed.

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3.0 Electrical System Interconnection Diagram (SID)

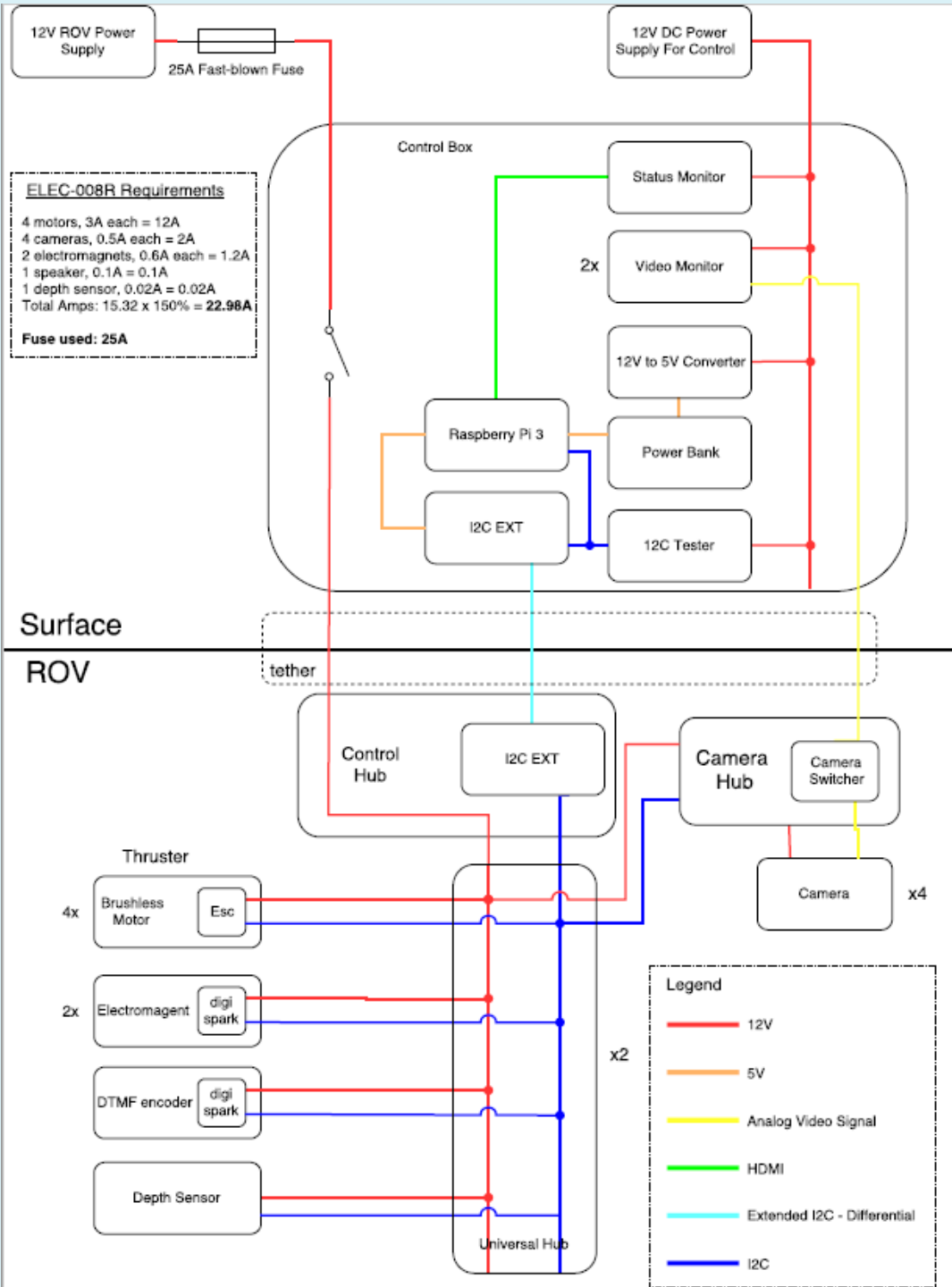
- System Interconnection Diagram (SID)** A SID is a system-level, connection diagram that includes electrical and, if applicable, fluid power wiring information. Board-level and component-level schematics should not be included; however, these may be brought to the engineering evaluation for reference purposes. The intent is to provide the competition judges with a one-line diagram showing how the various systems are interconnected without the detail of each and every wire.



