# Miramar Water Jets Non-ROV Design Document

## DOC-004: Bob the Non-Rov Device (Our Float)

## Buoyancy Engine

Our device uses a syringe with the plunger connected to an allthread driven by a continuous rotation servo as a buoyancy engine (Figure 1). To decrease the buoyancy and sink, the float pulls up the plunger to take in water. To increase the buoyancy and rise, the float pushes down the plunger to expel water. Our buoyancy engine also has a limit switch to detect the maximum amount to pull up the plunger which allows us to have a set point of reference to move the plunger from.

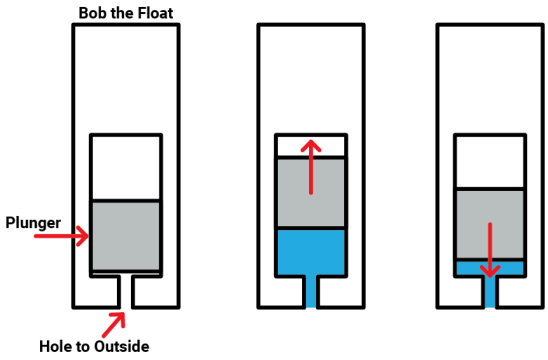


**Figure 1:** Diagram of the buoyancy engine's operation

Our float also has a MS5837 depth sensor. The MS5837 collects pressure and temperature data and our code uses a library to calculate the depth from these. When power to the float is switched on, the float will automatically record the current depth as the surface depth to mitigate sensor drift. The float uses this depth sensor to determine how to drive the buoyancy engine to maintain the competition required depth.

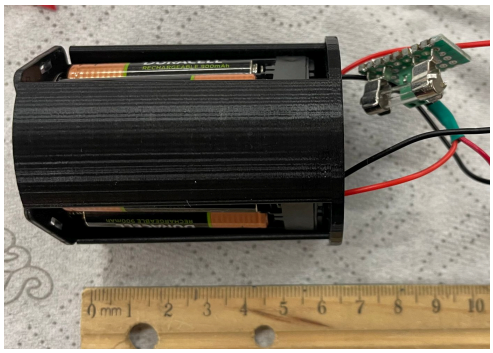

**Figure 2:** 500mA fuse connected to battery packs within 5cm of positive terminal

## Safety Overview

To conform with MATE Competition safety guidelines, our float uses four AAA Alkaline 1.5V batteries in series to make 6V that are protected by a 500mA glass cartridge fuse (Figure 2). Our device requires 5-6V to run the buoyancy

engine which comes directly from the AAA batteries and 4.5V to power everything which is processed by a zener voltage limiter. These batteries are mounted in one custom battery pack made of two double AAA battery holders in a 3d printed housing to keep them in place. Additionally, if the pressure inside of the float is greater than the pressure outside, either the top or the bottom fitting will pop off since they are press fit.

**Table 1:** FLA measurements

| **Float Operations** | **Current** |
|---|---|
| Pushing water out | 0.16A |
| Pulling water in | 0.15A |
| Startup inrush | 0.24A |
| While only transmitting packet via LoRa | 0.15A |
| While transmitting packet and pulling water in | 0.26A |

To select our fuse size, we measured the full load current of the float in water while the buoyancy engine was running and the LoRa module was actively sending a data packet (Table 1). The maximum current we measured was 0.26A which we took to be our full load current. This was less than the max allowed current for AAAs (0.294A). To give our device a safety margin of two in case of corrosion on the buoyancy engine screw or other inefficiencies and to conform with MATE competition rules, we decided to select a 500mA fuse. Because of availability, we selected a fuse rated to 250V at 500mA.

Typically, an AAA alkaline battery has an internal resistance of between 150 and 300 milliohms. Therefore, when our device is running at full load current, our batteries should be producing approximately 81mW of heat across the four batteries or 20mW each in the worst case scenario. Assuming convection to ambient air, this should produce an approximate 0.5 C temperature rise per battery which is very safe.

## Communication Overview

Our Non-ROV device uses a communication protocol called LoRa to enable two way communication with a receiver device. The float sends data in CSV formatted data packets that contain the time, depth, water temperature, and packet index number for each data point collected. The receiver is continuously listening for data packets from the float and will automatically collect and process each data packet received. Using LoRa, the receiver is also able to send basic commands to the float for diagnostic and repair purposes but these are not required for normal operation.

## Operational Overview

Our float has three indicator leds. The red indicator LED will light when data is being collected. The blue indicator will light when data is being sent to the receiver. The yellow indicator will light when data is being received from the receiver. Our float also has a waterproof switch that fully connects/disconnects battery power from the float.

Twisting the switch’s knob clockwise will close the switch while twisting the knob the other way will open the switch. When the waterproof switch on top of the float is switched on, the float will automatically wait a set period of time before beginning a profile. Once it starts a profile, the float will automatically collect depth data, rise up and down, and send packets when appropriate. This profile can also be initiated manually by sending the command ‘START’ from the receiver. Once all profiles have been completed and packets have been sent, the float will remain at the surface for easy retrieval.

# Miramar Water Jets SID

## DOC-004 Supplement: Bob the Non-Rov Device (Our Float)

**FLA in Water:** 0.26A
**Fuse Size:** 500mA 250V 5x20mm glass cartridge fuse