In the field of high altitude ballooning, the use of a zero pressure balloon has become common for its ability to stay at altitude longer than traditional latex weather balloons. This opens the doors for a new variety of high altitude experiments; however, these balloons can often present challenges when it comes to flight control and termination. For environmental and safety reasons, it is ideal to bring the balloon and payload system down together. The purpose of this project is to create a reliable form of termination for zero pressure balloons with the long term goal of being able to accurately control the balloon descent rate. While many companies already use a similar system, this valve grants amateur ballooning groups a more accessible way of flying zero pressure balloons.

### DESIGN CONSTRAINTS

- Valve will experience temperatures as low as -50C and must remain operable at -30C
- Leak rate must be as small as possible
- Iridium system will need to communicate between two termination systems at a distance of about 50 feet.

### METHODS

Testing for this system encompassed communications between XBEEs as well as functional ability at low temperatures.

In order to interface the valve into the apex a special zero pressure balloon was crafted by Raven Industries that includes a ring in the apex. Besides electronics and elastomer seal, all valve parts were 3D printed using ABS and PLA plastics. The circular base as seen in Figure 1 was individually sealed into the apex while being cautious of damaging the balloon envelope. An ATV sealant was used for its ability to withstand cold temperatures.

![Figure 1: Sealing valve base into the balloon apex](image)

### DISCUSSION AND RESULTS

The placement of a SPOT tracking system into the balloon fill arm allowed our team to recover the valve and zero pressure balloon. Upon retrieval of the valve, it was discovered that it had only opened partially. It was concluded that the valve didn’t open until after sending the cycle command, which is designed to open and close the valve repeatedly. From the command timeline during flight, it was determined that the cause for the valve not opening fully is that something was restricting its movement. The most likely reason for this would be that the cold temperatures created too much friction in the threaded rod. However, it is also possible that the different materials and corresponding coefficients of thermal expansion interfacing in the lid resulted in the inability to open the valve.

Comparing Figure 4 to past zero pressure balloon flight data showed that trends for ascent rate and maximum altitude were similar. Therefore despite the issues seen in the valve system there was no apparent leak rate that could be seen during ascent.

![Figure 2: Communications between command payload and termination systems](image)

![Figure 3: Exploded view of basic valve system.](image)

![Figure 4: Altitude changes during eclipse flight including totality period and sent commands.](image)

![Figure 5: Completed valve recovered from eclipse flight](image)