MATE FLOATS!

SCOUT and NAVIGATOR CLASS: *MATE Floats!* 2025

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 build an operational vertical profiling float

- **Prior to the competition, design and construct a vertical profiling float with a temperature sensor – 5 points**
- **Float completes a vertical profile – up to 30 points**
  - **Autonomously – 30 points**
  - **Manually – 10 points**
- **Float collects temperature data from four points – up to 20 points**
  - **Air (prior to being deployed) within 4°C – 5 points**
  - **Surface within 4°C – 5 points**
  - **Mid-water within 4°C – 5 points**
  - **Bottom within 4°C – 5 points**
- **Graph temperature versus depth – up to 5 points**

OR

Company does not design and construct a vertical profiling float, or the float does not contain a temperature sensor.

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

Total points = 60 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 data during the profile.

The vertical profiling float:

- May use a motor and propeller to travel from the surface to the bottom and back. Alternatively, the float may use other means to go up and down, such as a buoyancy engine.
- Propellers must be enclosed inside the frame of the float or shrouded. The propeller should not be able to touch any surface of the pool. Floats with propellers protruding outside the framework will not pass safety inspection and cannot be used.
- Must operate independently of the ROV. The float must go down and up independently of the ROV (on its own).
- May be operated by a pilot. This pilot can be the same person who pilots the ROV or a different pilot. NOTE: Companies that program their float to successfully operate (aka complete a vertical profile) autonomously will receive more points than those who operate their float manually.
- Must be less than 50 centimeters in overall height. The float may not have a diameter/length/width greater than 15 cm.
- MUST operate as a non-ROV device. See below for additional information on powering non-ROV devices.

Companies will receive 5 points for successfully designing and constructing a vertical profiling float. Successfully designing and constructing a float is defined as bringing the profiling float to the mission station and explaining to the judge how it operates (how it moves up and down in the water column).

Companies may deploy their float by hand at the side of the pool.

Once released, the float should attempt to complete a vertical profile. 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 attempt to complete their vertical profile autonomously or manually.

Companies choosing to do their vertical profile autonomously must program their float to complete a single vertical profile. Completing the vertical profile autonomously means using a computer program to control the motor or buoyancy engine. Companies are permitted to manually start the process, but once started the computer program must issue commands to the motor or buoyancy engine to drive the float from the surface to the bottom, and then reverse the motor to drive the float from the bottom back to the surface. Once the float reaches the bottom companies may not manually reverse the motor, that must be done autonomously. Any computer board (Arduino, Raspberry Pi, etc.) controlling the float must be on the surface, side of the pool; any power source for the float must also be on the surface. No electronics or power sources (batteries) are allowed onboard the float.

Companies will receive 30 points for successfully completing a vertical profile autonomously. Successfully completing a vertical profile autonomously is defined as the float on the surface of the pool, autonomously descending to and touching the bottom of the pool, then ascending to the surface again. Companies must inform the judge when their float is at or near the bottom and when it has returned to the surface. Companies must complete an entire vertical profile autonomously, from the surface to bottom to surface without manual input to the float in order to receive points.

Alternatively, companies may manually pilot their float to complete a vertical profile. Companies will receive 10 points for successfully completing a vertical profile manually. Successfully completing a vertical profile manually is defined as a pilot operating the float, and the float starting on the surface, descending to and touching the bottom of the pool, then ascending to the surface again. Companies must complete an entire vertical profile, surface to bottom to surface, to receive points.

Companies must incorporate a temperature sensor on their float to record four temperature measurements. One measurement must be recorded in the air. This measurement must be taken during the mission run before the float is deployed into the water by the ROV. Note that it cannot be taken during the set-up time. A second temperature measurement must be recorded at the surface. The temperature sensor must be underwater, but some portion of the float must be at the surface of the water. A third temperature measurement must be recorded in the midwater. No part of the float should be on or above the surface, no part of the float should be touching bottom. The float does not need to stop in the midwater in order to take the measurement. A sensor providing continuous temperature readings can be used, and a temperature reading recorded when the moving float reaches the midwater. A fourth temperature measurement should be recorded from the bottom of the pool. Some portion of the float must be touching the bottom of the pool. While the profiler completes its vertical profile autonomously, a company member may manually record temperature measurements at the given points in the profile.

