MN Space Grant Consortium (MnSGC)

2022-2023 Stratospheric Eclipse Ballooning

Intercollegiate Challenge

Preliminary Design Review

Team Name

[Insert a Meaningful Photo, Diagram, or Figure (like a logo)]

Written by: (*full names of all students*)

Advisor:

Institution:

Report Date: December 21, 2022

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1. **Introduction to Challenge**

Introduce the overall challenge, with a general description of what you are trying to accomplish and why. Talk about eclipses (both astronomically and what people study about/during eclipses (usually from the ground), but we are perhaps more interested in what happens in the atmosphere, or at least what can be seen from a vantage point 50,000 to 70,000 ft off the ground), stratospheric ballooning (how it works, what are some of the limits (especially weight limits) and challenges (like extreme temperature and pressure conditions), **and** eclipse ballooning (there is a literature on this – find and read some of it).

Describe a bunch of things that could be studied (and perhaps list some things that are impractical to study) using a stratospheric ballooning payload, then declare the things your team is most-interested in studying. (Details about how you plan do this will come later in this document.) Note: It is better to have a too-long list than a too-short list at this point: you can “down-select” based on weight, cost, priority, and/or progress later.

1. **Team Members**

Introduce all team members individually. Include a photo of each person, or else a team photo (with all individuals identified). Team roles will be described in an organizational chart later, but a brief description about who will be working on what parts of the project might be helpful here as well.

1. **Technical Skills**

Discuss the technical skills your team needs, and how learning them is going (if team members don’t already have these skills). You will definitely need to learn about “payload-box-building” (see the video posted at <https://www.mnspacegrant.org/ballooning-skills-training/>). Depending on what you elect to study, you will probably also need to learn about cameras, microcontroller programming, wiring sensors, logging sensor data, soldering (if you decide to go beyond just using solderless breadboards), testing hardware (mechanically (for sure) and in extreme conditions (if possible)), data analysis, and more.

1. **Preliminary Design of the Payload**

This section is the core of your report – what are you proposing to build, what will it do, what will it look like, how much will it weigh, how will it operate (probably it will record data autonomously once you turn it on, but if you plan to try to maintain a radio telemetry connection to a ground station, talk about that too), etc. Discuss how you selected components (or will select component) to make measurements of the things you plan to study (listed earlier). Discuss how you expect to do microcontroller programming (if required) and ground testing (definitely required).

If you don’t have all your payload components selected yet – likely – include at least representative components in the design such as “look-out video camera mounted on this wall – GoPro HERO Session camera (or something comparable) with external battery pack” and/or “UV and visible light sensors mounted at an angle in the lid – Sparkfun QWIIC VEML 6075 and VEML 7700 sensors (or something comparable)” and/or “microcontroller with micro-SD card slot mounted on the floor – Teensy 4.1 (or something comparable) with external battery pack” and/or “Neulog sensor chain mounted on this wall, with USB extender cable to go around the corner – list all modules explicitly, remembering that one battery can support a chain of up to 5 sensor modules.”

Here are graphics, some required, to consider, as well as some layout/design hints. Be sure that every photo, figure, and/or diagram has a unique number and a caption. Labels are usually a good idea as well.

* (required) Multiple 3D CAD views of the payload design. (If you don’t already know CAD, watch the OnShape video about stratospheric ballooning payload box modeling posted here <https://www.mnspacegrant.org/general-skills-training/>.) Hint: All contents will need to be attached with something “more serious” than Velcro or tape – something like zip-ties. You don’t need to include those in your CAD model, but keep them in mind as you design the layout. Also keep track of what needs to be touched (to turn it on) after installation – compact is good, but too-compact (so you cannot easily reach what you need) is a common design error.
* (required) Dimensioned CAD diagrams of the payload box, with contents, including details about all penetrations to walls (like holes for cameras and/or sensors to look through). Hint – Condensation sometimes accumulates if you try to cover holes with transparent “windows,” so we advise against that. On the other hand, you don’t want lots of (cold) air to penetrate into the payload shell, so keep your holes as small/tight as is practical.
* Wiring diagrams (required, if using a microcontroller-logged sensor-suite).
* Figures/photos of all parts. If you use any photos from the internet, include a direct link to the source.
* Aside: Be sure to include an estimated total weight (or mass) so it is clear whether you plan to be in the “light” versus the “heavy” payload category for this challenge. If you don’t have final components selected yet, still estimate a total weight. We will check back with teams in early February to confirm total weights, so be sure you have all your components nailed down at least by then.

