TASK: *MATE Floats!*

This year's preview mission focuses on Task 3: *MATE Floats!* 2025. The preview mission includes all of Task 3, hints for building a profiling float, and specification rules for constructing your profiling float non-ROV device. The mission outlined below will be included in the competition manuals as **one of the three tasks** for the 2025 competition season.

MATE Floats! 2025 is inspired by the National Science Foundation (NSF)-funded GO-BGC Project. The goal of GO-BGC is to build a global network of profiling floats with chemical and biological sensors to monitor circulation, chemistry, biology, and overall ocean health. Scientists, engineers, and technicians are using NSF grant funds to build and deploy 500 robotic ocean-monitoring floats around the globe. As of August 2024, 217 out of the targeted 500 GO-BGC floats have been deployed or will be deployed shortly.

This task involves the following steps:

Design and construct an operational vertical profiling float

- **Prior to the competition, design and construct a vertical profiling float – 5 points**
- **Float communicates with the mission station prior to descending – 5 points**
- **Float completes up to two vertical profiles –**
    - **Vertical profile 1**
        - **Float completes first vertical profile**
            - **Using a buoyancy engine – 10 points**
            - **Using a different mechanism – 5 points**
        - **Float communicates data to the mission station – 5 points**
        - **Data verifies that the float maintains a depth of 2.5 meters for 45 seconds – 10 points**
    - **Vertical profile 2**
        - **Float completes a second vertical profile**
            - **Using a buoyancy engine – 10 points**
            - **Using a different mechanism – 5 points**
        - **Float communicates data to mission station – 5 points**
        - **Data verifies that the float maintains a depth of 2.5 meters for 45 seconds – 10 points**
    - **Profile graphed as depth over time – 10 points**

OR

Company does not design and construct a vertical profiling float or float does not communicate data to the mission station.

- **MATE-provided data is used to graph depth over time – 10 points**

Total points = 70 points

Product Demonstration Notes:
Prior to the competition, companies must build a float capable of completing a vertical profile (i.e., traveling from the surface to a depth of 2.5 meters and back to the surface) and collecting and communicating data to the mission station.

Companies that design their float with a buoyancy engine will receive additional points. A buoyancy engine moves fluid from inside the float to outside the float, displacing seawater and changing the density of the float. Using a motor to change the volume (push or pull a syringe, pump water into or out of, or expand a section) of the float constitutes "using a buoyancy engine." Using thrusters to directly move the float constitutes "using a different mechanism." Companies that do not use a buoyancy engine to complete their vertical profiles will receive fewer points. The float must also be capable of communicating data to a receiving device (i.e., the receiver) located at the surface at the mission station. The company is responsible for designing and constructing both the transmitter on the float and the receiver that displays the data at the mission station.

Companies must submit a non-ROV device document outlining their float design, detailing its operation, and demonstrating that it does not violate any safety rules. This document must also detail the onboard battery design, fuse size for safe discharge of the current, and how the float communicates with the company's receiver at the mission station. See DOC-004 for more details. This non-ROV device document must be submitted in advance of the competition. Companies will receive 5 points for designing and building a float. Successfully designing and building a float is defined as submitting a non-ROV device document that meets the requirements of DOC-004 and transporting the float to the product demonstration station.

Companies competing at a regional may or not be required to submit float documentation. Contact your regional coordinator or visit your regional contest's website to determine if you must submit your float design document prior to the competition. IF REQUIRED BY THE REGIONAL COMPETITION, COMPANIES MUST SUBMIT THEIR FLOAT DOCUMENTATION OR THEY WILL NOT BE RECEIVE POINTS FOR BUILDING THE FLOAT.

Companies may deploy their float by hand through the 1-meter x 1-meter square at the side of the pool. Once the float begins its first vertical profile, or descends below the surface on its own, companies may no longer retrieve the float for repairs or repositioning.

