PIONEER/RANGER CLASS: *MATE Floats!* 2024

MATE Floats! 2024 is inspired by the National Science Foundation (NSF)-funded GO-BGC Project. The goal of GO-BGC is to help 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.

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**
- **Deploy the float into a designated area – 5 points**
- **Float communicates with the mission station prior to descending – 10 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 is graphed as depth over time – 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 is 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 the bottom 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 one-page Non-ROV device document outlining their float design, detailing its operation, including the mechanism the float uses to descend/ascend (e.g., a buoyancy engine, thruster, or other), and demonstrating that it does not violate any safety rules. This document must also detail how the float communicates with the company's receiver at the mission station. 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 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. See DOC-004 in the competition manual for more information. IF REQUIRED BY THE REGIONAL COMPETITION, COMPANIES MUST SUBMIT THEIR FLOAT DOCUMENTATION OR THEY WILL NOT BE RECEIVE POINTS FOR BUILDING THE FLOAT. Companies MUST present a copy of the float documentation to the station judges.

Companies must deploy their float in a designated location. The designated location is defined as anywhere beyond a red mark set 2.5 meters out in the pool. Companies will receive 5 points when they successfully deploy their float. Successfully deploying the float is defined as the float no longer in contact with the ROV, floating on the surface, and beyond the red mark 2.5 meters away from the side of the pool. If the float is released before reaching the designated location, companies are permitted to retrieve the float and reposition it in the designated location. However, if the float is released and begins communicating with the mission station receiver before reaching the designated area, companies may choose to disregard those communications and reposition the float in the designated area. Once deployed in the designated area, the float must communicate with the mission station to receive points for communication. Alternatively, if the float communicates with the mission station prior to being

deployed in the designated location, companies may choose to opt out of points for deploying the float and instead receive points for communication prior to descending. 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
- Depth data (optional)
- Any additional data as required by the company to complete this task

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 data (and depth data if transmitted) must correlate to a set time transmitted from the float. For example, a defined data packet from EXPLORER 01 could be:

EX01 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 on the surface and determined to be successfully deployed by the ROV, and before completing its first vertical profile, the float must transmit the defined data packet to the receiver; the receiver should not receive transmissions from any source other than the float.

Companies will receive 10 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 the 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.

The screen or display showing the defined data packets is not considered a video display for the purposes of number of video displays allowed.

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 until any part of the float touches the bottom, 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 first 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 all 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 defined data packets to the receiver. Successfully transmitting data to the receiver is defined as the station judge seeing the defined data packets from the float on a screen or display at the mission station.

Companies must use the defined data packet to graph the depth over time. How and when companies convert their pressure reading to a depth measurement is up to them. The sensor onboard the float may perform internal conversions and transmit both pressure and depth, companies may convert pressure to depth on their surface receiver device, or companies may use a different device at the station to convert pressure to depth.

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. Depth data should be graphed every 5 seconds. The depth should be measured from the bottom of the float. If the pressure sensor is not located at the bottom of the float, companies may use a conversion factor. Communicate to the station judge any conversion factor incorporated into your depth data. Companies should also communicate to the station judge how far below the waterline the pressure sensor is when on the surface. For example, if the pressure sensor is 10 cm from the bottom of the float and 20 cm from the waterline when on the surface, companies should let the station judge know that a depth reading of 2.4 meters is actually 2.5 meters actual depth. When on the surface, companies should inform the judge that their float will read 30 cm of depth (20 cm from waterline to pressure sensor, 10 cm from pressure sensor to the bottom of the float). Station judges will compare the depths provided on the graph when the float is on the surface and on the bottom to known depths. Company's depths must be within 25 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. Companies are not required to autonomously generate a graph of depth versus time.

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 should continue to collect data every 5 seconds. After the second vertical profile has been completed and the float is still on the surface, the float must transmit all 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 a 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 the defined data packets from the float on a screen or display at the mission station.

Companies must use the defined data packet to again graph the depth over time. 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. Depth data should be graphed every 5 seconds. The depth should be measured from the bottom of the float. If the pressure sensor is not located at the bottom of the float, companies may use a conversion factor. Communicate to the station judge any conversion factor incorporated into your depth data. Companies should also communicate to the station judge how far below the waterline the pressure sensor is when on the surface. Station judges will compare the depths provided on the graph when the float is on the surface and on the bottom to known depths. Company's depths must be within 25 cm of the true depth to receive points for successfully graphing the data. Companies must only send defined data packets from their second vertical profile. Likewise, the depth versus time graph provided to the judge for the second vertical profile must only include data points from the second vertical profile. Depth from the first profile should not be included.