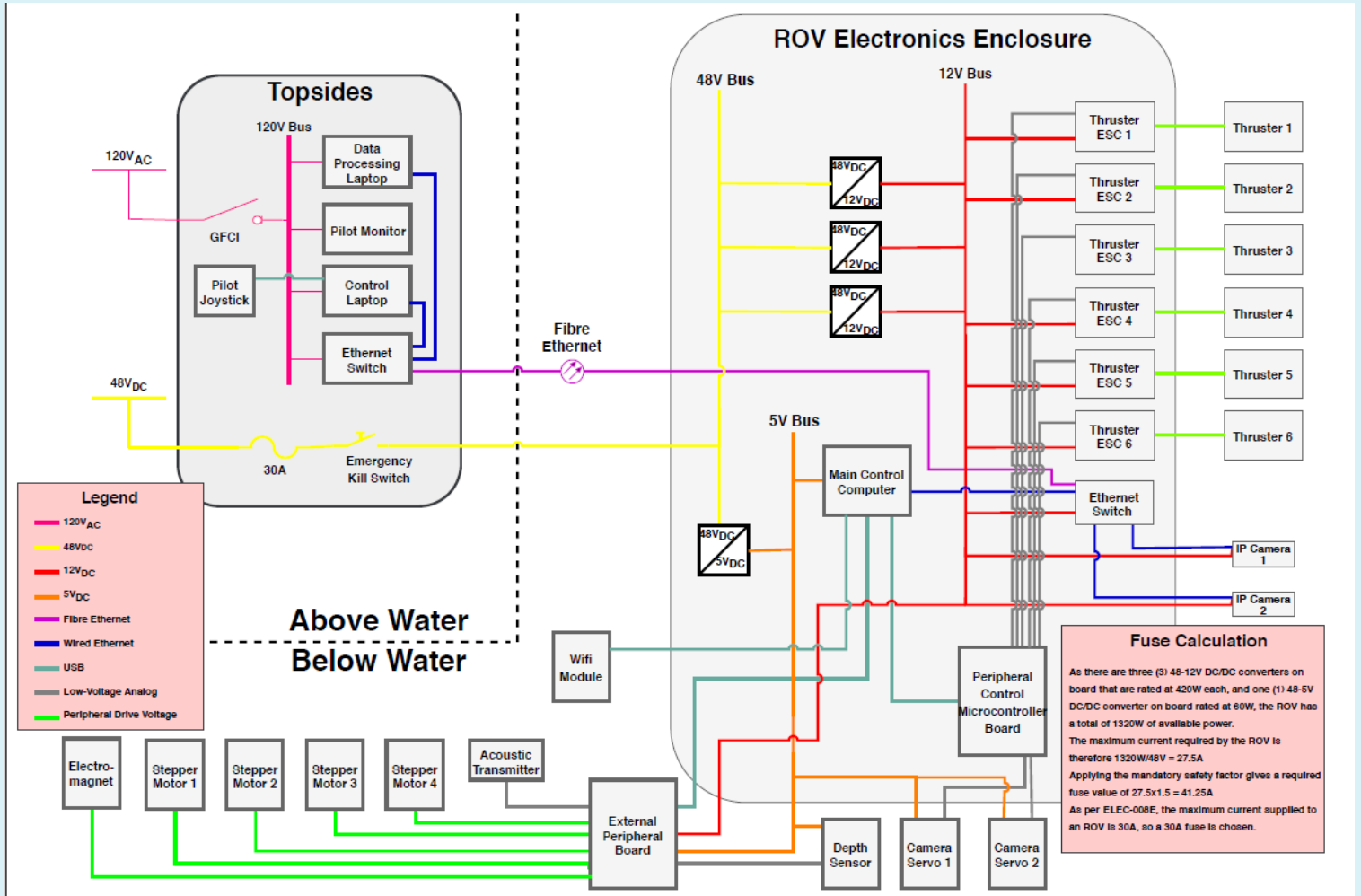
These are the only acceptable fuse symbols. A fuse is not a box, a line with an letter S over it, or any other non-standard symbol

A link to an example of an acceptable SID can be found in the **Competition Manual**. Additional SIDs can be found in technical reports from previous years.

