



TASK: *MATE Floats! 2027*

MATE Floats! 2027 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. GO-BGC is over the 450 mark, with 457 out of the targeted 500 GO-BGC floats deployed and another 29 floats scheduled to be deployed from research vessels.

Once again *MATE Floats!* is challenging SCOUT class competitors to build an autonomous float that can collect temperature data during a vertical profile. And like last year, *MATE Floats!* is also challenging SCOUT companies to incorporate decision-making into their floats by developing a program or code that controls the movement of the float. This means that the float is programmed to autonomously descend to the bottom and return to the surface (i.e., complete a vertical profile). Once on the surface companies are required to graph the temperature data collected by their floats during the profile.

This task involves the following steps:

Design and construct an operational vertical profiling float

- **Game Plan: Prior to the competition, design and construct a vertical profiling float – 5 points**
- **Execute: Float completes two vertical profiles**
 - **Completes first vertical profile as an autonomous float – 15 points**
 - **Completes second vertical profile as an autonomous float – 15 points**
 - or**
 - **Completes first vertical profile as a manual float – 10 points**
 - **Completes second vertical profile as a manual float – 10 points**
- **Check the Playing Conditions: Float collects temperature data**
 - **Float records all nine required temperature measurements – 10 points**
 - **Float records two to eight required temperature measurements – 5 points**
- **Review the Play: Data is graphed as temperature versus depth – 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 temperature versus depth – 5 points**

Total Points = 50 points

Product Demonstration Notes:

Prior to the competition, companies must build a float capable of completing two vertical profiles (i.e., descending from the surface to the bottom of the pool, then ascending back to the surface).

How a company chooses to move their float through the water column does not influence points. The float can use a buoyancy engine or a different mechanism (something other than a buoyancy engine) to complete vertical profiles. A [buoyancy engine](#) moves fluid from inside the float to outside the float, displacing seawater and changing the volume and thus the density of the float. This moves the float vertically (up and down) in the water. Alternatively, companies can use motors and propellers to move the vertical profiling float through the water.

Also, companies can choose to design a float that is tethered to the surface but operates autonomously (hereafter called an autonomous float) OR is tethered to the surface and is operated manually (hereafter called a manual float).

An autonomous float:

- Must be tethered to and powered from the surface but use a computer program to move the float vertically through the water. An autonomous float may be manually started (i.e., a button pressed or program activated to start the autonomous process), but once started, the computer program must issue commands so that the float descends to the bottom. Companies may not manually reverse the process to bring the float to the surface; a computer program must do this autonomously.
- Must be 50 cm or less in overall height
- Must be 18 cm or less in overall diameter/length/width
- Must move independently from the ROV. After deployment, the ROV may not interact with the float to move it up and down.
- Any source of power for the float must be on the surface. Electronics/computer boards (Arduino/Raspberry Pi, etc.) may be on the surface or on the vehicle. Floats using electrical power must be connected to the MATE power supply. Onboard batteries or onboard power is not allowed for floats tethered to the surface. Floats not using electrical power must still be tethered to the surface by an airline tube, rope or other line.
- May not use an air compressor to send compressed air to the float but may use a manually powered pump (operated autonomously) to push air into an open bottom container. Likewise a syringe (operated autonomously) on the surface could open and close a syringe on the float.
- MUST operate as a non-ROV device. See below for additional information on powering non-ROV devices.

- Propellers, if used, must be shrouded to IP-20 standards

A manual float:

- Is controlled by a company member on the surface, side of the pool. This would include a company member operating:
 - a switch controlling the direction of a thruster motor
 - a manual pump pushing air into an open bottomed section of the float
 - a syringe (operated manually) on the surface opening and closing a syringe on the float.
- Must be 50 cm or less in overall height
- Must be 18 cm or less in overall diameter/length/width
- Must move independently from the ROV. After deployment, the ROV may not interact with the float to move it up and down.
- Any source of power for the float must be on the surface. Floats using electrical power must be connected to the MATE power supply. Onboard batteries or onboard power is not allowed for floats tethered to the surface. Floats not using electrical power must still be tethered to the surface by an airline tube, rope or other line.
- May not use an air compressor to send compressed air to the float but may use a manually powered pump to push air into an open bottom container. Likewise a manually powered syringe could open and close a syringe on the float.
- MUST operate as a non-ROV device. See below for additional information on powering non-ROV devices.
- Propellers, if used, must be shrouded to IP-20 standards

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 SID that meets the requirements of DOC-004 and transporting the float to the product demonstration station. The document must outline the company's float design, detailing its operation, and demonstrating that it does not violate any safety rules. This document must also detail whether the float uses a buoyancy engine or uses a different mechanism (i.e., uses something other than a buoyancy engine) and which building option, autonomous float or manual float, the company uses. The float design document should include a photo or CAD diagram of the float. A SID of the float MUST be included with the non-ROV device design document. See DOC-004 for more information.