Once the float has been deployed, it must communicate to the receiver located on the surface at the mission station. Companies are responsible for constructing both the transmitter on the float and the receiver at the mission station. Companies should design their float so that the transmitter can be maintained high enough above the surface of the water to communicate with the mission station.

The float must communicate (i.e., transmit) the following information to the mission station, referred to as the defined data packet:

- Company number (provided by MATE a few weeks prior to the competition)
- Time data (UTC or local or float time [float time would be time since float starts recording])
- Pressure data and/or depth data
- Any additional data as required by the company to complete this task

Sensors onboard the float must measure pressure and/or depth and transmit at least one of those to the mission station receiver. If a pressure to depth conversion is completed by the sensor on the float, companies may transmit depth data as part of their defined data packet. Alternatively, companies may choose to only transmit pressure data as part of their defined data packet and convert pressure to depth at the mission station.

Pressure data must be displayed in pascals (pa) or kilopascals (kpa).
Depth data must be displayed in meters (m) or centimeters (cm).

Pressure and/or depth data must correlate to a set time transmitted from the float. For example, a defined data packet from RANGER 01 could be:

RN01 1:51:40 UTC 9.8 kpa 1.00 meters

NOTE: MATE is requiring WHAT data is transmitted (i.e., company number, time, pressure, depth). Companies must determine HOW to transmit that data and should consider that there will be other companies transmitting data at same time.

While the float is in the water, no longer in contact with a company member, and still on the surface, the float must transmit the defined data packet to the receiver. The receiver should not receive transmissions from any source other than the float. The float must transmit the defined data packet before starting its first vertical profile.

Companies will receive 5 points when their float successfully transmits the defined data packet to the receiver at the mission station upon deployment. Successfully transmitting the information is defined as the station judge seeing at least ONE defined data packet from the float on a screen or display at the mission station. The float only needs to transmit one defined data package prior to descending, but companies will not be penalized for sending additional defined data packets. If the float does not transmit and has not started its first vertical profile, companies may recover the float and attempt repairs.

The float should attempt to complete two vertical profiles. A vertical profile is defined as any part of the float on or above the surface, descending in the water column to a depth of 2.5 or more meters*, then ascending to and breaking the surface once again. Companies may use a buoyancy engine, thrusters, or another means to move their float through the water. A buoyancy engine is defined as moving air or liquid from inside the float to outside the float, changing the volume and thus the density of the float. Using motors to move air or liquid does constitute a buoyancy engine. Using motors as thrusters to directly move the float, by turning a propeller or emitting a jet of water, constitutes using a different mechanism to complete a vertical profile. Companies will receive 10 points for completing their first vertical profile using a buoyancy engine, or 5 points if they use a different mechanism.

During the vertical profile, the float must collect data every 5 seconds. After the first vertical profile has been completed and the float is still at the surface, the float must transmit the defined data packets taken every five seconds to the mission station receiver. Companies will receive 5 points when the float successfully communicates to the mission station receiver. The float MUST have completed one vertical profile to receive points for transmitting data packets to the receiver. Successfully transmitting data to the receiver is defined as the station judge seeing at least one defined data packet from the vertical profile on a screen or display at the mission station.

After successfully demonstrating that at least one data packet has been transmitted, companies must display all of the data packets transmitted by the float during the entire vertical profile so that the mission station judge can verify that the float maintained a depth of 2.5 meters* for 45 seconds. If at any time the float moves above or below 2.5 meters (+/- 50 cm), it must reestablish itself and maintain a depth of 2.5 meters (+/- 50 cm).

Companies will receive 10 points for successfully maintaining a depth of 2.5 meters (+/- 50 cm) for 45 seconds. Successfully maintaining a depth of 2.5 meters for 45 seconds is defined as the station judge seeing 10 defined data packet cycles (1 data packet every 5 seconds) where the float depth was 2.5 meters +/- 50 cm on a screen or display at the mission station. Companies should design their float so that their pressure / depth sensor maintains a depth of 2.5 meters.