Example RANGER SID



Example EXPLORER SID



Eastern Edge Robotics - ROV Florizel Electrical System Integration Diagram

Revision History

2018-05-15 - Originally Drawn - NG
 2018-05-23 - Minor Corrections - NG

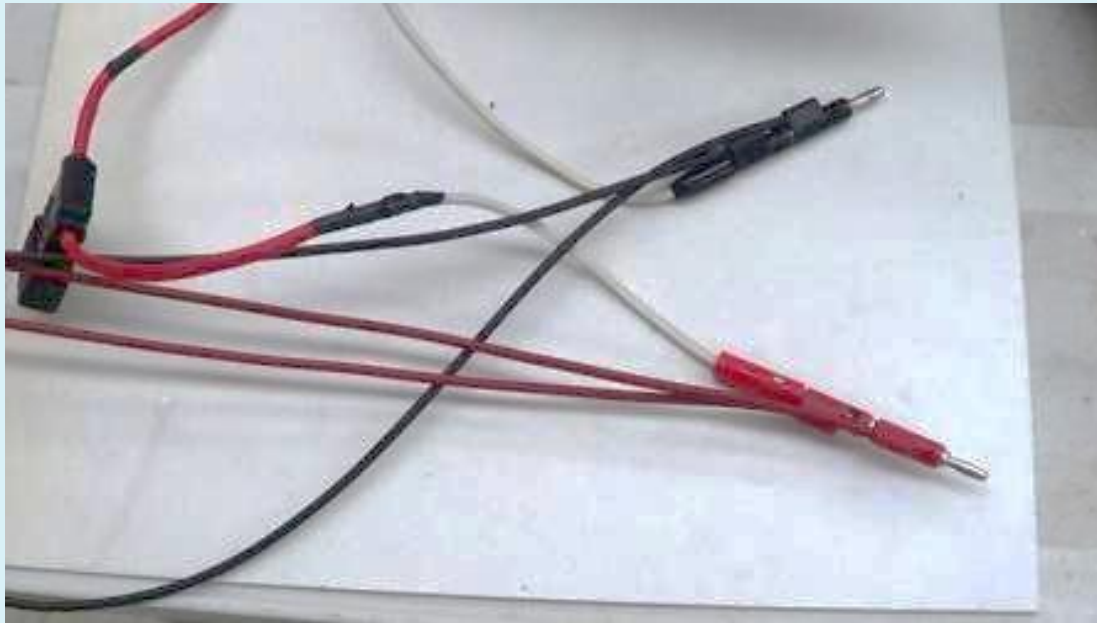
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3.0 Electrical

Single inline fuse or circuit breaker within 30cm of attachment point.

Examples:

This is an example of multiple attachment points ahead of the fuse and **WILL NOT** pass safety inspection.



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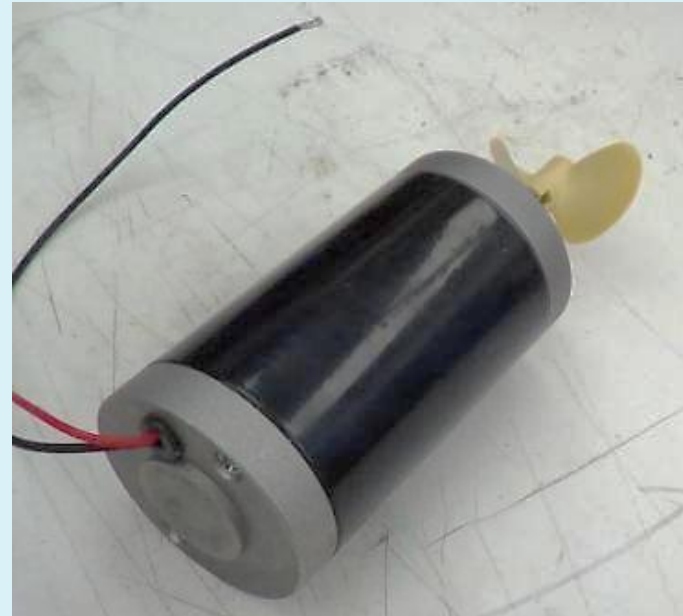
3.0 Electrical

No exposed copper or bare wire. No exposed motors.

Examples:

These motors with exposed connections, that are not waterproof, **WILL NOT** pass safety inspection. The motor on the left is both exposed and has bare wire.

The motor on the right is exposed and not sealed.



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3.0 Electrical

No exposed copper or bare wire.