Your regional may not require float documentation to be submitted prior to the event. [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. If not required by the regional, companies must bring their float documentation, including a SID, and their float to the mission station to receive points for successfully designing and building a profiling float.

Companies may choose to either hand-launch the float from the side of the pool or the pilot of the ROV may maneuver the float to a position on the surface of the pool. The float should attempt to

complete two vertical profiles. A vertical profile is defined as the float on the surface of the water, descending to the bottom of the pool, then ascending to and breaking the surface of the water. Depending on the float design, companies will receive variable points for completing two vertical profiles.

If the float operates autonomously, companies will receive 15 points for completing their first vertical profile and 15 points for completing their second vertical profile. If the float operates manually, companies will receive 10 points for completing the first vertical profile and 10 points for completing their second vertical profile.

Companies must incorporate a temperature sensor on their float to record nine temperature measurements. The temperature measurements should be taken at the:

1. **Surface** prior to the first vertical profile
2. **Midwater** on the descent of the first vertical profile
3. **Bottom** on the first vertical profile
4. **Midwater** on the ascent of the first vertical profile
5. **Surface** after the first vertical profile but before the second vertical profile
6. **Midwater** on the descent of the second vertical profile
7. **Bottom** of the second vertical profile
8. **Midwater** on the ascent of the second vertical profile
9. **Surface** after the second vertical profile

Companies will receive 10 points for successfully recording all nine temperature measurements. Companies will receive 5 points if they successfully record two to eight temperature measurements. 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 temperature by hand on paper or enter them into a computer or other device. MATE will not provide paper or a device for recording.

Temperature collection on the surface is defined as the float in the water, but any part of the float protruding above the surface.

Temperature collection midwater is defined as no part of the float above the surface and the float not touching the bottom.

Temperature collection on the bottom is defined as the float on the bottom or within 5 cm of the bottom of the pool.

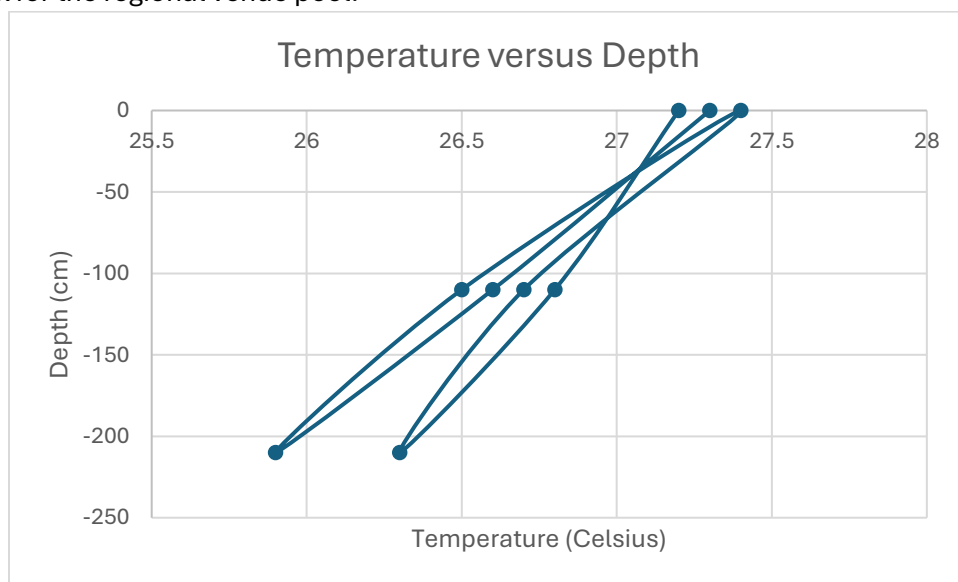
The accuracy of the temperature measurement must be within 4° Celsius of the true temperature. Station judges will have a temperature sensor that will measure the temperature of the pool. Companies can compare their temperature sensor against the station sensor to determine if there is any offset (i.e. to determine if your sensor differs from the station sensor). Temperature measurements outside of the 4°C range will not be counted as successful temperature measurements. For example, if a company collects nine temperatures, but one of those temperature measurements is outside of the 4°C range, that company would only be successful in recording eight temperatures, and would receive 5 points for this portion of the task.