The ten data packets at 2.5 meters do not need to be sequential. For example, if a float maintains depth at 2.5 meters for 15 seconds (4 data packets), descends to the bottom, but then ascends back to 2.5 meters, it would need to collect 6 more data packets (25 seconds) at 2.5 meters to arrive at a total of 10. The station judge must see 10 data packets showing the depth at 2.5 (+/- 50 cm) to receive full points; these data points do not have to be in a continuous 45 second block.

The float should then attempt to complete a second vertical profile. Companies will receive 10 points for completing a second vertical profile using a buoyancy engine, or 5 points if they use a different mechanism.

During the second vertical profile, the float must collect data every 5 seconds. After the second vertical profile has been completed and the float is still at the surface, the float must transmit the defined data packets taken every five seconds to the mission station receiver. Companies will

receive 5 points when the float successfully communicates to the mission station receiver. The float MUST have completed its second vertical profile to receive points for transmitting defined data packets to the receiver. Successfully transmitting data to the receiver is defined as the station judge seeing at least one defined data packet from the vertical profile on a screen or display at the mission station.

After successfully demonstrating that at least one data packet has been transmitted after the second vertical profile, companies must display all of the data packets transmitted by the float so that the mission station judge can verify that the float maintained a depth of 2.5 meters* for 45 seconds. If at any time the float moves above or below 2.5 meters (+/- 50 cm), it must reestablish itself and maintain a depth of 2.5 meters (+/- 50 cm).

Companies will receive 10 points for successfully maintaining a depth of 2.5 meters (+/- 50 cm) for 45 seconds. Successfully maintaining a depth of 2.5 meters for 45 seconds is defined as the station judge seeing 10 defined data packet cycles (1 data packet every 5 seconds) where the float depth was 2.5 meters +/- 50 cm on a screen or display at the mission station.

Companies will receive 10 points for successfully graphing depth versus time of one vertical profile. Companies may graph either their first or second vertical profile. Successfully graphing the data is defined as showing the station judge a graph with time on the X-axis and depth on the Y-axis. Companies must graph the data received from their vertical profile, even if their float did not maintain a depth of 2.5 meters for 45 seconds. Depth data should be graphed every 5 seconds. The depth should be measured from the pressure/depth sensor on the float. Station judges will compare the depths provided on the graph when the float is on the surface and when maintaining a depth of 2.5 meters. If the float's pressure/depth sensor is above or below the waterline when the float is on the surface, companies should communicate how far below the waterline the pressure/depth sensor is when on the surface. Company's depths must be within 50 cm of the true depth to receive points for successfully graphing the data. Companies must use a computer or device to graph the data; companies may not draw a graph by hand. Data points may be entered (or cut and pasted) to a device by hand.

If the float fails to communicate to the mission station after its first or second vertical profile, it can continue to complete vertical profiles until it successfully transmits data. For example, if the float completes its first vertical profile but fails to communicate to the mission station before descending for its second vertical profile, companies will receive points for a vertical profile, but would not receive points for communication or maintaining depth at 2.5 meters. After completing a second vertical profile, if the float communicates successfully with the surface station, companies will receive points for their second vertical profile and would receive points for communication and maintaining a depth of 2.5 meters (if the data packets verify the proper depth for 45 seconds). If the float then completes a third vertical profile and successfully communicates to the mission station, companies will not receive any additional points for the third vertical profiles, but they would receive points for the missed communicating and maintaining a depth of 2.5 meters (if the data packets verify the proper depth).

