University of Minnesota and MN Space Grant Consortium

AEM 1905 Freshman Seminar: Fall 2016

High-Power Rocketry

Team Project Documentation

of Scratch-Built Rocket

*Insert Team Name Here*

*Insert team photo or meaningful graphic here*

Written by:

*List All Team Member Names (First and Last Name!) Here*

Report Date:

Revision 0 or A or B or C (circle or underline one)Revision Log

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| --- | --- | --- |
| **Revision** | **Contents** | **Due Date** |
| 0 | Declaration of Team Roles  (3 points) | Tuesday, Oct. 11, in class |
| A | Conceptual / Preliminary Design Report (15 points) | Wednesday, Oct. 26, 5 p.m. |
| B | Construction Progress / Pre-Flight Report (20 points) | Wednesday, Nov. 16, 5 p.m. |
| C | Post-Flight / Final Report  (30 points) | Friday, Dec. 2, 5 p.m. |

This template describes the topics which should be discussed during the evolution of your documentation. The following sections have a Rev (Revision) letter following the section description. This indicates when this section is expected to first become a part of the document**. If a section is required in Rev A, then that section should be written for Rev A then updated as necessary in subsequent revisions based on instructor feedback and on evolution/refinement of the design.**

Each report is due in editable electronic form (e.g. Microsoft Word, **not pdf**) at the times listed in the table above. Please follow this template format exactly.

Write your text sections just like this page – single spaced, 1 inch margins, 12 point Times New Roman font (or something very similar), leaving single blank lines between paragraphs. Maintain the numbering scheme for the sections. Update the page numbers on the Table of Contents as your document grows in length.

**Table of Contents** *(update these page numbers as the document evolves)*

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**0.0 Team Project Documentation Roles/Writing Assignments** (Rev. 0)

Note: Leave these pages in place for all subsequent submissions.

Team Name

Overall Team Lead

Other team members

Assign a **lead author** to each section, making sure that every team member is lead author on at least one section. Notice that the sections vary considerably in length and complexity, so be thoughtful in how you distribute lead authorship here. (Rev 0)

Introduction

Rocket Design Overview

Rocket Design Specifics

Project Management

Project Budgets

Construction Photographs

Failure Modes and Risk Mitigation

Expected Flight Results

Launch Day

Results and Analysis

Conclusions and Lessons Learned

Appendix – Supporting Calculations

**Oral Presentation Assignments**

Assign two team members to **coordinate making slides** for your each of your two oral presentations (four people total – no duplicates). Of course, all group members need to pitch in when working on generating slides for oral presentations. (Rev 0)

Flight Readiness Review

Post-Flight Analysis Review

**Design/Build/Fly Roles**

The job of the overall “team lead” (AKA “team contact”) is to keep tabs on the whole project and keep the instructors informed of progress as requested, to organize team meetings, and to make sure everything gets done in a timely manner. **Distribute leadership** of the other aspects of the project among the other team members. Remember – one or two people might be the “Av-bay guru(s)” but don’t need to be the only one(s) who work on that part of the rocket. (Rev 0)

Overall team lead (AKA “team contact”)

OpenRocket (simulation) gurus (2 people)

CAD 3D printing and laser cutting gurus (2)

Budget and parts ordering lead

Construction lead

Construction main photographer

Wiring av-bay, programming altimeter gurus (2)

GPS tracking installation and use guru

Launch day rocket prep lead

Launch day main photographer

Post-launch data analysis lead

# 1.0 Introduction

Write a pithy introduction (0.5 to 1 single-spaced page of text) about high-power rocketry in general and about the goal(s) your rocket will try to accomplish. This is prose, not a list nor a table nor a discussion of your proposed design. Those will show up in later sections. (Rev A)

# 2.0 Rocket Design Overview

Write a pithy introduction (0.5 to 1 page of single-spaced text) to your actual design, describing (in prose) how it will work and how it will accomplish the goal(s). Accompany this prose with at least one drawing (hand-drawn or OpenRocket 3D oblique view) of the design. (Rev A)

# 3.0 Rocket Design Specifics

This section is mostly tables and figures (with titles and/or captions) – not much free prose.

* List your design requirements/limitations. (Rev A)
* Include at least three high-level trade study tables. In engineering circles a “Trade Study” is a table about a specific issue listing the options considered, the pros and cons of each option, and the decision made (and the reason(s) for that decision). A high-level trade study might be “Which real rocket to downscale” or “Mechanism to slow the rocket down to hit the altitude target”. A mid-level trade study might be “Material used for the airframe” or “Shape and number of fins”. A low-level trade study might be “Paint scheme”. Note: When doing engineering design there are often many solutions to a given problem, but some solutions are definitely better than others. Trade studies are a way of documenting what options have been considered, even if they are not ultimately selected, and to defend decisions made. Your documentation here will probably only scratch the surface of the options you actually considered and the decisions you actually made. (Rev A)
* OpenRocket side view of the design with labels (re-do this drawing as the design evolves for later revisions) (Rev A)
* Construction Materials Needed and Rocket Parts List (Rev A)
* CAD drawings of the parts of the design that you will be 3D printing and/or laser cutting (av-bay and gps mount at least) using SolidWorks or Autodesk Inventor or a comparable 3-D CAD software (Rev B)

# 4.0 Project Management

Here you need to provide a graphical “org” chart showing how the team will be organized and who is primarily responsible for what aspects of the project: design, document, simulate, order parts, build, test, fly, analyze, work on slides for oral presentations, etc. It is not sufficient to say “everyone will participate” in every part, though that might be appropriate for certain items. Also, provide a project schedule with specific dates to finish specific tasks (see the syllabus for the dates by which you need to be ready to fly, for example). The more detail your team agrees upon and provides here, the more likely it is that your project will go well (as long as you stick to your org chart and your schedule).

