Near Space Mission of a High Altitude Balloon

RFP-SP-2019-1

1/18/2019

Proposal Due No Later Than	
Date:	March 1, 2019
Time:	5:00 PM CST
Electronic Submission	
Award Notifications:	March 4, 2019

Contents

1 Introduction

The Mechanical and Aerospace Engineering Department and the Missouri S&T Satellite Research Team at the Missouri University of Science and Technology are accepting proposals for a Near Space Mission on a High Altitude Balloon. The launch will target weeks 14-15 of the spring semester 2019. This request (RFP-SP-2019-1) will allow teams to submit proposals for one of the following experimental sensors:

- IMU
- Humidity Sensor
- UV Light Sensor
- Luminosity Sensor
- Methane Gas Sensor

In addition, each team will be provided with (and expected to fly) one Arduino Uno and custom shield that includes one internal and one external temperature sensor, one pressure sensor, one SD card holder and micro SD card, one heater kit, and payload activation switches. Additionally, teams will be provided sheets of black 3/16 inch foam core, flight batteries, aluminum tape, hot glue, Velcro, insulation, and other miscellaneous items that are available or required to complete the payload. This hardware is valued at over $450 and shall be returned at the end of the course. The organizations listed above expect to award 3 missions for each experimental sensor under this solicitation. Hardware and supplies remain the property of the Missouri University of Science and Technology and shall be returned at the end of the course.

2 Deliverable Dates

Deliverable	**Date Due**
Proposal Announcement	1/28/2019
Mission Proposal Due Date	3/4/2019
Award Announcements	3/4/2019
Power Budget	3/18/2019
Payload CAD Model	3/18/2019
Mass Budget	3/18/2019
Command Execution Test	3/25/2019
Functional Payload/Test Records Delivered	4/27/2019
Final Report	5/15/2019
Final Presentation	5/15/2019

3 Eligibility Requirements

Proposals shall only be accepted from the teams associated with the Introduction to Spacecraft Design course (AE 2790). Only one proposal per team.

4 Proposal Formatting

Proposals must be typed, 12 point, single-spaced, Times New Roman font, with one-inch margins, the page number in the footer, and the project name in the header. Proposals must be no less than 5 pages and not exceed 8 pages, including a cover sheet. Proposals must include drawings of your concept (include dimensions), an organization chart with those responsible for each task, and a functional block diagram. It should also include a clear mission statement detailing what you expect to discover and how you will process the data collected.

Proposals must be submitted in Portable Document Format (.pdf) and shall not exceed 20 MB. Please submit proposals on Canvas by 5:00 PM on February 25, 2019. All images, tables, and figures must be included in the single, electronic file. Proposals turned in after the deadline will be penalized. While this is not expected to be the final iteration of your design, your mission, at its core, should not change. Cover the *WHY* and *HOW* of your mission in great detail. Special attention should also be made to formatting details, and proposals should be written in third person with concise grammar and technical writing style.

5 Proposal Instructions

The following section (Section 5) outlines the exact format that you should follow when creating your proposal. Be sure to cover every item of each subsection in your proposal. The order of the sections shall be followed but the order of items within each section can be arranged in the manner your team feels best supports your effort.

5.1 Overview and Mission Statement

Concisely state your mission concept (mission statement) and which one of the five experimental sensors your team would like to use.

- Explain why your mission is important and why the findings are relevant
- Outline what you plan to discover
- Briefly outline your mission Concept of Operations (CONOPS) and generate a basic CONOPS figure
- Create a mission requirements verification matrix, including general requirements listed in Section 6.
- This section should be a minimum of one page of your proposal
- You must reference *at least one* external source (i.e. do research on the WHAT and WHY of your mission and cite those research references).

5.2 Management Overview

- Include an organizational chart of who is on your team and their role
- Include contact information for each team member
- Designate a point of contact on your team that will manage team correspondences with the course instructors

5.3 Technical Overview

- Outline specifically your science goals, including the type of data you will collect
- Detail the specifications of the sensor your team would like to use and how these specifications meet your science objectives
- Estimate the frequency at which you will need to gather data to achieve the aforementioned science goals
- Discuss what data products will be saved to the on-board memory (SD cards)
- Designate what data processing will be carried out on the OBC and what data processing will be carried out exclusively on the ground
- Discuss any safety concerns, and outline the appropriate risk management strategies
- Include a functional block diagram showing how the all systems of your design are connected

- Include a plan on how your team intends to track, meet, and verify all the requirements (listed in Section 7) of this RFP. All of these requirements shall be discussed in your proposal and met in your final design

5.4 Conclusion

Write a brief conclusion summarizing your mission and why it should be flown.

6 General BalloonSat Mission Requirements

The following sections outline general requirements that your payload shall meet. These will helpful in completing your requirements verification matrix and give you more detail about the project itself.