Companies will receive 5 points for successfully recording each measurement, up to 20 points. Successfully recording a temperature measurement is defined as showing the station judge your temperature reading and recording that temperature at the mission station. Companies may record the temperatures by hand on paper or enter them into a computer or other device. MATE will not provide paper or a device for recording.

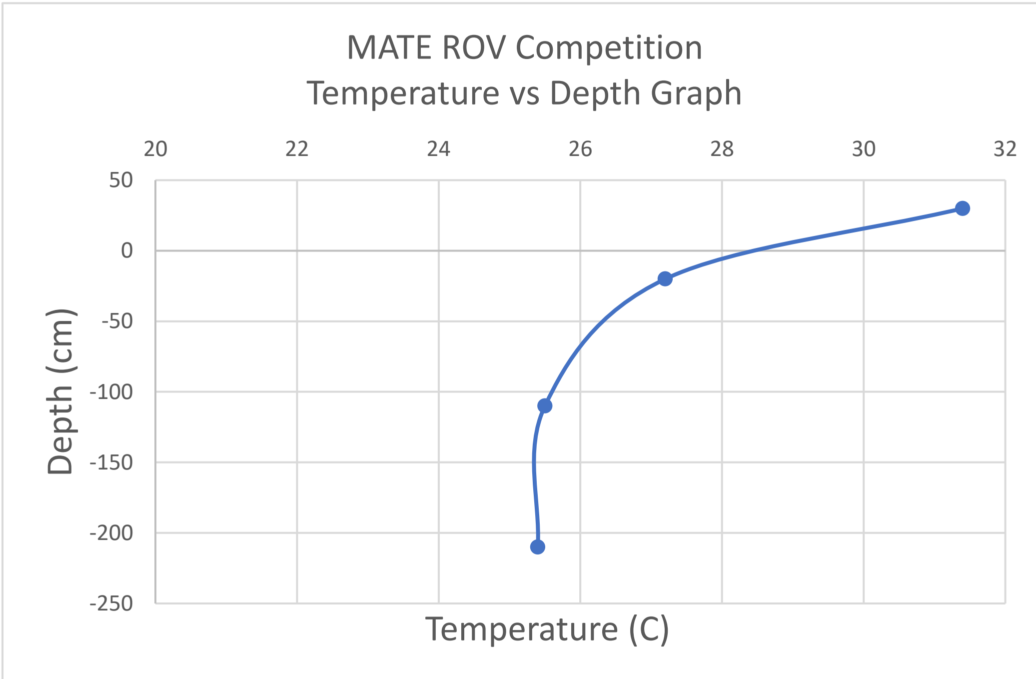
The accuracy of the temperature measurement must be within 4° Celsius of the true temperature. Station judges will have a temperature sensor that will measure the temperature of the pool and the air. Companies can compare their temperature sensor against the station sensor to determine if there is any offset (i.e. to determine if your sensor differs from the station sensor).

Once all four temperature measurements have been recorded, companies must graph those four data points as temperature versus depth. Companies should use the known depth of the pool to estimate the depths for each temperature measurement. For example, in a pool 2.2 meters deep, companies could use 20 cm for their air depth, -10 cm for their surface temperature measurement, -110 cm for their midwater depth temperature measurement, and -220 cm for their bottom temperature measurement.

Companies will receive 5 points when they successfully graph the temperature versus depth. Successfully graphing the data is defined as plotting depth on the Y-axis and temperature on the X-axis and showing the resulting graph to the station judge. All dots should be linked by a line. Companies may use Excel or another computer program to plot their data points or may graph the data points on paper. MATE will not provide computers or graph paper at the mission station; companies must provide their own method for graphing the data. All graphs must have their axes labeled. An example of a graph plotting temperature versus depth is represented below:

Data measured:

Location	**Depth (cm)**	**Temperature (°C)**
Air	**30**	**31.4**
Surface	**-20**	**27.2**
Mid-water	**-110**	**25.5**
Bottom	**-210**	**25.4**



If a company does not build a float, or if the float that they build does not have a temperature sensor, or if the temperature sensor fails to send temperature data back to the mission station, companies should inform the station judge that they are choosing to instead graph data provided by MATE. The judge will then provide a set of ten depth versus temperature data points. Once a company requests the MATE data, they can no longer receive points for collecting four temperatures and graphing those four temperatures. Instead, companies will receive 10 points for successfully graphing depth versus temperature. Successfully graphing the data is defined as showing the station judge a graph with temperature on the X-axis and depth on the Y-axis. All ten data points must be included on the graph. MATE will not provide computers or graph paper at the mission station; companies must provide their own method for graphing the data. All graphs must have their axes labeled.