If a float communicates data to the mission station, but that data does not verify that the float maintained a depth of 2.5 meters, companies will still receive points for the tasks that they did complete during the vertical profile. If a subsequent vertical profile accomplishes additional tasks, the station judge will replace the lower score with the later score. For example, if a float completes a vertical profile and transmits data packets, but those data packets do not verify that the float maintained a depth of 2.5 meters for 45 seconds, companies would receive points for completing a vertical profile and transmitting data, but would not receive points for data verifying the float maintained depth. After completing two vertical profiles, if a subsequent vertical profile is completed by the float, and that profile verifies the float maintained a depth of 2.5 meters for 45 seconds, companies would then receive points for data that verifies that the float maintained a depth of 2.5 meters for 45 seconds. Companies MUST inform the station judge that their recent profile has additional points scored and show the station judge the data confirming a high score. The station judge is not responsible for tracking additional vertical profiles; a company member must show the judge the data verifying the additional points.

The float must be less than 1 meter in overall height.
The float may not have a diameter/length/width greater than 18 cm.
The float may not have an airline to the surface or a rope/line to the surface or the bottom. The entire float must be less than 1 meter in length, including an antenna for broadcasting data. The float must be less than 1 meter in length for the entire mission, it cannot have multiple compartments that separate, nor may it raise or lower any objects beyond the 1-meter limit.

The float must move independently from the ROV. The float must operate independently; it may not be connected to the shore by a tether nor can the ROV interact with the float after successful deployment. Any air used on the float must be stored on the float. Floats may not have an airline to the surface. All electrical power to the float MUST go through a single fuse. The float will operate as a non-ROV device (see 3.3.1 Non-ROV Device Power Specifications for additional rules on powering a non-ROV device). Small button batteries are allowed to power timing devices on the float. All other batteries must adhere to the non-ROV device battery rules.

Companies that do not design and construct a float can use data provided by the MATE ROV Competition to create a graph of depth versus time. Likewise, if a company's float does not transmit data back to the station receiver, companies may choose to use data provided by the MATE ROV Competition to create a graph of depth versus time. Companies that design and construct a float may still earn points for completing vertical profiles; creating a graph from MATE-provided float data replaces all points for communicating to the mission station after a vertical profile, maintaining depth at 2.5 meters and any graphing of data received from the float. Companies cannot receive points for graphing data communicated from their float AND graphing data provided by MATE.

Companies that do not design a float, or whose float is unable to transmit data back to the station, should inform the station judge that they are choosing to instead graph data provided by MATE. The judge will then provide a set of depth versus time data to the company. Once a company requests the MATE data, they can no longer receive points for communicating to the station after a vertical

profile, for verifying their float maintained a depth of 2.5 meters or for graphing data from their own float. Companies will receive 10 points for graphing depth versus time. Successfully graphing the data is defined as showing the station judge a graph with time on the X-axis and depth on the Y-axis. Companies must use a computer or device to graph the data; companies may not draw a graph by hand. Data points may be entered (or cut and pasted) to a device by hand.

*Regional competitions may take place in pools that are shallower than 2.5 +/- 50 cm. If that is the case, contact your regional coordinator or visit your regional contest's website to determine the depth your float must reach to complete a vertical profile and what depth the float should maintain depth at.

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. Companies must measure the full load amps of the float device and calculate their fuse size from this calculation. This non-ROV device design document must contain:

- A photo or diagram of the non-ROV device.
- The type of batteries used.
- A photo of all battery packs.
- A photo of the fuse(s) used on the ROV.
- Fuse calculations showing the full load amps measurements for both waiting mode and buoyancy change mode.

For the *2025 MATE Floats!* task, this document must also include:

- A description of the buoyancy engine or different mechanism 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 amps 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 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 calculations

3.3.1 Non-ROV Devices

The vertical profiling float qualifies as a non-ROV device in 2025.

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 utilize thrusters but may not include any cameras. Vertical profiling floats cannot use a camera onboard to take images or video of pressure data and transmit those images/videos to the surface station.

NEW for 2025!!! 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.

- AAA, AA, C, D and 9V alkaline batteries are allowed. See table below for maximum amperage allowed for each battery type.
- NiMH (Nickel Metal Hydride) batteries and AGM (Absorbed Glass-Mat) batteries are also allowed.
- 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.