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 is successful. 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. 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 their first communication. 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 their second communication attempt.

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 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. 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 in the competition manual for additional rules on powering a non-ROV device).

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. The data provided by MATE will be taken from a real-world GO-BGC float. Companies that design and construct a float may still earn points for deploying it and completing vertical profiles; creating a graph from MATE-provided float data replaces the communicating to the mission station and graphing portion of the tasks. 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 or 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.

Companies that choose to graph data provided by MATE will only receive points for creating ONE graph. They cannot earn points from creating two graphs from the same data.

3.3.1 Non-ROV Device Power Specifications

The vertical profiling float is considered a non-ROV device and therefore must meet all of the following specifications.

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 6 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 use thrusters to descend/ascend but cannot use an onboard camera(s) to take images or video of pressure data and transmit those images/videos to the surface station.

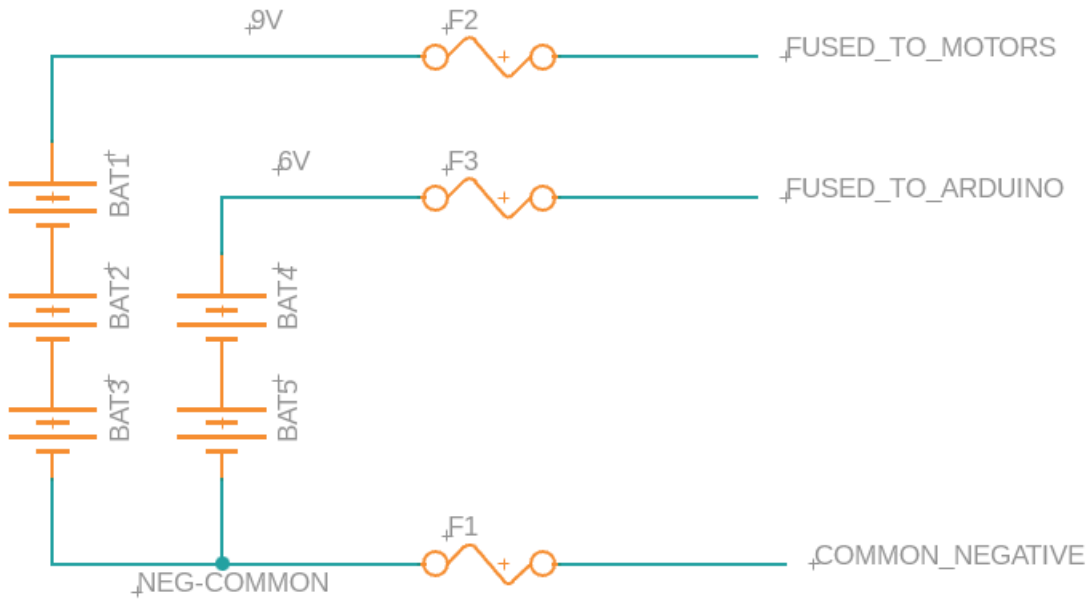
ELEC-NRD-003: Companies may not power the vertical profiling float non-ROV device from the surface.

ELEC-NRD-004: Onboard power is allowed for non-ROV devices. If onboard batteries are being used, the following specifications must be met:

- Batteries must be primary (non-rechargeable).
- AAA, AA, A, A23, C, D or 9V alkaline batteries are allowed. No other size or chemical composition is allowed. 12-volt, outdoor, rechargeable batteries are **NOT** allowed. High discharge LiPo batteries are **NOT** allowed.
- Batteries are mounted in a manner that they are not loose inside the container.

ELEC-NRD-005: Battery fusing for non-ROV devices is an important consideration and the following rules must be followed.

- Non-ROV devices must include a single fuse that will shut down all power sources in the non-ROV device if the fuse blows.
- A fuse (7.5 amps max) must be installed within 5 cm of the battery positive terminal.
- The maximum distance from the battery pack to any fuse is 5 cm.
- 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.
- ATO type blade fuses or MINI blade fuses MUST be used for any fusing. 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.
- For systems with multiple battery packs, the battery packs should be connected on the negative terminals with the fuse (7.5 amps max) located off of the common negative terminal connection. Each individual battery pack should also be fused with fuses no more than 7.5A each.



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

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 with a rubber plug 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 open 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 it together. There must be at least one 2.5 cm or larger opening that serves as a pressure release.
- The use of pressure release valves are not acceptable as they cannot be tested at the competition site.

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