Hints on building your vertical profiling float and incorporating a temperature sensor:

- One motor is sufficient to move your ROV up and down in the water. The same is true for a float.
- Your float only needs to move in two directions, up and down. For manual piloting, a DPDT switch is capable of controlling a bilge pump motor on your float.
- For autonomous control of the vertical profiling float, consider using a board such as Arduino, Raspberry Pi, or other to control the motor. The board can send signals through the tether to the motor to turn in one direction to have the profiler descend to the bottom, then send signals to reverse the motor direction to ascend. Companies can adjust the timing of their program depending on the depth of the pool. Contact your regional coordinator or visit your regional contest's website to determine the depth of the pool.

- Like GO-BGC floats, your float should be positively buoyant. When released by the ROV, it should float on the surface, but do not use so much flotation that your motor and propeller cannot move the float to the bottom of the pool.
- Simple underwater temperature sensors consist of a probe, which goes into the water, and a display that remains out of the water. These components are connected by a short pair of wires. Like the float itself, the temperature sensors may be connected to the mission station by the tether (most temperature sensors will need to be elongated and can use two wires in the tether). The temperature sensor probe must be attached to the float, but wires from the probe can extend from the float to the mission station where your display is located.
- The float wires and the temperature sensor wires may be incorporated into a single tether.
- Want to learn more about temperature sensors on your ROV or float? Check out the MATE ROV Competition **Sensors** presentation.
- Glass thermometers are not allowed in the pool! A glass thermometer on a float will NOT pass safety inspection.

Like ROVs, floats do not need to be overly complicated to work. Here is an example of a float using a propeller. While this float uses onboard batteries, which are not allowed for NAVIGATOR and SCOUT, it does use a motor with a shrouded propeller to complete vertical profiles.
Brother Rice Robotics – VESCO Float Documentation

Here are examples of floats that use buoyancy engines to move up and down. These floats also use onboard batteries (again, these not allowed for NAVIGATOR and SCOUT), but are shared here to demonstrate different ways to move a float up and down.
Seattle Academy of Arts – Triton Float Documentation
Fukien Secondary School – Over Defined Float Documentation
Valley Christian School – WarriorTIDES Float Documentation

Additional company float documentation can be found in the **2023 Archives** and the **2024 Archives**. See the Technical Reports & Spec Sheets.

Non-ROV Device Power Specifications

The vertical profiling float with a temperature sensor is considered a non-ROV device. This is a device separate from the ROV that a company can deploy and control to fulfill its mission. The following are rules for the float.

ELEC-NRD-001: The vertical profiling float MUST be powered from the surface, it may not 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 come from a surface supply, must go down tether wires, and must go through a single fuse (see ELEC-NRD-004).

The temperature sensor on the non-ROV device may be powered independently from the vertical profiling float if the sensor:

- Is purchased "off the shelf" with integrated batteries
- Has a voltage less than or equal to 9v

Provided the off-the-shelf temperature sensor system meets the above requirements, the system does not need to be opened to insert a fuse. **This rule is for the non-ROV device temperature sensor only!** This does not apply to the ROV.

Only electrical wires are allowed to be connected to the float. **You may not use pneumatics or hydraulics on your float.**

ELEC-NRD-002: The vertical profiling float non-ROV device may use thrusters or a buoyancy engine to descend/ascend but no cameras are allowed on the float.

ELEC-NRD-003: Connection to power must be red/black Anderson Powerpole Connectors. The red and black pole pieces must be attached together. Loose Powerpoles (those not attached together) will not pass safety inspection. MATE will provide a 12-volt power source for the float at the mission station.

ELEC-NRD-004: A 5-amp (or less) fuse is required. The fuse must be installed in the positive power supply line within 30 cm of the power supply attachment point.

- 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.