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

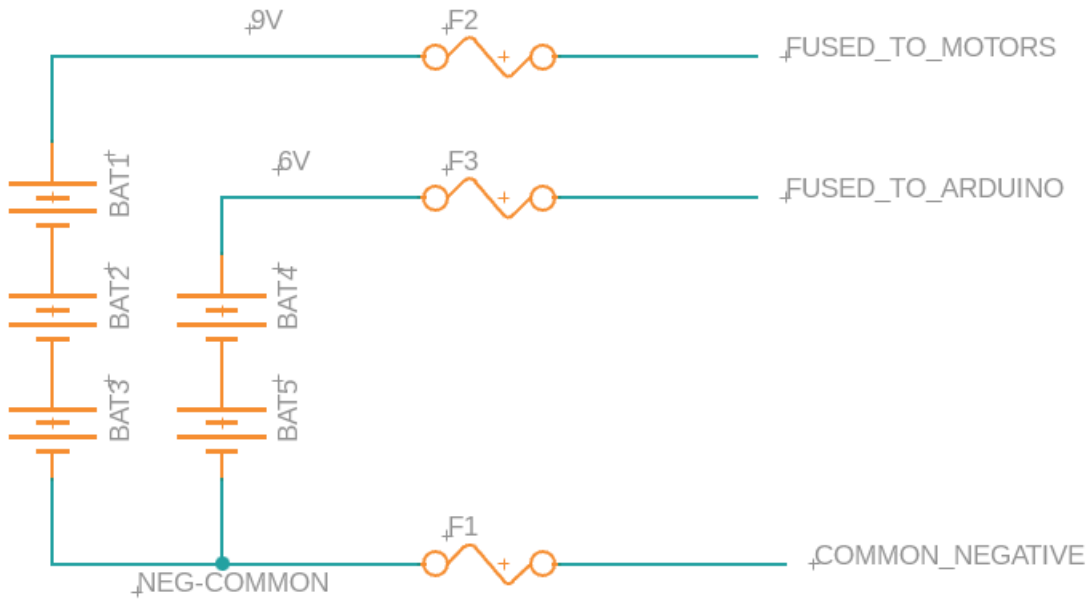
Battery Type	Amps	Ohms	Maximum amps	Maximum Fuse Size	Fuse Link
AAA	0.294	5.1	0.588	500mA	500mA fuse
AA	0.353	4.25	0.706	750mA	750mA fuse
C	0.517	2.9	1.034	1.0 A	1.0 A fuse
D	0.682	2.2	1.364	1.25 A	1.25 A fuse
9V	0.05	180	0.1	100mA	100mA fuse

For the NiMH and AGM batteries:

- Maximum nominal voltage is 12V
- Maximum overall current and fuse size is 5 amps

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.
- ***New for 2025!!!*** Cartridge fuses MUST be used for fusing alkaline batteries. Use a link from the above table for the fuse for alkaline batteries. All cartridge fuses must be readily accessible and must have the current stamped on the end of the fuse. Minimum DC voltage for the fuse must be 32 volts.
- ***Note for 2025!!!*** ATO type blade fuses or MINI blade fuses MUST be used for fusing NiMH and AGM batteries. The fuses to select from are 1A, 3A 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 have the current stamped on the end of the fuse.
- 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 C batteries, the maximum fuse size is 1.0 amps. If three battery strings are placed in parallel, the maximum fuse size is 3 amps (3 * 1.0A = 3.0 Amps).
- For systems with multiple battery packs, the battery packs should be connected on the negative terminals with the fuse (5 amps max) located off of the common negative terminal connection. Each individual battery pack should also be fused with the properly sized fuse for that battery pack.



ELEC-NRD-005: Fuse Calculations. 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 calculated using the full load amps measurement.

In the non-ROV device fuse calculations, they 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 2025!!!*** Utilization of pressure release valves are not acceptable as they cannot be tested at the competition site.
- ***Note for 2025!!!*** 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