1. Design shall have one additional experiment(s) that collects science data and teams must analyze these data
2. Design shall have one additional sensor that collects engineering data about the flight.
3. After the flight, the BalloonSat payload shall be returned to the instructors in working condition and ready to fly again (completely reusable)
4. Flight string interface tube shall be a non-metal tube (provided) through the center of the BalloonSat and shall be secured to the box so it will not pull through the BalloonSat or interfere with the flight string.
5. Design shall allow for a Arduino UNO (provided)
6. Design shall allow for an external temperature sensor (provided)
7. Design shall allow for an active heater system (provided)
8. BalloonSat shall be made of foam core
9. All BalloonSats shall have contact information written on the outside along with a US Flag
10. Proposal, design, and other documentation shall be written using SI units
11. All BalloonSats shall have visual indicators on the outside of the flight structure to confirm at launch that the payload is active.
12. All BalloonSats must be ready and delivered in flight configuration to flight inspection crew on or before April 27, 2018.
13. Have fun, be creative and no complaining about the amount of work.

7 Payload Design Requirements

7.1 Payload Physical Envelope, Mass, and Center of Gravity Requirements

The following points outline the basic physical requirements of the payload structure.

- The BalloonSat payload must fit within a physical envelope of 18x18x8 cm. Absolutely no part of the payload may separate from the payload unless it remains tethered to the flight string.
- The mass of the Experiment payload shall not exceed 750 grams.
- The center of gravity (CG) for the payload shall be as close to the balloon flight string tube as possible. It is recommended that all balloon flight string tubes be through the center of the payload. Adherence to this requirement will ensure a stable flight for all the other payloads attached to the flight string. As such a strict requirement for CG is to lie inside the 3 cm radial line from the string and not be above half the height of the box.

7.2 Electrical Design Requirements

Experiment plans must address standard electrical/power system safety hazards including:

- Electrical shorting, which may lead to fire or ignition sources
- Routing of wiring such that failures in one circuit will not affect safety features in physically adjacent circuits
- Battery hazards, such as shorting, temperature, and pressure related failures
- Inadvertent activation of hazardous subsystems

7.3 Payload Interfaces

7.3.1 Mechanical Interface

The experiment payload will be mounted to the balloon via a flight string with a knot on each end of payload. The flight string consists of a 3/16" diameter braided Dacron cord. The default spacing between the payloads will be 1 meter (3 ft). Each team must have the recommended attaching interface on their BalloonSat for attaching it to the flight string.

- Straight-through non-metallic tube with an inner diameter of 6.4 mm (1/4 inch) maximum
- Nylon Washers (attached to structure)
- Cotter pin (paper clip) pushed through tube so that it rests on top of the metal washers. Cotter pins should hug the inside wall of the tube to allow the flight string to pass through

7.3.2 Electrical Interface

- The Experiment payload shall be electrically self-contained
- No power is supplied from the balloon
- No power is available at the launch site
- It is recommended that all electrical switches be on the outside of the payload for easy activation moments before launch
- No radio devices are used on the flight without prior approval and wavier of the course instructors

8 Acceleration Loading

The Experiment payload will experience minimal loads during launch. Upon burst of the balloon, the payload can experience severe loading. Some crude measurements have been made in previous flights that showed loads exceeding 15 g's. Barring a parachute failure, landing loads should not exceed 5 g's. Pre-launch testing of the Experiments (discussed in Section 9) should validate the typical loads that the payloads will experience. (An interesting experiment might be a high-fidelity characterization of the 3D shock and vibration environment.)

9 Thermal Loading

Each team is required to build and implement adequate thermal heating for the payload. Heaters (provided) are highly recommended for all balloon payloads. Environmental conditions during the flight can be extreme reaching -80 deg C.

10 Payload Test Requirements

Testing of the Experiment payloads should be performed by each team to ensure payload survivability and mission success. All tests shall be documented and/or recorded and provided to flight inspection crew for payload acceptance.

10.1 Structural Testing

The Experiment box or superstructure should undergo sufficient testing to demonstrate containment and survivability of payload contents. It is the team's responsibility to ensure safety to other Experiments.

10.1.1 The Whip Test (required)

A crude "whip test" simulates the post burst environment in which maximum g's are experienced. Attach the structure to a similar flight string cord, knots on each end. Spin the payload above the tester's head, spinning the payload as fast as possible. At some point, try to impart a directional change to the payload, the more abrupt the better.

10.1.2 The Drop Test (required)

Another crude test for the landing environments the payload will experience can be simulated in the Drop Test. Drop the structure from a height of 10 to 15 feet onto a hard surface. This will represent a worst case parachute landing.

10.1.3 The Stair Pitch Test (required)

Pitch the structure down a full flight of concrete steps. This test will crudely simulate the worst case effects of the payload being dragged across a field after landing, due to high winds re-inflating the parachute.

10.2 Day in the Life Test

The Experiment payload should be operated on the bench as an integrated payload for the entire mission time, typically 90 minutes during ascent and 45 to 60 minutes during descent. This test should be performed before the cooler test.

10.3 Environmental Testing

The environmental conditions the payload will experience during the flight will be extreme. The following tests simulate some of the worst case environmental conditions the payload will experience.

10.3.1 Cooler Test

This may be the single most important test of the Experiment payload. Prepare a fully functional payload in the flight configuration. Place 7 to 10 pounds of dry ice into a medium to large cooler. Distribute dry ice uniformly in the cooler. Place a non-conductive material (Styrofoam, wood, etc.) in the center. Activate payload and place onto non-conductive material. Shut lid of cooler. Operate the payload for at least 30 minutes. Run the payload in the same configuration as launch (i.e. if a heater is intended for launch than have heater in the payload).