1. **Expected Results**

Describe, in as much detail as possible, what you expect your payload will measure on both a non-eclipse day, like April 8, 2023, and on an eclipse day (they should be different!), like April 8, 2024. This will entail looking into the literature of stratospheric ballooning and eclipse ballooning (see links in the References section below, at least). If you include data/plots from literature sources, be sure to include direct links to where the information is from.

You probably will expect variations with altitude (on both days) and variations with degree of solar coverage (just on the eclipse day). Look up how long the eclipse lasts – the time it takes for the Sun to be covered, the duration of “totality” (for in Indianapolis area, on April 8, 2024), and the time it takes for the Sun to be uncovered. Note: A stratospheric balloon typically is set to ascend at about 1000 ft/min, so an ascent to 60,000 ft will take about 1 hour. For this project, balloons will not “float” but just ascend to burst (unless you try to design a mechanism to allow for a float – hard!), after which payloads will come down by parachute, which takes about 30 minutes. It is hard to collect good data during the turbulence of a parachute descent, so plan on taking most/all data on ascent. You might make recommendations like “Launch the balloon 45 minutes before totality begins (which might be after solar coverage actually begins – look into that) to try to ensure that the balloon is relatively high, but not yet burst, at least through the duration of totality.”

1. **Org Charts**

Create one or more organizational charts (AKA “Org chart” – look up examples on the internet to see what this might look like – this is a graphic, not just a list) describing roles and stating who is fulfilling which role(s). Team members may well play multiple roles simultaneously and might have different roles at different times like “hardware/software development/testing roles” then “roles on the flight date” then (post-flight) “data analysis” roles.

1. **Budget and Parts List**

List all items that will fly, include vendor, purchasing direct link, cost, weight (or mass) (that might be the most important detail), size, and any other details that may be relevant (like availability). Make a separate list of non-flight items you need to support the project, with purchasing information for any items you don’t already have. Possibilities for the latter list include soldering tools, microcontrollers and sensors to practice with, etc. Explain how you will acquire the items that need to be purchased: where is the funding coming from, who is doing the purchasing, etc.

1. **Schedule**

This will include accomplishments to date (such as fall term team meetings, videocons with the TA, and generating this PDR), as well as plans for the future. Detail how the past term went (what you got done, how long it took (compared to expectations), etc.). Lay out an explicit timeline for the upcoming term – what you are hoping to accomplish, in what order, by when, and by whom. Look up “Gantt Chart” to see one way such a schedule might be organized. Note: In addition to listing the tasks and the deadlines, be sure to list the team member(s) responsible for each step on the schedule. Declare Milestones by which you will make key decisions and move on, so you don’t keep looking back. Post your schedule and stick to it! Spread the load!

1. **References**

Cite web links and/or other reference materials you have used. This might include links to instructional videos or other posted (or local) teaching materials, datasheets for sensors and other electronics, etc. Be sure to include literature citations about eclipses, stratospheric ballooning, actual eclipse ballooning, etc. Hint: Look up the role eclipses played in confirming the theory of general relativity (1919) and in discovering cosmic radiation (Nobel prize, 1936). Peruse conference proceedings for Academic High-Altitude (Ballooning) Conferences (<https://www.iastatedigitalpress.com/ahac/collections/>) and also the Journal of High-Altitude Ballooning (<https://www.iastatedigitalpress.com/jhab/>).

1. **Appendices**

This section is for other supporting documents. For example, include a printout of all microcontroller code used/developed so far, with explanatory comments. If you have done calculations about when/where to launch from, based on “reasonable” weather predictions – we cannot do actual predictions until a few days before the actual flight date, of course – include them as well.