Companies must graph the temperature data collected by their float. Companies will receive 5 points when they successfully graph temperature versus depth. Successfully graphing data is defined as plotting the 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)
Surface 1	0	27.2
Midwater Descent 1	-110	26.8
Bottom 1	-210	26.3
Midwater Ascent 1	-110	26.7
Surface 2	0	27.4
Midwater Descent 2	-110	26.5
Bottom 2	-210	25.9
Midwater Ascent 2	-110	26.6
Surface 3	0	27.3

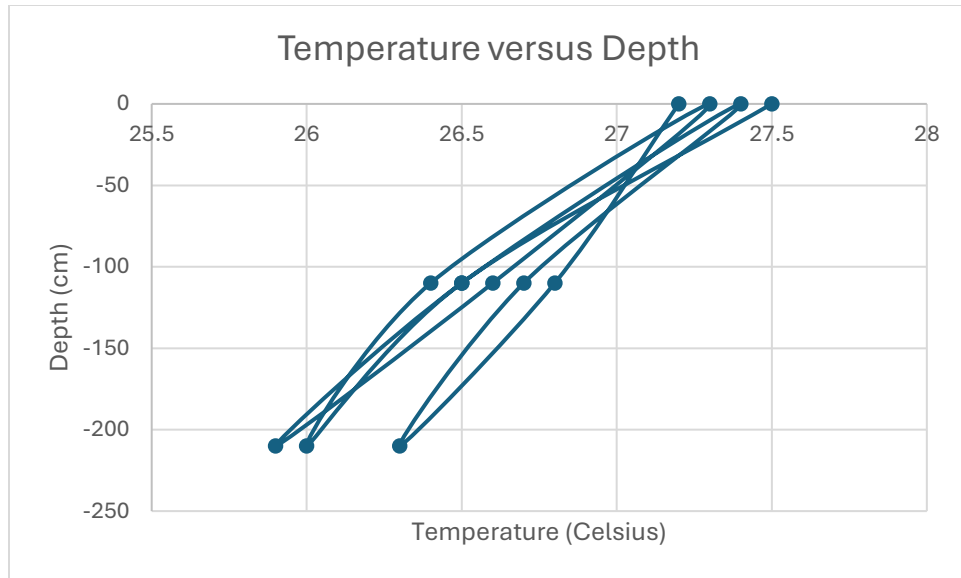
Note: Depths reflect a 2.1-meter (7 feet) deep pool. Depending on the depth of your regional pool, other midwater and bottom depths can be used. Companies do not need to determine the exact depth the temperature measurement was taken, any mid-water measurement can use the halfway depth mark for the regional venue pool.



If a company does not build a float, or if the float that they built 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 13 depth versus temperature data points. Once a company requests the MATE data, they can no longer receive points for graphing their own data. Instead, companies will receive 5 points for successfully graphing the data provided by MATE. Successfully graphing the data provided by MATE is defined as showing the station judge a graph with temperature on the X-axis and depth on the Y-axis. All thirteen 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.

An example of MATE supplied data and graph resulting from the data:

Location	Depth (cm)	Temperature (°C)
Surface 1	0	27.2
Midwater Descent 1	-110	26.8
Bottom 1	-210	26.3
Midwater Ascent 1	-110	26.7
Surface 2	0	27.4
Midwater Descent 2	-110	26.5
Bottom 2	-210	25.9
Midwater Ascent 2	-110	26.6
Surface 3	0	27.3
Midwater Descent 3	-110	26.4
Bottom 3	-210	25.9
Midwater Ascent 3	-110	26.5
Surface 4	0	27.5



Like ROVs, floats do not need to be overly complicated to work.

- One motor is sufficient to move your ROV up and down in the water and your float only needs to move in those two directions. For manual piloting, a DPDT switch is capable of controlling a bilge pump motor on your float.
- For a buoyancy engine, moving air into the float can make it positively buoyant (ascend). Pushing a syringe on the surface can open and close a syringe on the 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. Consider how that motor could open and close a syringe on the float, changing its density and moving it up and down in the water. For all of these devices, 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.

The SeaMATE Store offers a Profiler kit: [MATE Floats! Vertical Profiler Kit – SeaMATE](#). This kit is designed to run **manually** but can be modified to operate autonomously.

Images of competition floats can also be seen in the [MATE ROV Competition Flickr](#) albums.

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 (if electrical power is used).

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 (if electrical power is used)
- Full load amps fuse measurements (if electrical power is used)

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.

Non-ROV Device Power Specifications

The vertical profiling float 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: If using electricity, 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 electrical 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).

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.