Examples:

This **WILL NOT** pass safety inspection. Using banana plugs at both ends of the wire to route power from one section to another violates the MATE safety rules. It is possible for the hot end of the wire to become unplugged and create a safety hazard.



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3.0 Electrical

Tether is properly secured at ROV.

Examples:

On the left, all the wires are loose and unsecured. On the right is an example of a well-secured tether. Companies should be prepared to lift their ROV by the tether to ensure proper strain relief.

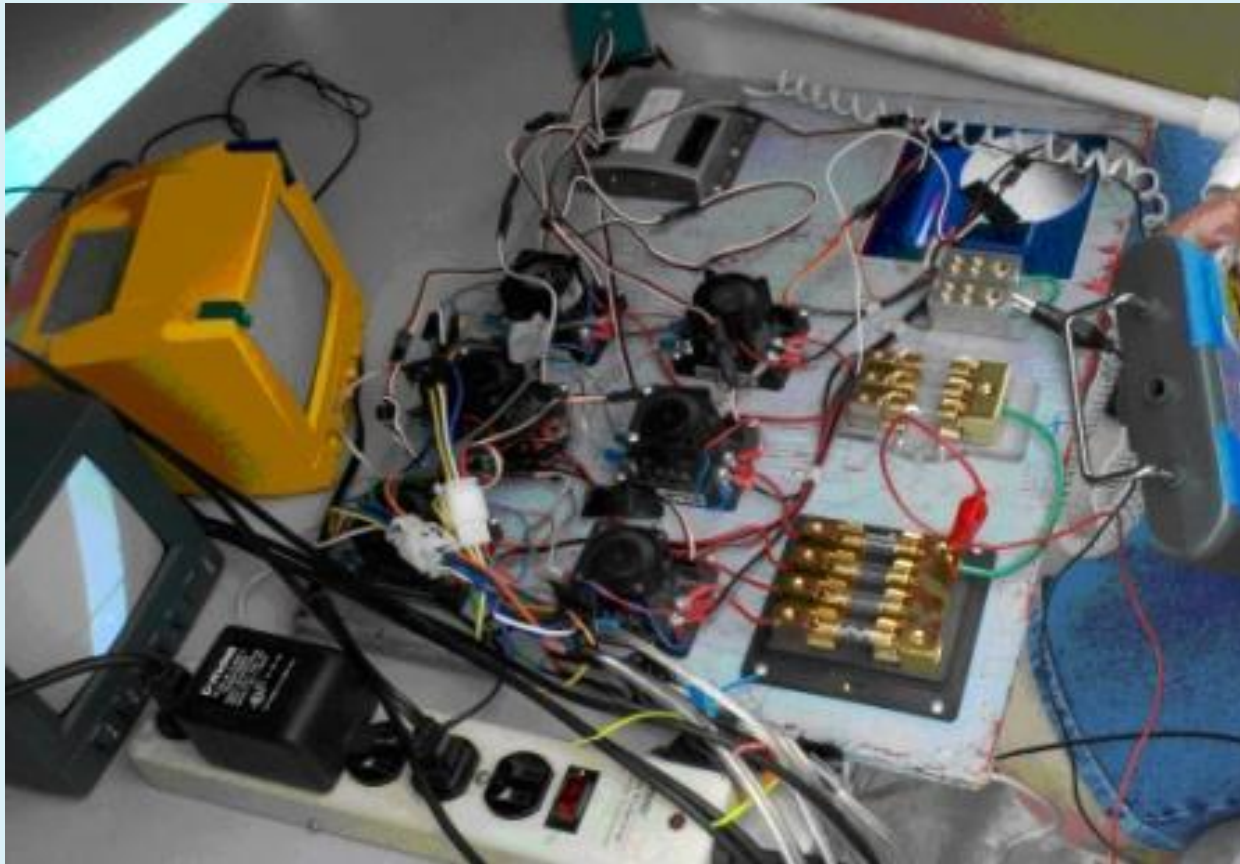


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3.0 Electrical

Surface controls: All control elements are mounted with wiring inside an enclosure.

There are multiple FAILS in the photograph below!



- Exposed wiring
- Multiple fuses instead of single point fuse for power.
- Loose wires.
- Alligator clips used for connections.
- No strain relief provided for wires coming from power or going to ROV.

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3.0 Electrical (Related to ELEC-025R)

Dangerous Wiring Methods.