* Org Chart (shows the tasks to be done and also who is in charge of getting them done) (Rev A)
* Planned Schedule (shows the tasks and the order in which they will be done, as well as the dates by which they will be done) (Rev A)
* Actual schedule (Rev B (optional update) and Rev C (required update – nothing ever happens exactly the way you plan it))

# 5.0 Project Budgets

Provide budgets listing both your mass and your expenses. Try to keep your new hardware budget under $200, including construction materials (like epoxy, paint, etc.) and all rocket parts. List altimeters, motors, motor casings, and radio beepers too, with their prices, but these do not need to be covered by your $200 budget since we already have them. Explicitly identify any parts that are not off-the-shelf and how you will procure or fabricate them.

Note 1: Dr. Flaten will talk through your money budget with you and issue “Authority to Proceed” before you are allowed to actually start purchasing anything. Place orders through him or through a designated TA. Don’t go out and buy things on your own without explicit permission from Dr. Flaten. If you are given permission to purchase things, keep your receipts.

Note 2: The original mass budget will be an estimate – once you’ve actually completed construction record the actual masses of your (composite) components.

* Money Budget (add Prices and Vendor Sources to Parts List from section 3.0) (Rev A)
* Mass Budget (or Weight Budget) (leave a 15% contingency if mass is limited) (Rev A)
* Actual Masses (or Actual Weights) (might be of composite pieces) (Rev B)

# 6.0 Construction Photographs

Include photographs, with captions, of the actual scratch-build. (~2 pages of photos, with captions on every photograph). Comment on unique aspects of the construction. (Rev B)

# 7.0 Failure Modes and Risk Mitigation

Discuss (in prose or in a table or both – about 1 page) risks and challenges associated with your design, potential failure modes, consequences of various types of failures, and what you did to mitigate (avoid/limit) the risks. Possibilities include “drag separation of airframe” (look that up if you don’t know what that means – this risk applies to every rocket), “failure of our ejection charges to separate rocket body” (this applies to every rocket), etc. (Rev B)

# 8.0 Expected Flight Results

Describe qualitatively and quantitatively your expected flight results, simulated with OpenRocket. This will probably be at least 1 page of text, plus tables/figures. You will want to explicitly compare your real flight results to these expected results in your analysis section (next), so be sure to simulate all the types of data you will get back from the actual flight. (Rev B)

# 9.0 Ejection Testing and Launch Day

Provide an account of Ejection Testing and Round 2 Launch Day (about 1 – 2 pages of prose, plus perhaps ~2 pages of photographs, with captions). (Rev C)

# 10.0 Results and Analysis

Analyze your flight data and compare it explicitly to your expected results from section 8.0. Provide plots when appropriate. Explore/explain discrepancies as best you can, or describe how discrepancies could be studied with additional ground tests or flights (possibly with additional instrumentation on the rocket). Include still frames from your on-board camera plus a link to your flight video (posted online). If your rocket suffered any failures, minor or major, describe them in detail, explain why they happened (as best you can), and discuss how they could have been avoided. (Rev C)

# 11.0 Conclusions and Lessons Learned

Summarize what your team learned from these rocket builds (Round 1 and Round 2) and what you would have done differently if you had a chance to do it again (about 0.5 to 1 page of text). Write some “Words of Wisdom” (2 or 3 sentences or a few bullet points) as advice to a future high-power rocketry class about what worked well and what could have worked better. (Rev C)

# 12.0 Appendix A – Supporting Calculations

Include results of (and details, if not done with OpenRocket) all supporting calculations you did. These should include thing like location of CG and CP, static margin, thrust-to-weight ratio, size of ejection charge(s) (support that with a spreadsheet calculation), what (explosive) events you called for (and when), delay grain timing (for your motor eject backup), descent rate (under one or two parachutes, depending on your design), etc. If you flew a microcontroller (unlikely in AEM 1905, but this will happen if you do additional rocketry projects), include a complete printout of the code here as well.

# 13.0 Appendix B – List of Associated Files/Links

Include a list of file names (or links, for any items that are posted) for supporting documents. Here is a preliminary list – note the mention of one file that should have been included but was not (and the reason it was not). Submit all listed files electronically along with Rev. C.

OpenRocket final model: xxxx.ork

CAD file(s) of av-bay: xxx.SLDPRT (or from another CAD program)

Other CAD file(s) (if any): xxx.SLDPRT (or from another CAD program)

Round 2 launch video (trimmed): posted at xxxxxx (clickable link)

Round 2 pad video (trimmed): xxx.mov

Round 2 in-flight video (trimmed): xxx.mp4

Raven-3 altimeter file: “Missing – failed to save when better dislodged on hard landing”

Etc.