*When building your ROV, think about potential danger issues
Ask yourself whether if someone were not told about a wiring issue, would they be safe.*

An example of this was seen in the use of 120VAC connectors to provide power for the ROV. One team distributed power on the surface using a 120VAC plug strip that had been modified to plug into the 12VDC MATE supply. Each thruster then had a 120VAC connector that plugged into the plug strip. This presents a very real safety hazard for the student who unknowingly plugs the thruster into 120VAC and ends up getting shocked or burned.

Safe wiring should need no warnings.

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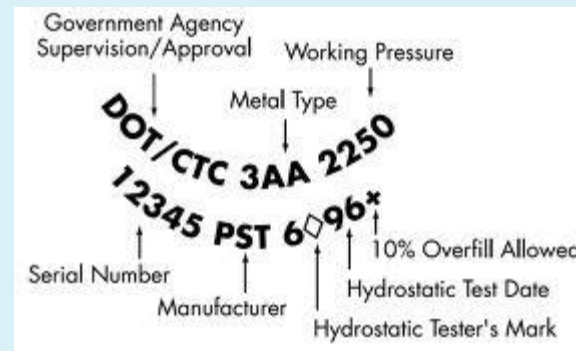
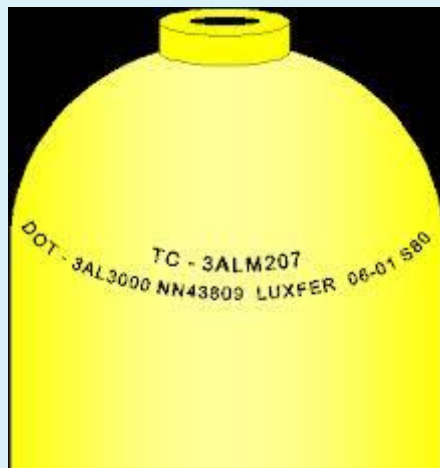
4.0 Pneumatic / Hydraulic Checklist

- ◆ Did you PASS the pneumatics/hydraulics test?
- ◆ Do you have your pneumatic or hydraulic SID(s) present?
- ◆ Are pneumatic and/or hydraulic component specifications provided?
- ◆ Are you using pressure rated lines and fittings?
- ◆ Is your attachment to pressure source is secure?
- ◆ Is your pressure regulated to 40psi max for pneumatics and 150 psi max for hydraulics? **COMPANIES MUST PROVIDE THE REGULATOR.**
- ◆ Do your pressure vessels have a stamped pressure rating or verification by specification and do the pressure vessels have current inspection sticker?
- ◆ Are your pressure vessels secured on pool deck and not rolling around?
- ◆ If a company fabricated pressure accumulator is used, are pressure test results provided?
- ◆ Are hydraulic fluids leaking?
- ◆ Do your pneumatics utilize compressed air or inert gas?

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4.0 Pneumatic / Hydraulic

Examples of Tank Certifications and Inspection Stickers



The tank must have a current visual inspection certificate (above) AND current hydrostatic test stamp (on the right).



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5.0 Laser Checklist

- ◆ Did the team send the laser specs to the competition coordinator two weeks prior to the regional?
- ◆ Does your SID show the laser driver?
- ◆ Does your laser have an on/off switch on the surface controller?
- ◆ Is the laser powered through the MATE surface power supply?
- ◆ Are batteries used to power the laser? (**this is not allowed**)
- ◆ Are your lasers the proper type? Visible Laser in 630-680 nm (red) or near 532 nm (green) Class I, Class II, or Class IIIa Category; Red Laser: 5mW or less Green Laser: 1 mW or less. **Be sure and bring your laser specs to the safety inspection.**
- ◆ Is the laser voltage at or below laser rated voltage & current?
- ◆ Was a specification sheet showing laser and laser glasses sent to, **and approved by**, MATE ROV Competition officials prior to event?
- ◆ Does your ROV have a Laser shield or beam stop attachment within 30 cm of laser when out of water?
- ◆ Do the team members have laser safety glasses, regardless of the laser output power?

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SAFETY FIRST!

Our goal is not to fail teams and keep them from competing, but rather to run a fair and **SAFE** competition for all.

If you have a question or concern, You can ask your question on the MATE forum boards at: <https://forums.marinetech2.org/> or contact that MATE ROV Competition Technical Manager at mgardner@marinetech.org. In this case it is better to ask for permission, not forgiveness. Remember, it is better to be **SAFE** than sorry!